# Lower San Joaquin River Flood Control Project System Assessment

Upper San Joaquin River

## Regional Flood Management Planning

April 2026

LOWER SAN JOAQUIN LEVEE DISTRICT

# Executive Summary

## Introduction

The Lower San Joaquin Levee District (LSJLD; District) is preparing this system assessment of the Lower San Joaquin River Flood Control Project (Project) as part of the Upper San Joaquin River (USJR) Regional Flood Management Plan (RFMP). The goals of this assessment are to provide the District, California Department of Water Resources (DWR), Central Valley Flood Protection Board (CVFPB), and other State of California (State) and federal agencies with an overview of existing flood infrastructure, flood management issues, and system deficiencies; to offer proposed improvements to restore the Project to its original published design capacity; and to improve the resilience of the Project to prepare for future more extreme hydrologic conditions.

This reconnaissance-level assessment incorporates available information from State and federal agencies but focuses on incorporation of local knowledge and experience. It identifies and prioritizes potential capital improvements, actions, and recommended studies. Although the District maintains the flood system through their operations and maintenance (O&M) charter (LSJRFCP 1978), the State owns the Project. Maintenance is within the scope of the District's budget and O&M manual (LSJRFCP 1978), but capital projects are outside of the scope of the District's agreement with the CVFPB and are the responsibility of the State.

## Approach

The assessment of the Project accomplishes the following:

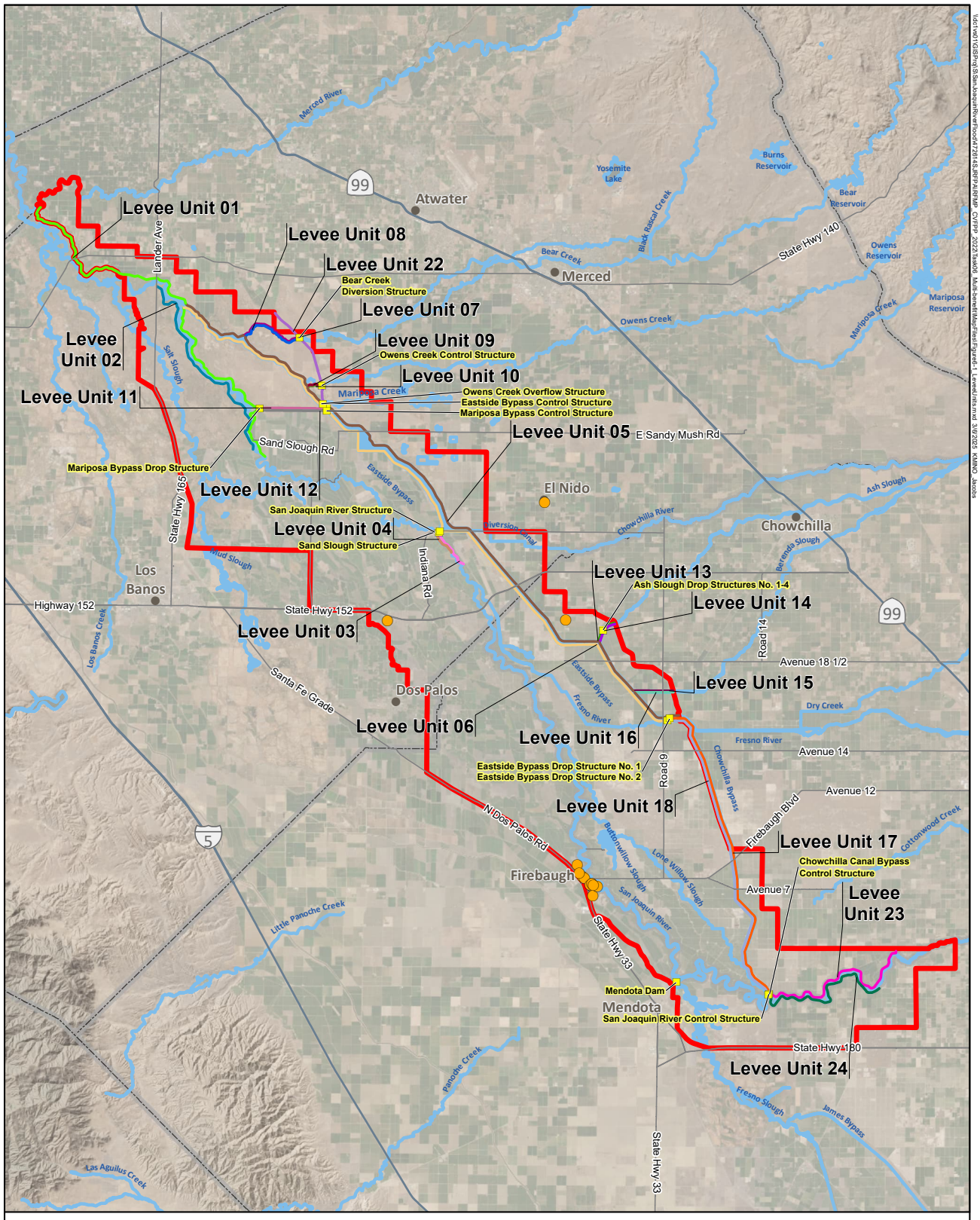
- Documents existing flood risk conditions along the San Joaquin River and flood bypasses from reports and inspections by various agencies such as DWR, U.S. Bureau of Reclamation (Reclamation or USBR), the USJR RFMP, and the District.
- Identifies flooding problems and issues, such as subsidence, seepage, and aging infrastructure, organized by levee unit (LU).
- Identifies and prioritizes potential capital improvements, actions, and studies needed to restore the published design capacity and enhance resilience to future extreme hydrologic conditions.
- Identifies potential State and federal funding sources.
- Coordinates this assessment with other planning efforts in the region.

This report uses the best available existing information and does not include new system modeling or study material.

## Flood Management Issues and System Deficiencies

Figure ES-1 shows the overall Project with LU notation, District facilities, and essential facilities (such as schools and hospitals). Major concerns and proposed system improvements, to address the concerns, were developed for each LU. Major concerns for the Project include the following:

- Channel Capacity Issues – Current channel capacity estimates were obtained from the following:
  - *2022 Flood System Status Report Update* (FSSR; DWR 2022b)
  - Hydrologic Engineering Center – River Analysis System (HEC-RAS) modeling results from 2024 Central Valley Floodplain Evaluation and Delineation data provided by DWR (2024), or District-provided information on high flows during winter 2023 (District 2023a, 2023b)
- Levee Deficiencies – Deficiencies include historical levee breaches, historical levee overtopping, subsidence, sedimentation, significant levee vegetation, seepage, sand boils, erosion, sinkholes, geometry, freeboard, structural and slope stability, and Non-Urban Levee Evaluation (NULE) overall hazard classification (DWR 2022b).




**LEGEND**

- City
- Levee Unit 01
- Levee Unit 02
- Levee Unit 03
- Levee Unit 04
- Levee Unit 05
- Levee Unit 06
- Levee Unit 07
- Levee Unit 08
- Levee Unit 09
- Levee Unit 10
- Levee Unit 11
- Levee Unit 12
- Levee Unit 13
- Levee Unit 14
- Levee Unit 15
- Levee Unit 16
- Levee Unit 17
- Levee Unit 18
- Levee Unit 22
- Levee Unit 23
- Levee Unit 24
- Essential Facilities
- LSJLD facilities
- Lower San Joaquin Levee District
- County
- Highway, Interstate

0 4.75 9.5
Miles

N

**FIGURE ES-1**
**All Levee Units**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*

## System Improvements and Prioritization

System improvements were developed based on flood management issues and deficiencies documented in the FSSR (DWR 2022b), NULE, draft Non-Urban Levee Seepage Evaluation (NULSE; DWR forthcoming), USJR RFMP (SJRFCPA 2015), and field observations from the 2023 and 2024 flood seasons. These system improvements are for assessment purposes only and are reconnaissance-level concepts developed during the desktop study system evaluation. The list includes system improvements developed during the 2015 USJR RFMP, the 2022 Central Valley Flood Protection Plan Update efforts (DWR 2022a), the *Firebaugh Multi-Benefit Flood Management Project Flood Risk Reduction Feasibility Study* (Gouveia 2022), and during this assessment. Similar to the 2015 USJR RFMP (SJRFCPA 2015), the system improvements are prioritized into three tiers, with Tier 1 considered the highest priority. The following criteria were used to categorize system improvements into the appropriate tier:

- Tier 1
  - Channel Sediment Excavation. Levee reaches with greater or equal to 50% estimated reduced flow from the published design flow.
  - Slurry Wall Installation. Levee reaches identified by draft NULSE (DWR forthcoming) or the *Fall 2022 Levee Maintenance Deficiency Summary Report* (Fall 2022 DWR Inspection Report; DWR 2022c) where serious or critical sites are identified.
  - Other system improvements based on correspondence with the District.
  - Tier 1 system improvements respond to significant public safety threats.
- Tier 2
  - Channel Sediment Excavation. Levee reaches with less than 50% to 20% estimated reduced flow from the published design flow.
  - Other system improvements based on correspondence with the District.
  - Tier 2 system improvements respond to additional public safety threats after Tier 1.
- Tier 3
  - Channel Sediment Excavation. Levee reaches with less than 20% estimated reduced flow from the published design flow.
  - Other system improvements based on correspondence with the District.
  - Tier 3 system improvements respond to minor threats to public safety while providing additional improvements.

The list of Tier 1 prioritized system improvements, with estimated costs, is presented in Table ES-1. These system improvements are needed to address major concerns and restore the system to its original published design capacity. As funding becomes available, Tier 1 system improvements should be implemented first. The approximate total cost for the projects is $1.31 billion, with $529 million assigned to Tier 1 projects. The cost estimates are approximate given the conceptual

definitions of the proposed system improvements. Several recommended studies would lead to the identification of additional system improvements and refined cost estimates.

**Table ES-1. Tier 1 System Improvements and Cost Estimates**

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Channel Sediment Excavation at LU 5/6 LMs 0 to 3.7 | Excavate sedimentation areas to reduce the estimated constricted flow (67% of published design flow). | To be developed | $83,800,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Evaluation of Sediment Removal | Study to be developed. Identify the most efficient locations from which to remove sediment buildup. Preliminary locations and cost estimates are given in this table based on a reduction in capacity; however, a more detailed study (such as operational justification for sediment removal and costs of trucking and disposal) should be implemented before proceeding with these projects. | To be developed | $200,000-$400,000 | High-level cost estimate for studies is based on engineering judgment. | -- |
| 1 | Comprehensive Evaluation of All Control Structures | This evaluation would include the Mariposa, Chowchilla, Eastside, and Owens Creek (including the Owens Creek Bridge) Control Structures. This evaluation would exclude Sand Slough and San Joaquin River Control Structures. The current DWR inspection reports provide ratings on control structures for the District. Three were determined to be minimally acceptable according to the Fall 2022 DWR Inspection Report (DWR 2022c) (Ash Slough Drop Structure 3, the San Joaquin River Structure, and the Sand Slough Structure); the San Joaquin River Structure has been closed for years and is nonoperational. The Sand Slough Drop Structure is being considered for removal. The evaluation would provide a comprehensive technical and engineering analysis to determine actions needed for rehabilitation or replacement. USBR is also considering control structure improvements as part of the SJRRP; however, this does not include the District system along the bypass channels. The Owens Creek Control Structure is planned to be investigated under DWR's FSRP in late 2024, along with the Sand Slough Structure and the San Joaquin River Structure. Owens Creek Control Structure is a part of the SPFC, owned by the State, and listed under District as-builts. For the last 10 years, DWR inspectors have marked it as unacceptable. A feasibility study is needed to assess the options for repair of the Owens Creek Control Structure versus replacement. | To be developed | $200,000-$400,000 | High-level cost estimate for studies is based on engineering judgment. | District-identified (2023–2024) |
| 1 | Rehabilitation of San Joaquin River Control Structure | Settlement has occurred at the San Joaquin River Control Structure, resulting in the wing walls separating from the structure. The wing wall backfill could be excavated and the voids grouted under the spread footings, or spread footings could be added or enlarged to minimize further settlement. This is a high-priority project for the District. Depending on phasing or timing, the design could be coordinated with the SJRRP 2B project to allow incorporation of fish passage or habitat restoration elements within the project footprint. However, it is also possible that improvements to the San Joaquin River Control Structure resulting from implementation of Reach 2B would occur as a separate project. | To be developed | $1,030,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Costs were escalated to 2026 dollars and increased based on engineering judgment. | 2015 USJR RFMP (SJRFCPA 2015) |
| 1 | Rehabilitation of Chowchilla Canal Bypass Control Structure | Similar to the Rehabilitation of San Joaquin River Control Structure, the overall condition of the Chowchilla Canal Bypass Control Structure requires rehabilitation, including repair of wing walls, general concrete structure, and gates. | To be developed | $1,030,000 | Same cost as Rehabilitation of San Joaquin River Control Structure project was assumed. | District-identified (2023–2024) |
| 1 | Levee Assessment — Upstream of Chowchilla Canal Bypass Control Structure | Many boils and a large amount of erosion and seepage occurred upstream of the bifurcation in the 2023 water year. Potential system improvements could include levee rehabilitation or slurry walls. This area includes approximately 4 miles on both the right and left banks. | To be developed | $150,000-$300,000 | High-level cost estimate for studies is based on engineering judgment. | -- |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Slurry Wall on LU 24 from LMs 0 to 8.34 | Install slurry wall because of the following issues. The draft NULSE PI Score is 93 (DWR forthcoming). The District identifies seepage as the most significant issue and cites 20+ years of seepage issues for the entire levee. Draft NULSE reports critical seepage issues for the entire levee length from LMs 0 to 8.3. This segment has experienced extensive under-seepage and boils at multiple locations approximately between LM 0.0 and LM 3.9. Seepage has historically been observed along the landside toe, which indicates that under-seepage issues may be of more significant concern. Previous site reconnaissance indicates seepage berms have been placed in some of the previously identified locations; however, the District reports that the levee experiences chronic boils and seepage during high-water events. The Fall 2022 DWR Inspection Report (DWR 2022c) identifies four critical and one serious seepage sites at LMs 0.8, 1.6, 1.7, 2.8, and 3.6 to 3.8. NULE states that the entire levee does not meet criteria for through-seepage or under-seepage hazard. The 2022 FSSR identifies more than five historical boil sites from LMs 0.3 to 1.2 (DWR 2022b). | To be developed | $24,300,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 6 from LMs 12 to 18 | Improve Eastside Bypass levees in areas of subsidence from El Nido Crossing to Sandy Mush Road (LMs 12 to 18). Subsidence occurs from Avenue 7 in Madera County to Washington Road in Merced County, but the capacity issues are downstream of Washington Road North to Mariposa Bypass. The levees in this area have been increased in size three times since their original design, and the concern now is the integrity of the levees rather than the height. This levee reach has an estimated reduced flow of 34% from the published design flow. | To be developed | $17,500,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | 2015 USJR RFMP (SJRFCPA 2015) |
| 1 | Eastside Bypass (LUs 5 and 6) Drop Structures | Construct four drop structures in the Eastside Bypass to aid in addressing seepage, sedimentation, and capacity issues from LMs 8.8 to 28.6, which includes Sandy Mush Road to Washington Road (LMs 12 to 20). | To be developed | $82,500,000 | Appendix E provides detailed cost estimates. As-built drawings for Ash Slough drop structures were referenced. | District-identified (2023–2024) |
| 1 | Slurry Wall on LU 23 from LMs 0 to 10.23 | Install slurry wall because of the following issues. The draft NULSE PI Score is 83 (DWR forthcoming). The District identifies seepage as the most significant issue and cited 20+ years of seepage issues for the entire levee. Draft NULSE reports critical seepage issues for the entire levee length of LMs 0 to 10.2. This segment experienced boils and seepage at multiple locations in 1997, between approximately LM 0.5 and LM 1.8. A seepage berm was constructed under the PL 84-99 program, between LM 0.6 and LM 1.5. However, the District reports that the segment still experiences chronic boils and seepage during high-water events. Through-seepage is generally not as significant of a problem as under-seepage. The Fall 2022 DWR Inspection Report cites three critical seepage sites located at LMs 0.2 to 0.6, 1.9, and 3.6 (DWR 2022c). NULE states that the entire levee does not meet criteria for through-seepage hazard. The 2022 FSSR identified fewer than five historical boil sites from LMs 0.3 to 1.2 (DWR 2022b). | To be developed | $29,900,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 6 from LMs 0 to 9.64 | Install slurry wall because of the following issues. The draft NULSE PI Score is 86 (DWR forthcoming). The 2022 FSSR identified more than five historical seepage sites along the levee (DWR 2022b). | To be developed | $28,200,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Evaluation of Ash Slough Drop Structures | The existing drop structures were built in the late 1960s. Ash Slough Drop Structure 3 was determined to be minimally acceptable according to the Fall 2022 DWR Inspection Report (DWR 2022c). The drop structure bays will also need to be evaluated. | To be developed | $200,000-$400,000 | High-level cost estimate for studies is based on engineering judgment. | 2015 USJR RFMP (SJRFCPA 2015) |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Third-Party Impacts Caused by the San Joaquin River Restoration Program Study | This study would evaluate the impacts on the District's system from the USBR SJRRP. The bypasses were designed to remain dry until they are needed to convey flood flows. SJRRP operations have introduced fishery flows into the bypasses during non-flood periods that cause excessive vegetation growth, which reduces flood flow capacity and significantly increases vegetation management costs. The District spent $30,000 on large-scale vegetation removal during approximately 2022 to 2024 in an area with excessive vegetation growth caused by high water levels throughout the year from SJRRP flow releases. The District states that some of the erosion issues may have resulted from high flows and rapid changes in water levels caused by changes in SJRRP flow releases. | To be developed | $200,000-<br>$400,000 | High-level cost estimate for studies is based on engineering judgment. | District-identified (2023–2024) |
| 1 | Slurry Wall on LU 5 from LMs 8.8 to 28.6 | Install slurry wall because of the following issues. The draft NULSE PI Score is 56 (DWR forthcoming). The District indicated that the segment experiences chronic boils and seepage during high-water events. The 2022 FSSR identified more than five historical boil sites and more than five historical seepage sites along the levee (DWR 2022b). From Mariposa Bypass to Ash Slough, the levee does not meet criteria for NULE through-seepage hazard. From the Chowchilla Canal Bypass to Mariposa Bypass, the levee does not meet criteria for NULE under-seepage hazard. This includes the levees identified from El Nido Crossing to Sandy Mush Road (LMs 12 to 18), where subsidence has caused capacity issues. The levees in this area have been increased in size three times since their original design, and the concern now is the integrity of the levees rather than the height. This levee reach has an estimated reduced flow of 34% from the published design flow. | To be developed | $58,000,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 18 from LMs 1.5 to 8.4 | Install slurry wall because of the following issues. The draft NULSE PI Score is 54 (DWR forthcoming). This segment experienced boils, piping, and seepage at LM 1.5, LM 4.9, and LM 8.4 in 1997 and 2006. | To be developed | $20,200,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 12 from LMs 0 to 3.4 | Install slurry wall because of the following issues. The draft NULSE PI Score is 53 (DWR forthcoming). The entire levee experiences seepage and boils during high-water events according to the District. Under-seepage has been identified as a greater concern than through-seepage. The Fall 2022 DWR Inspection Report identified two serious seepage sites (DWR 2022c). | To be developed | $9,930,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 2 from LMs 2.3 to 13.8 | Install slurry wall because of the following issues. The draft NULSE PI Score is 51 (DWR forthcoming). The District indicated that boils, under-seepage, and through-seepage occur during high-water events and that under-seepage is more of a concern. There were fewer than five historical seepage sites identified in the 2022 FSSR (DWR 2022b). The entire levee does not meet criteria for NULE under-seepage hazard. | To be developed | $33,600,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 6 from LMs 18 to 21.4 | Install slurry wall because of the following issues. The Fall 2022 DWR Inspection Report identified nine serious and two critical seepage sites (LMs 18 to 21.4) (DWR 2022c). | To be developed | $9,930,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Slurry Wall on LU 1 from LMs 4 to 11.4 | Install slurry wall because of the following issue. The Fall 2022 DWR Inspection Report identified serious seepage sites (DWR 2022c). | To be developed | $21,800,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 3 from LMs 1.2 to 1.6 | Install slurry wall because of the following issues. The Fall 2022 DWR Inspection Report identified three serious seepage sites from LMs 1 to 2 (DWR 2022c). The 2022 FSSR identified fewer than five historical seepage sites (DWR 2022b). | To be developed | $1,170,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 1 from LMs 14.2 to 14.5, LMs 15.7 to 17.3, LMs 19.3 to 19.8, and LMs 20.5 to 21.1 | Install slurry wall due to the following issue. The Fall 2022 DWR Inspection Report identified serious seepage sites (DWR 2022c). | To be developed | $9,070,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Firebaugh Project Area 1: Setback Levee and Riparian Restoration at the Wastewater Treatment Plant | Project includes 4,850 LF of replacement levees, 4,850 LF of recreational trails, and 115 acres of riparian/wetland habitat land purchase and implementation. | To be developed | $16,200,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia 2022) |
| 1 | Firebaugh Project Area 2: Stabilization of the Eroding Bank at a Sharp Bend in the San Joaquin River | Project includes 500 LF of sheet pile and 500 LF of recreational trails. | To be developed | $3,520,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia 2022) |
| 1 | Firebaugh Project Area 3: Setback Levee to Protect the Firebaugh Water Treatment Plant near the Rodeo Grounds | Project includes 1,000 LF of replacement levees, 1,000 LF of recreational trails, and 15 acres of riparian/wetland land purchase and habitat implementation. | To be developed | $3,000,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia 2022) |
| 1 | Firebaugh Long-Term Projects | Project includes 13,000 LF of replacement levees, 13,000 LF of recreational trails, and the Eastside Acres Improvements. | To be developed | $48,200,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia2022) |
| 1 | Channel Sediment Excavation at LU 13/14 (Entire Length) | Excavate sedimentation areas to reduce the estimated constricted flow (50% of published design flow). | To be developed | $14,100,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Levee Breaches Unit 1, LM 9.90 | Levee breaches at Unit 1, LM 9.90 and Unit 5, LM 0.25 are the result of previous flood flow actions. Levee washout occurred during a flooding event in the late 1960s. Past USACE inspection rated the LUs unacceptable for project standards (potential for PL 84-99 eligibility). The addition of structures with a series of flap gates is proposed; the structures would contain floodwater in the river channel and permit landside floodwater to drain into the river by removing the flash boards. | To be developed | $413,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 1 | Levee Breaches Unit 5, LM 0.25 | Levee breaches at Unit 1, LM 9.90 and Unit 5, LM 0.25 are the result of previous flood flow actions. Levee washout occurred during a flooding event in the late 1960s. Past USACE inspection rated the LUs unacceptable for project standards (potential for PL 84-99 eligibility). The addition of structures with a series of flap gates is proposed; the structures would contain floodwater in the river channel and permit landside floodwater to drain into the river by removing the flash boards. Rebuild and reinstall Desktop Study Identification Designations. | To be developed | $413,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 1 | Sand Slough Control Structure Removal | Remove the Sand Slough Control Structure to improve fish passage and increase flow capacity. DWR inspectors have marked this feature as unacceptable for the last 10 years. | To be developed | $446,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |

CY = cubic yard(s)
LF = linear foot (feet)
LM = levee mile(s)
PI = performance index
PL = Public Law
SJRRP = San Joaquin River Restoration Program
USACE = U.S. Army Corps of Engineers

## Funding Sources

The District was created by the California State Legislature in 1955 to operate, maintain, and repair facilities of the Project. District revenue is generated through benefit assessments on land parcels within District boundaries. These assessments support District O&M and are not intended or adequate to fund capital improvements. The District continues to face critical challenges in acquiring funding for flood system improvements to address subsidence, sedimentation, and aging infrastructure, all of which continue to significantly decrease the ability of the Project to safely convey and manage flood flows as the region is subject to more frequent extreme events and increasing flood risk. The State has started to address some of these challenges, particularly through its grant funding programs and assistance with local cost share requirements, but significantly more financial support is needed to restore the Project to original design capacities and increase system resilience to cope with future extreme hydrologic events. Continued coordination and action are needed at the local, State, and federal levels to meet increasing financial challenges to the District.

The cost of the system improvements adds up to a total estimated cost of $1.30 billion, with $519 million assigned to Tier 1 projects. These improvements provide significant benefits to public safety, environmental stewardship, system resilience, and regional economic stability. Detailed financial plans will need to be prepared for each improvement as more information becomes available and as projects are considered for specific funding opportunities.

The City of Firebaugh faces significant challenges to funding new capital expenditures for proposed system improvements. The City of Firebaugh has four system improvements (Tier 1) that amount to $68.7 million. State and federal assistance is needed to fund these improvements.

In June 2023, the USJR region released an update to the 2015 USJR RFMP finance chapter (SJRFCPA 2023), which recommended the following District actions:

- DWR and CVFPB need to respond to USACE's letter deauthorizing the Project. Submit a request to USACE to reauthorize federal recognition of the Project to make it eligible for PL 84-99 funding.
- Because the State owns the Project, the State needs to provide assurances of future emergency assistance to the Project if USACE will not reconsider federal authorization.
- Continue engagement in regional and State planning efforts to help identify remaining critical funding gaps and align local projects with statewide priorities for direct funding opportunities.
- Continue to look for opportunities to broaden and deepen collaboration across water sectors by actively engaging in integrated regional water management networks and local groundwater sustainability agency efforts.
- Advocate for lower or no local cost share or in-kind services for grant programs to assist small, rural, or disadvantaged communities.

- Advocate for continued funding for DWR's direct funding programs and new direct funding programs that address underfunded critical needs for capital improvements.
- Take advantage of California Office of Emergency Services Prepare California funding opportunities to support grant application efforts and help meet local cost share requirements.

# Conclusion and Recommendations

This section provides conclusions and presents several recommendations.

## Conclusions

Significant investment is needed to return the flood system to its original design capacity, and substantial funding sources are needed to support these investments. Although the District was able to convey excessive flood flows during the 2023 storms, without catastrophic failure, significant improvements must be implemented to improve system resiliency to manage future extreme hydrologic events. The District has critical needs to significantly improve flood infrastructure, flood system resiliency, emergency management, and environmental enhancement through acquiring funding to implement single-purpose public safety and multi-benefit projects.

## Recommendations

This reconnaissance-level system assessment serves as a foundation for considering future system improvements and studies in the District. State and federal grant program funding is needed to implement prioritized system improvements identified in Table ES-1. The District needs to pursue initial funding for feasibility studies for these flood system improvements and potential multi-benefit opportunities. Completion of feasibility studies provides critical information and refined cost estimates needed to apply for permitting, design, and construction funding. The following summarizes recommended flood system improvement projects, studies, and other future actions.

### Flood System Improvement Projects

The proposed flood system improvements address major concerns about the flood system, such as conveyance capacity, erosion, sedimentation, subsidence, and levee seepage and stability deficiencies. The following provides a summary of the Tier 1 proposed improvements identified:

- Channel sediment excavation to address sedimentation that has significantly reduced channel flow capacity
- Rehabilitation of the San Joaquin River Control Structure and Chowchilla Canal Bypass Control Structure
- Slurry wall installation to address recurring and significant levee deficiencies throughout the District, such as seepage, boils, sinkholes, erosion, and subsidence

- Construction of Eastside Bypass drop structures
- Firebaugh Project Areas 1 through 3 and long-term projects
- Levee breaches at Unit 1 (LM 9.9) and Unit 5 (LM 0.25)
- Sand Slough Control Structure removal

### Proposed Studies

Given the conceptual-level scope of this system assessment, several studies are recommended to evaluate complex system-wide issues, such as sedimentation, subsidence, erosion control, and aging facility conditions. These studies will help focus rehabilitation efforts and the need for funding to properly address these complex issues. The following studies are proposed:

- Evaluation of District-wide sediment removal
- Comprehensive evaluation of all control structures
- Levee assessment upstream of Chowchilla Canal Bypass Control Structure
- Evaluation of Ash Slough drop structures
- Third-party impacts caused by the SJRRP

### Multi-Benefit Projects

Multi-benefit projects reduce flood risk and provide other benefits, such as enhancing fish and wildlife habitats, improving water supply reliability, addressing subsidence, and providing recreational opportunities. An example of a proposed multi-benefit opportunity is with the City of Firebaugh. The city has a history of flooding, and 100-year flood protection for Firebaugh could combine structural flood protection (levee improvements) with potential levee setbacks and ecosystem restoration.

The District should continue to participate in, and provide feedback to, the DWR Flood-Managed Aquifer Recharge (Flood-MAR) program. Additionally, the District should continue coordination with DWR's program Multiple Benefit Floodplain Restoration Studies, in which DWR is conducting studies in several pilot study areas, including the USJR region.

### Future Actions

In addition to District-specific feasibility studies and flood system improvements, the following actions are recommended to continue engagement with the federal, State, and local entities involved in the region. By coordinating with other interested parties and regional planning agencies, the District can best leverage available funding opportunities and address governance issues.

- DWR and CVFPB need to respond to USACE's letter (USACE 2015) deauthorizing the Project. Submit a request to USACE to reauthorize federal recognition of the Project to make it eligible for PL 84-99 funding.

- Because the State owns the Project, the State needs to provide assurances of future emergency assistance to the Project if USACE will not reconsider federal authorization.
- Create direct-assistance rehabilitation funding for projects that will mitigate the loss of conveyance capacity because of extreme subsidence in the region.
- Establish DWR/CVFPB funding for flood system rehabilitation.
- Participate in development of a San Joaquin River Basin-wide-focused study.
- Monitor future funding opportunities from potential State and federal sources, such as the Urban Flood Risk Reduction and Small Communities Programs.
- Continue coordination with regional flood management planning teams on the San Joaquin River (Upper, Mid, and Lower) to ensure that planning efforts and projects are coordinated.

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# Acronyms and Abbreviations

| | |
|---|---|
| AF | acre-foot (feet) |
| CCTR | Channel Capacity Technical Report |
| cfs | cubic foot (feet) per second |
| CIP | cast-in-place |
| CVFED | Central Valley Floodplain Evaluation and Delineation |
| CVFPB | Central Valley Flood Protection Board |
| CVFPP | Central Valley Flood Protection Plan |
| CY | cubic yard(s) |
| District | Lower San Joaquin Levee District |
| DMC | Delta Mendota Canal |
| DWR | California Department of Water Resources |
| EAD | expected annual damage |
| FEMA | Federal Emergency Management Agency |
| Flood-MAR | Flood-Managed Aquifer Recharge |
| FSRP | Flood System Repair Program |
| FSSR | Flood System Status Report |
| GPS | global positioning system |
| H:V | horizontal to vertical |
| HEC-RAS | Hydrologic Engineering Center – River Analysis System |
| LF | linear foot (feet) |
| LM | levee mile(s) |
| LSJLD | Lower San Joaquin River Levee District |
| LU | levee unit |
| MSG | Merced Streams Group |
| NULE | Non-Urban Levee Evaluation |
| NULSE | Non-Urban Levee Seepage Evaluation (draft pending DWR updates) |
| O&M | operations and maintenance |
| PI | performance index |

| | |
|---|---|
| PL | Public Law |
| POI | point of interest |
| Project | Lower San Joaquin River Flood Control Project |
| Reclamation | U.S. Bureau of Reclamation |
| RFMP | Regional Flood Management Plan |
| RM | river mile(s) |
| SJRFCPA | San Joaquin River Flood Control Project Agency |
| SJRRP | San Joaquin River Restoration Program |
| SPFC | State Plan of Flood Control |
| State | State of California |
| USACE | U.S. Army Corps of Engineers |
| USBR | U.S. Bureau of Reclamation |
| USJR | Upper San Joaquin River |

# Chapter 1 Purpose and Need

The Lower San Joaquin Levee District (LSJLD; District) is preparing this system assessment of the Lower San Joaquin River Flood Control Project (Project) as part of the Upper San Joaquin River (USJR) Regional Flood Management Plan (RFMP). The goals of this assessment are to provide the Lower San Joaquin Levee District (District), California Department of Water Resources (DWR), Central Valley Flood Protection Board (CVFPB), and other State of California (State) and federal agencies with an overview of existing flood infrastructure, flood management issues, and system deficiencies; to offer proposed improvements to restore the Project to its original published design capacity; and to improve the resilience of the Project to prepare for more extreme hydrologic conditions in the future.

This reconnaissance-level assessment incorporates available information from State and federal agencies but focuses on incorporation of local knowledge and experience. The assessment of the Project accomplishes the following:

- Documents existing flood risk conditions along the San Joaquin River and flood bypasses from reports and inspections by various agencies such as DWR, U.S. Bureau of Reclamation (Reclamation or USBR), the USJR RFMP, and the District.
- Identifies flooding problems and issues, such as subsidence, seepage, and aging infrastructure, organized by levee unit (LU).
- Identifies and prioritizes potential capital improvements, actions, and studies needed to restore the published design capacity and enhance resilience to future extreme hydrologic conditions.
- Identifies potential State and federal funding sources.
- Coordinates this assessment with other planning efforts in the region.

Additional goals of the assessment include the following:

- Preserve the unique and historical agricultural community.
- Improve operations and maintenance (O&M).
- Expedite capital improvement permitting and construction.
- Enhance environmental stewardship.
- Promote development of multi-benefit opportunities.

This report uses the best available existing information and does not include new system modeling or study material.

Although the District maintains the flood system through their O&M charter, the State owns the Project. Maintenance is within the scope of the District's budget and O&M manual (LSJRFCP 1978), but capital projects are outside of the scope of the District's agreement with the CVFPB and are the responsibility of the State.

# Chapter 2 History and Background

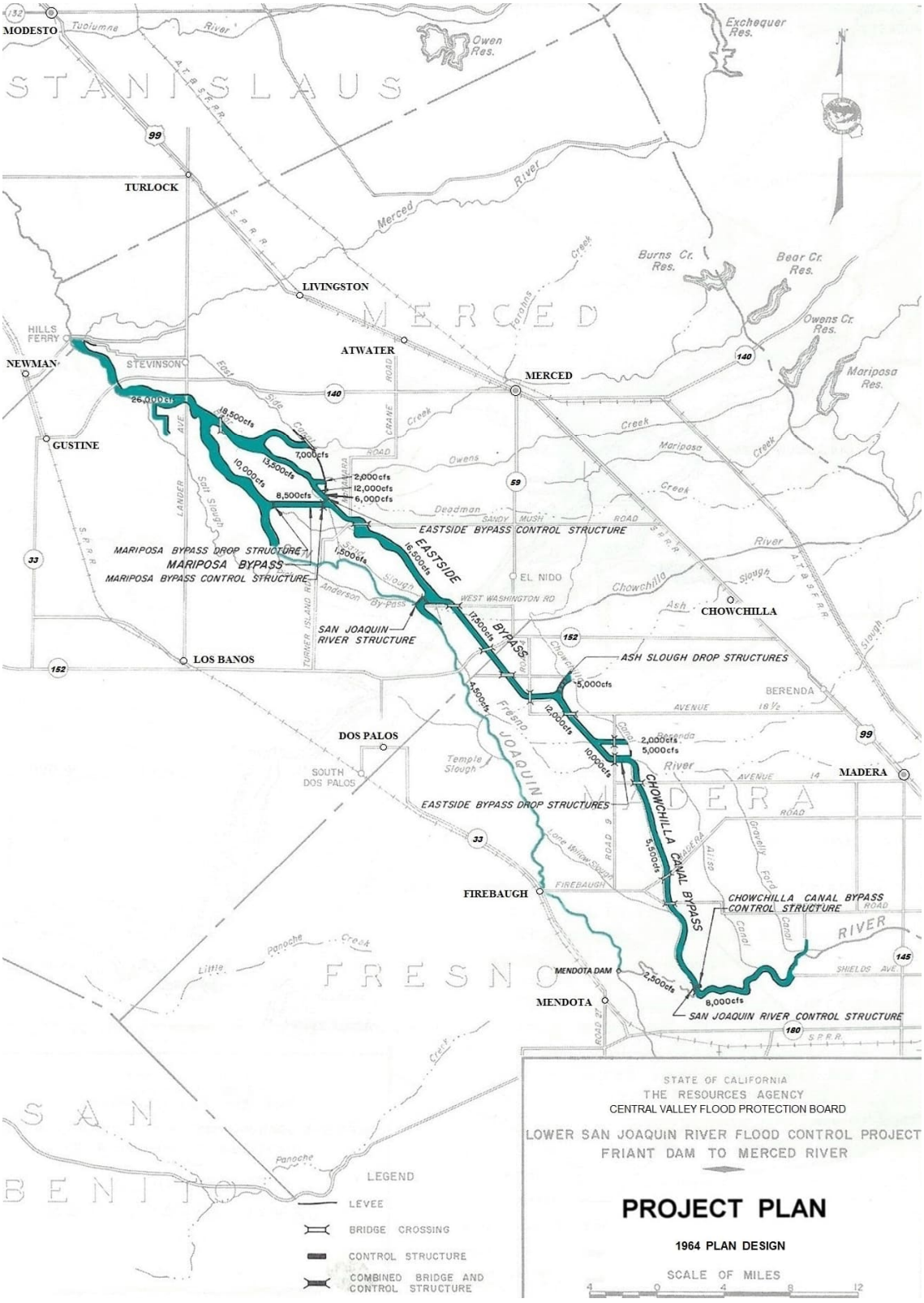
The San Joaquin River and its tributaries have historically caused flooding problems that threaten life and property. Flooding problems have been lessened, but not eliminated, through the construction and maintenance activities of federal, State, and local governments and the efforts of landowners affected by the river.

Although the Project was authorized by Congress in 1944 and approved by the California Legislature in 1946, it would be decades before the Project would be constructed. After World War II, it was assumed flowage easements would be acquired during Project construction. However, this proposal needed re-analysis as grassland water rights were acquired by the U.S. Bureau of Reclamation (Reclamation or USBR) in connection with the Central Valley Project and land was reclaimed along the river.

Completion and operation of Friant Dam in 1947 reduced flow volumes but contributed to a major sedimentation problem in the river. Reservoir operations reduced peak flows that previously transported much of the sediment downstream and cleared out the river, maintaining high channel capacity. Sediment buildup has reduced the river's flow capacity and increased the potential for flooding and erosion problems. Sedimentation has also led to vegetation encroachment in the San Joaquin River channel. Flood flows are impeded and flood levels rise to higher stages due to these constrictions (District 2022).

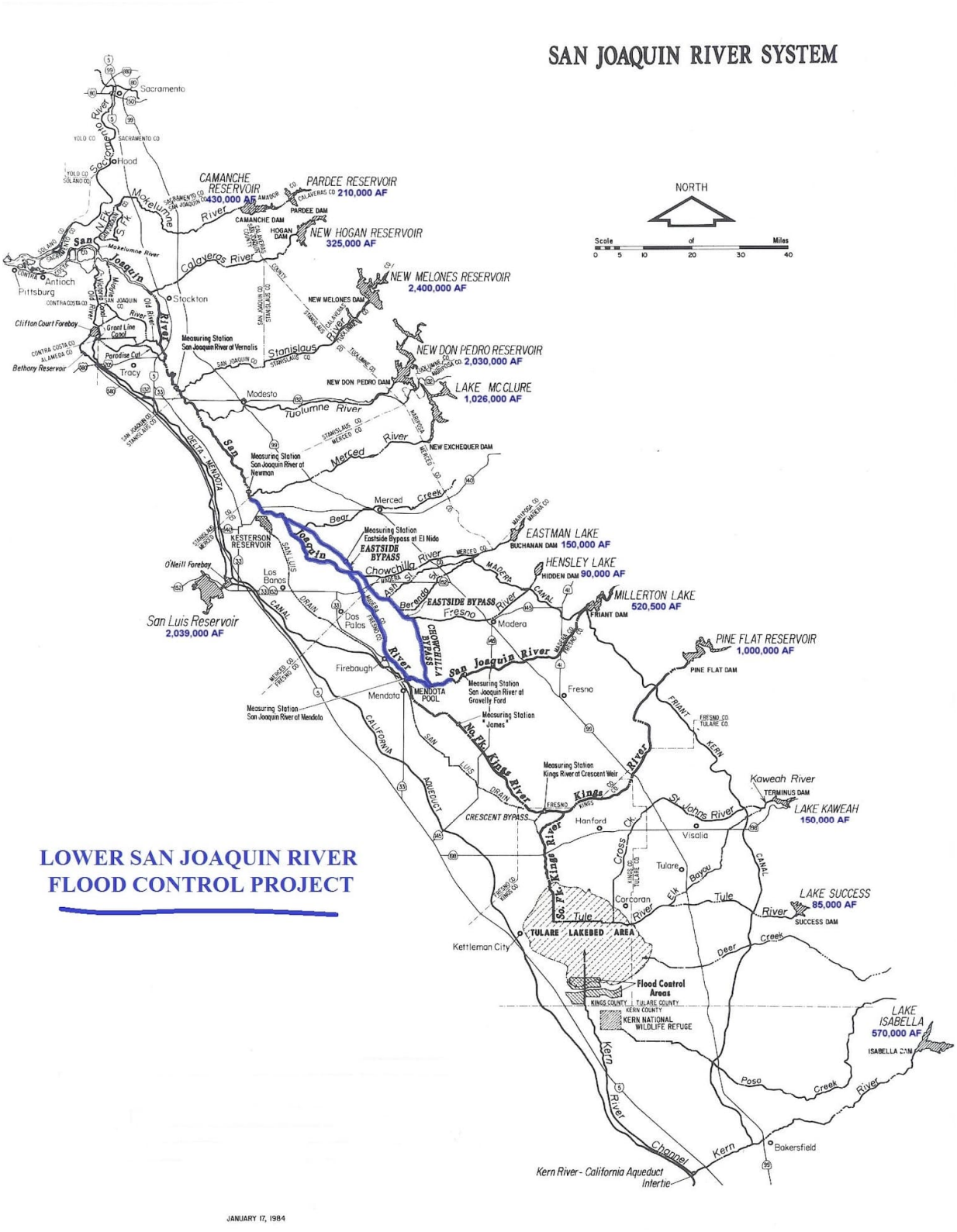
The Project was designed and constructed by DWR between 1959 and 1966 (Figure 2-1). The Project's purpose is to provide flood protection along the San Joaquin River and tributaries in Merced, Madera, and Fresno Counties. The Project protects nearby cities, including disadvantaged communities like Firebaugh, essential facilities, and high-value agricultural land in the region. The Project contains 191.5 miles of levees, covers 108 river miles (RMs), and protects over 300,000 acres. The Project encompasses approximately 90% of the total USJR RFMP region. The Project is composed of a series of bypasses built to convey San Joaquin River flood flows and floodwater from the Kings River system (Figure 2-2). The bypasses divert and convey high flows around San Joaquin River stretches, where constrictions impair its flow capacity.

## Figure 2-1. Lower San Joaquin River Flood Control Project 1964 Design




*Source: District 2022.*

## Figure 2-2. Lower San Joaquin River Flood Control Project in the San Joaquin River System




*Source: District 2022.*

The District was created by the California State Legislature in 1955. Its purpose, in part, is to operate, maintain, and repair levees, bypasses, channels, control structures, and other facilities in connection with the Project. The District, through its agreement with the CVFPB, is obligated to maintain not only the bypasses but also the channel of the San Joaquin River within the Project in a condition such that the channel will carry flood flows by the maximum benefit for flood protection. The District maintains the Project according to the O&M manual (LSJRFCP 1978) developed by the State, which conforms to U.S. Army Corps of Engineers (USACE) standards. The District's responsibilities for maintenance of the Project began in 1960 with the completion of the first contract, which was 51 miles of levee. DWR governs the O&M of the Project and regularly inspects it to ensure that it is properly maintained.

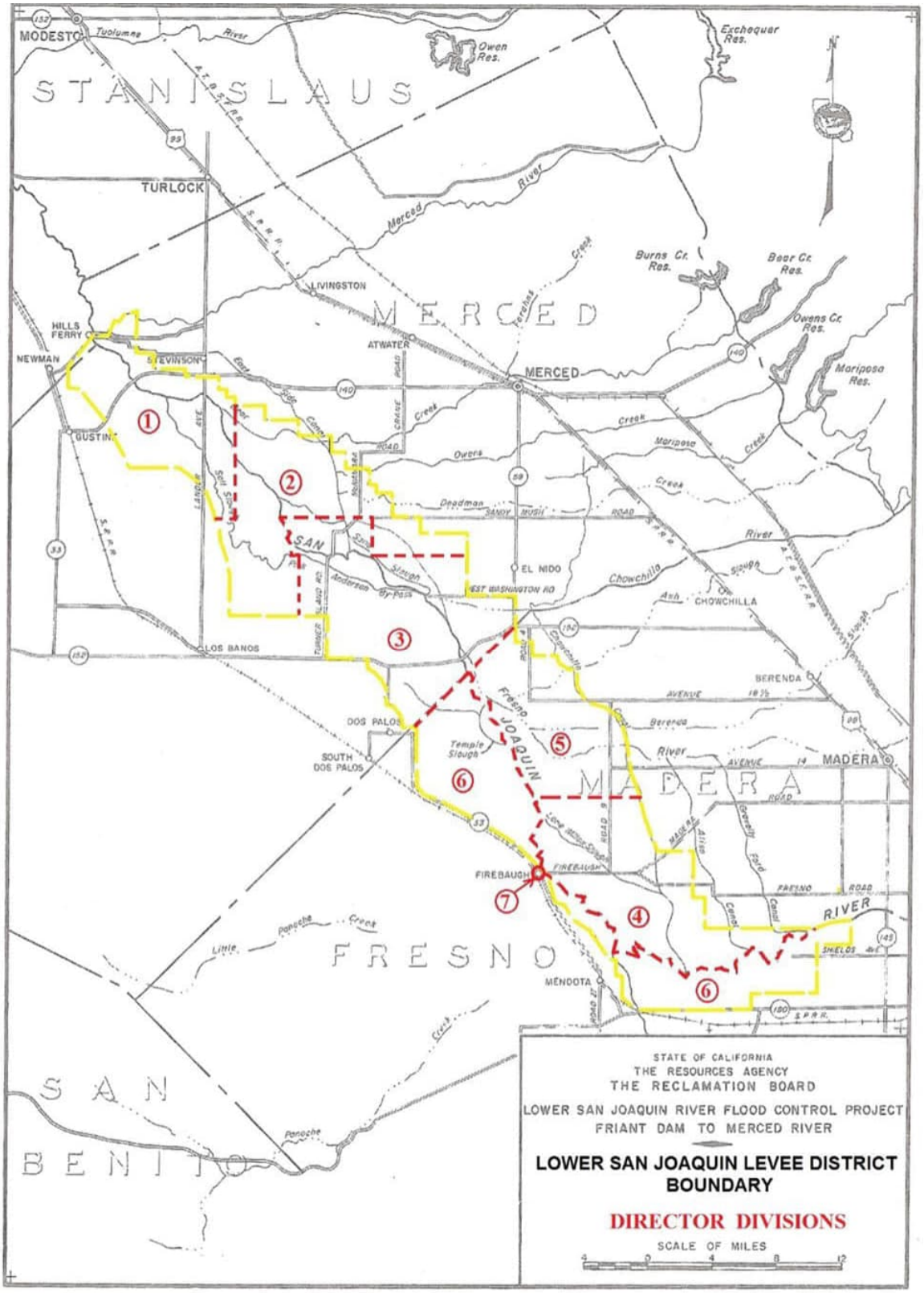
In 1958, the District agreed to operate and maintain the Project when completed. Amendments to the agreement with the CVFPB were instituted in 1962 and 1978. DWR completed construction of the Project in 1966. The O&M manual was adopted by the Reclamation Board (now CVFPB) in 1967 with an amendment in 1978 (LSJRFCP 1978). In May 2024, Unit 2 (levee miles [LMs] 0 to 2.33) and Unit 25 were removed from the District's obligation and transferred to the California Department of Parks and Recreation.

District revenue is generated through benefit assessments on land parcels within District boundaries. Each parcel in the District is assigned to a category with an assessment value. The assessment is in proportion to the benefit received as it relates to each parcel's ability to be put into use and its size. The total parcel count for Merced, Madera, and Fresno Counties is over 4,200 parcels.

District boundaries were based on historical data on areas subject to actual flooding and/or receiving benefit from the Project, as it relates to the published design capacity of the system. The boundary was established along existing section lines, roads, canals, drains, or other permanent lines that were reasonably close to the probable floodplain (Figure 2-3). The boundary description is incorporated into the legislative authorization for the District and covers parts of Merced, Madera, and Fresno Counties.

The District is governed by a seven-member board of directors, and appointments are made by the board of supervisors of the respective counties. Figure 2-3 provides a map of the Director Divisions. Merced County appoints three directors, Madera County appoints two, and Fresno County appoints two.

## Figure 2-3. District Boundary and Director Divisions




*Source: District 2022.*

# Chapter 3 Existing Flood Infrastructure

## 3.1 Flood Infrastructure

The Project was designed and constructed by DWR for a 50-year flood frequency protection. Construction began in 1959 and concluded in 1967 under 16 total contracts. The Project includes a network of bypass channels, levees, and structures to provide flood management from Gravelly Ford to the confluence with the Merced River. Major Project facilities are described in Table 3-1.

Project levees extend from Gravelly Ford to the Chowchilla Bifurcation Structure, where high flood flows can be diverted into the Chowchilla Canal Bypass. Flood flows in the Chowchilla Canal Bypass are conveyed into the Eastside Bypass, which also receives flood flows from the Fresno and Chowchilla Rivers. Flood flows that are in the San Joaquin River downstream of the bifurcation are routed farther downstream into the bypass system at the interchange area of the Sand Slough Control Structure. Flood flows in the Eastside Bypass are delivered to the San Joaquin River, either going through the Mariposa Bypass or continuing down the Eastside Bypass that converges with Bear Creek flows, and then enter the San Joaquin River. Project levees along the river in this portion of the USJR region extend from the confluence of the Mariposa Bypass outlet to the confluence of the Merced River.

The Project has altered the hydrologic regime downstream of Reach 2A (LUs 23 and 24) by routing the majority of winter and spring high flows away from the main river channel to protect downstream areas and the city of Firebaugh. The Project as designed confines flows to the primary San Joaquin River channel and the bypass channels.

**Table 3-1. Summary of Major Infrastructure of the Lower San Joaquin River Flood Control Project**

| Component | Location | Description or Comments |
|---|---|---|
| Levees | | |
| Private Levees | San Joaquin River from Chowchilla Bifurcation Structure (LUs 23 and 24 at LM 0) to backwater areas upstream of Mariposa Bypass (LU 3 at LM 2.2 and LU 4 at LM 1.5) | Private levees were constructed by individual landowners to protect localized areas (private properties). |

| Component | Location | Description or Comments |
|---|---|---|
| SPFC Project Levees | • SPFC levees from Gravelly Ford to Chowchilla Bifurcation Structure (LUs 23 and 24)<br>• From Mariposa Bypass to Merced River (LUs 1 and 2)<br>• Along Chowchilla Canal Bypass (LUs 17 and 18), Eastside Bypass (LUs 5 and 6), and Mariposa Bypass (LUs 11 and 12)<br>• Along Bear Creek (LUs 7 and 8) and crossing (LU 22) Bear Creek<br>• Along Owens Creek (LUs 9 and 10), Ash Slough (LUs 13 and 14), and the Berenda Slough (LUs 15 and 16) | Constructed as part of the Project, SPFC levees were designed to provide 50-year flood protection. |
| Diversion Structures | | |
| Chowchilla Bifurcation Structure (Composed of the San Joaquin River Control Structure and the Chowchilla Canal Control Structure) | LUs 23 and 24 at LM 0 | The structures control the diversion of flows from San Joaquin River into the Chowchilla Canal Bypass. |
| Eastside Bypass Control Structure | LU 5 at LM 9.7 | The structure controls flow in the Eastside Bypass downstream of the Mariposa Bypass. |
| Sand Slough Control Structure and San Joaquin River Control Structure | LU 4 at LM 0 (Sand Slough Control Structure) and LM 0.1 (San Joaquin River Structure) | The structure diverts San Joaquin River flows into Reach 4B (downstream of LUs 3 and 4). The gates in the structure are currently closed, and flood flows have not been released into Reach 4B in many years. |
| Mariposa Bypass Structure | LU 11 at LM 0 | The structure diverts flow from Eastside Bypass into the Mariposa Bypass and the San Joaquin River. |
| Bypass Channels | | |
| Fresno Slough | Upstream of Mendota Dam (no SPFC levees) | The channel conveys high flows from Kings River to Mendota Pool. |
| Chowchilla Canal Bypass | LUs 17 and 18 | The channel conveys high flows from Chowchilla Bifurcation Structure to Eastside Bypass. |

| Component | Location | Description or Comments |
|---|---|---|
| Eastside Bypass | LUs 5 and 6 | The channel conveys flows from Chowchilla Canal Bypass to Mariposa Bifurcation Structure and Bear Creek (both of which convey flows back into San Joaquin River). |
| Mariposa Bypass | LUs 11 and 12 | The channel conveys water from the Mariposa Bypass Bifurcation Structure into the San Joaquin River. |

SPFC = State Plan of Flood Control

## 3.2 State Plan of Flood Control Project Levees

SPFC project levees were constructed along natural drainage channels to increase floodwater carrying capacity and create floodwater bypass channels. Top-of-levee crowns have widths of 12, 20, 24, or 28 feet and are covered with gravel roads (for patrolling the levee). Waterside slopes are 3 to 1 (horizontal to vertical [H:V]), and landside slopes are 2 to 1 (H:V). The design freeboard (distance below top of levee) is 3 feet for rivers and streams and 4 feet for bypass channels. However, on the right bank of LUs 5, 7, 8, 9, and 10, freeboard was constructed as much as 2 feet higher than on the left banks because levees in this section were constructed at different times with different hydraulic capacities. Actual freeboard may be different from the original published design values due to land subsidence, along with erosion and sediment deposits in the channels. Table 3-2 provides information about SPFC project and adjacent levees and the agencies responsible for their O&M. Table 3-3 lists LUs, their section, right or left bank, and length in miles.

**Table 3-2. Levees Within and Adjacent to the Lower San Joaquin River Flood Control Project**

| Channel | From | To | County | Responsible Agency |
|---|---|---|---|---|
| San Joaquin River | Gravelly Ford | Chowchilla Canal Bypass | Fresno, Madera | LSJLD |
| | Chowchilla Canal Bypass | Mendota Pool | Fresno, Madera | Non-project[a] |
| | Mendota Pool | 1.6/2.2 miles upstream of Sand Slough Control Structure | Fresno, Madera, Merced | Non-project[a] |
| | 1.6/2.2 miles upstream of Sand Slough Control Structure | Sand Slough Control Structure | Merced | LSJLD |
| | Sand Sough Control Structure | 2.0/3.0 miles upstream of Mariposa Bypass | Merced | LSJLD |

| Channel | From | To | County | Responsible Agency |
|---|---|---|---|---|
| | 2.0/3.0 miles upstream of Mariposa Bypass | Merced River confluence | Merced | LSJLD |
| Chowchilla Canal Bypass | San Joaquin River | Junction with Eastside Bypass at Fresno River | Madera | LSJLD |
| Eastside Bypass | Junction with Chowchilla Canal Bypass at Fresno River | San Joaquin River downstream of Bear Creek | Madera, Merced | LSJLD |
| Fresno Slough | Junction with James Bypass (west of railroad tracks) | Mendota Pool | Fresno | Non-project[a] |
| Fresno River | Road 18 (approximately) | Junction with Chowchilla Canal Bypass | Madera | Madera County |
| Berenda Slough | Avenue 17 ½ (approximately) | Junction with Eastside Bypass | Madera | Madera County, LSJLD |
| Ash Slough | Road 8 (approximately) | Junction with Eastside Bypass | Madera | Madera County, LSJLD |
| Chowchilla River | Highway 59 | Junction with Eastside Bypass | Madera, Merced | Madera County |

[a] Non-SPFC project

### Table 3-3. Levee Units and Miles

| Levee Units | Section | Right or Left Bank | Length (miles) |
|---|---|---|---|
| Unit 01 | San Joaquin River | Right bank | 22.52 |
| Unit 02 | San Joaquin River | Left bank | 13.79[a] |
| Unit 03 | San Joaquin River | Right bank | 2.1 |
| Unit 04 | San Joaquin River | Left bank | 1.41 |
| Unit 05 | Eastside Bypass | Right bank | 34.85 |
| Unit 06 | Eastside Bypass | Left bank | 36.47 |
| Unit 07 | Bear Creek Bypass | Right bank | 3.62 |
| Unit 08 | Bear Creek Bypass | Left bank | 3.63 |
| Unit 09 | Owens Creek Bypass | Right bank | 0.87 |
| Unit 10 | Owens Creek Bypass | Left bank | 0.8 |

| Levee Units | Section | Right or Left Bank | Length (miles) |
|---|---|---|---|
| Unit 11 | Mariposa Bypass | Right bank | 3.31 |
| Unit 12 | Mariposa Bypass | Left bank | 3.33 |
| Unit 13 | Ash Slough | Right bank | 1.27 |
| Unit 14 | Ash Slough | Left bank | 1.28 |
| Unit 15 | Berenda Slough | Right bank | 2.03 |
| Unit 16 | Berenda Slough | Left bank | 1.96 |
| Unit 17 | Chowchilla Canal Bypass | Right bank | 16.09 |
| Unit 18 | Chowchilla Canal Bypass | Left bank | 15.35 |
| Unit 22 | Eastside Canal | Left bank | 5.51 |
| Unit 23 | San Joaquin River | Right bank | 10.24 |
| Unit 24 | San Joaquin River | Left bank | 8.36 |
| Unit 25[a] | San Joaquin River | Right bank | 2.49 |

Source: DWR 2022d.

[a] LU 02 (LMs 0 to 2.33) and LU 25 were removed from the O&M manual in 2024 due to new ownership for Great Valley Grasslands State Park. The length under District jurisdiction is now 11.46 miles.

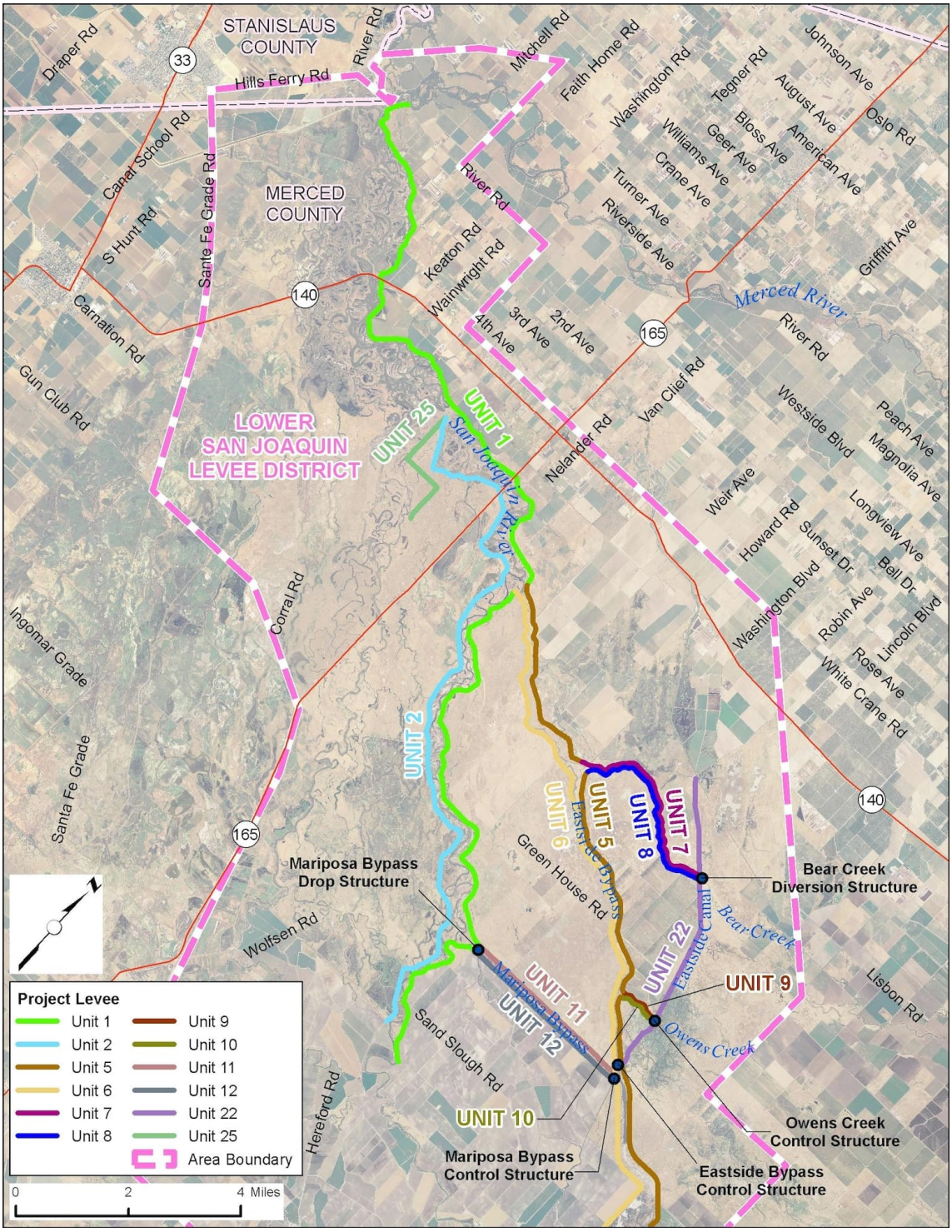
DWR designed the flood system to provide protection from a 50-year flood event, according to the definition of the event at the time of design in the 1950s. The published design flow capacity for the main San Joaquin River channel is based on a design freeboard requirement of 3 feet. The published design capacity for the bypass channels is based on a design freeboard requirement of 4 feet. The San Joaquin River from the Chowchilla Bifurcation Structure to the Mariposa Bypass is lined with non-project levees or canal banks. Aggradations of the channel bed, subsidence, and vegetation encroachment have reduced the capacity of the channel to convey the published design flows. Portions of levees along Ash and Berenda Sloughs and the Fresno River are also part of the system.

There are access roads to the levees and patrol bridges across the flood and river channels from levee crown to levee crown such that all portions of the flood control system are reachable by vehicle at all times for maintenance of the levee or flood fighting, as well as Project maintenance activities. Fencing along the levees and fence gates on the levee patrol and access roads secure the Project. There are two areas where levees have been breached to allow flows to reenter the bypass. These breaches impact travel during emergency operations.

The District has not been able to conduct O&M activities in the San Joaquin River channel for many years due to permitting issues and environmental restrictions. In certain areas where it is possible to get permits, Project channels are cleared and grubbed of debris, brush, trees, and other wild growth to maintain the floodwater design carrying capacity. Figures 3-1 through 3-3

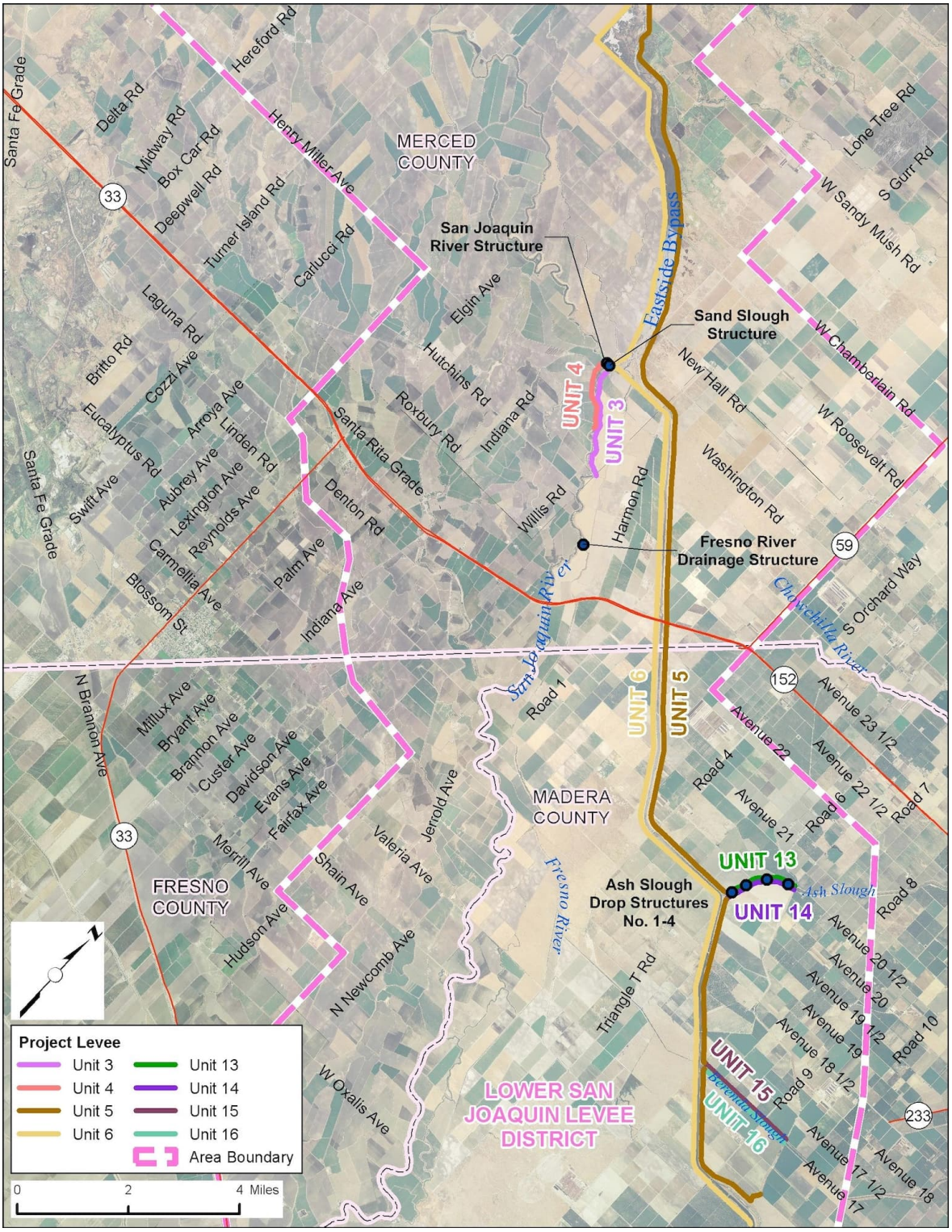
depict SPFC project levees along with their respective LUs, as well as structures in the system described in this chapter.

## Figure 3-1. North Section Levee Units and Structures



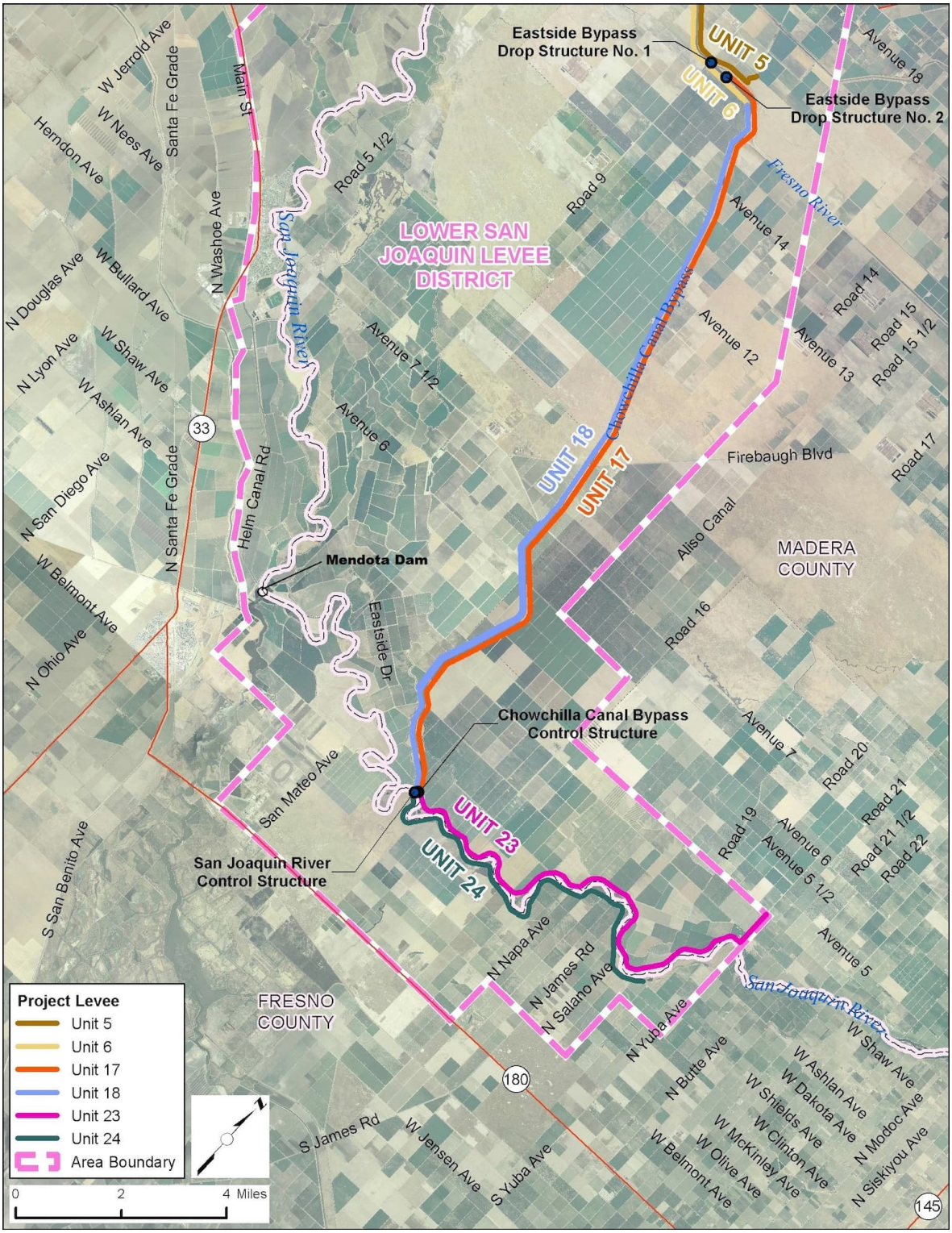

*Source: DWR 2022d.*

## Figure 3-2. Middle Section Levee Units and Structures




*Source: DWR 2022d.*

## Figure 3-3. South Section Levee Units and Structures




*Source: DWR 2022d.*

## 3.3 Bypasses and Other Flood Management Structures

The Project includes a complex system of flood bypasses that convey floodwater during high flow events. Additional descriptions of the SPFC facilities can be found in the State Plan of Flood Control Descriptive Document (DWR 2022e). Table 3-4 presents the published capacities for each reach of the bypass system.

**Table 3-4. Published Design Capacity for the Bypass System of the Lower San Joaquin Flood Control Project**

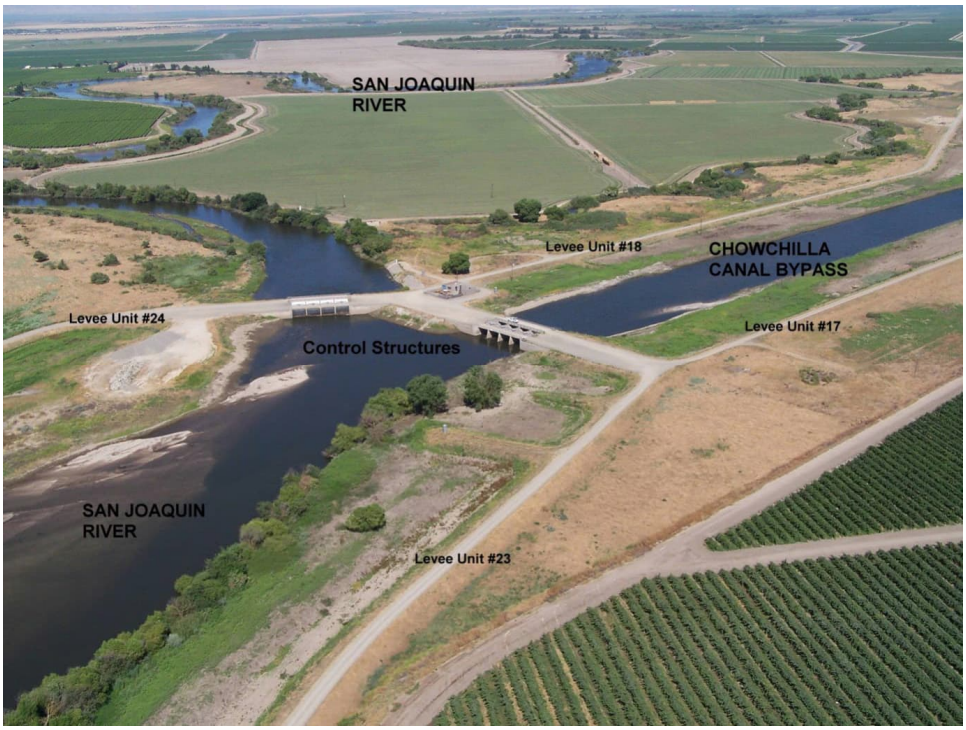
| Bypass | Location Description | Published Capacity with 4-foot Freeboard (cfs) |
|---|---|---|
| Chowchilla Canal Bypass | San Joaquin River to the Eastside Bypass confluence | 5,500 |
| Eastside Bypass | Fresno River to Berenda Slough confluence | 10,000 |
| Eastside Bypass | Berenda Slough to Ash Slough confluence | 12,000 |
| Eastside Bypass | Ash Slough to Sand Slough Control Structure confluence | 17,500 |
| Eastside Bypass | Sand Slough Control Structure to Mariposa Bypass confluence | 16,500 |
| Eastside Bypass | Mariposa Bypass to Owens Creek confluence | 12,000 |
| Eastside Bypass | Owens Creek confluence to Bear Creek confluence | 13,500 |
| Eastside Bypass | Bear Creek to San Joaquin River confluence | 18,500 |
| Mariposa Bypass | Eastside Bypass to San Joaquin River confluence | 8,500 |

Note: Published values from the O&M manual (LSJRFCP 1978). Existing capacities for the Eastside Bypass from Berenda Slough to Mariposa Bypass are reduced due to sedimentation and subsidence.
cfs = cubic foot (feet) per second

### 3.3.1 Chowchilla Bifurcation Structure

The Chowchilla Bifurcation Structure controls the flows routed into the Chowchilla Canal Bypass and the flows routed into Reach 2B of the San Joaquin River. This structure consists of two identical gate control structures, one in each channel, at the junction of the San Joaquin River and the Chowchilla Canal Bypass (Figure 3-4). These structures are the Chowchilla Canal Bypass Control Structure and the San Joaquin River Control Structure. The structures are operated together to control the flow that is diverted from the San Joaquin River to the bypass channel. Each structure has four 20-foot-wide bays with fabricated steel radial gates. The gates are raised and lowered by cable hoists with electric motors. A standby engine-generator set with a propane fuel tank provides backup electrical power to the gate hoists in the event of a power outage. Electrical controls for the gates are located in a concrete-block control building.

## Figure 3-4. Control Structure Bifurcation, San Joaquin River and Chowchilla Canal Bypass Control Structures




*Source: District 2023c.*

### 3.3.1.1 Chowchilla Canal Bypass Control Structure

The Chowchilla Canal Bypass Control Structure is an SPFC facility consisting of four gated bays, each 20 feet wide, with a published total design capacity of 5,500 cfs. Water enters the bypass system from the San Joaquin River through the Chowchilla Canal Bypass Structure. Historically, higher discharges of up to 12,000 cfs have been diverted into the bypass under extreme flood conditions. Approach embankments connect the structure with the levee system. The Chowchilla Canal Bypass Control Structure operates in conjunction with a nearby identical structure across the San Joaquin River.

### 3.3.1.2 San Joaquin River Control Structure

The San Joaquin River Control Structure (Figure 3-5) is an SPFC facility identical to the Chowchilla Canal Bypass Control Structure. The structure has four gated bays, each 20 feet wide. This control structure differs from the Chowchilla structure in that it has a trash rack, which can slow flows during flood events. Approach embankments connect the structure with the levee system. The San Joaquin River Control Structure operates in conjunction with the Chowchilla Canal Bypass Control Structure at the head of the Chowchilla Canal Bypass. The San Joaquin River has no SPFC facilities downstream from the control structure for about 33 miles (near the Sand Slough Control Structure).

## Figure 3-5. San Joaquin River Control Structure

*Source: District-provided photo.*

#### 3.3.1.3 Chowchilla Bifurcation Structure Operations

The operation of the Chowchilla Bifurcation Structure depends on the following factors:

- Flood flows delivered to the San Joaquin River from Kings River (via Fresno Slough) at Mendota Pool
- Water diversions from Mendota Pool, which determine the need for check boards and the water elevation at the dam

The conveyance of high flows from Kings River via Fresno Slough has priority over the conveyance of San Joaquin River flows through Mendota Pool. When the combined flow contributions from the Kings River and San Joaquin River are below the hydraulic capacity of the downstream channel (the capacity of Reach 3 is 4,500 cfs),[1] the operating rules for the Chowchilla Bifurcation Structure are not explicit, and the District has the flexibility to "best utilize the design capacities of the San Joaquin River Flood Control Project" (SJRFCPA 2015). When flows are less than or equal to irrigation demands, the check boards at Mendota Dam remain in place to maintain the water surface elevation of Mendota Pool.

If the flow contribution from the Kings River is below 3,000 cfs, as much as 1,300 cfs of San Joaquin River water could be routed to Mendota Pool at the Chowchilla Bifurcation Structure. To sustain a total combined flow of less than 4,500 cfs (total of San Joaquin River and Kings River flows) in Reach 3, incremental increases in flow contributed from the Kings River above 3,000 cfs are offset by reduced flows at the San Joaquin River Control Structure. The residual San Joaquin River flow is routed into the bypass channel.

[1] Reach 3 is located on the San Joaquin River, downstream of Mariposa Pool.

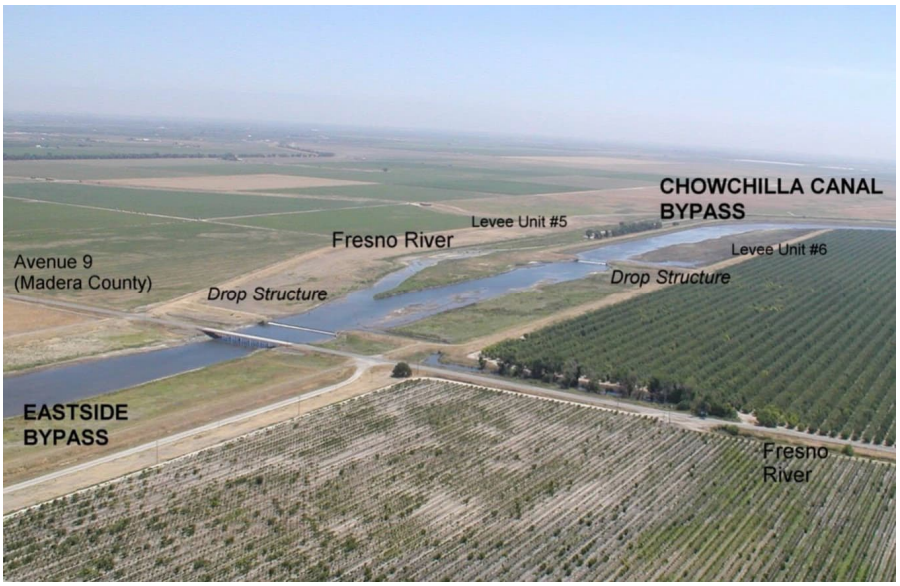
Surplus flows (flows not diverted by the Exchange Contractors to meet water demands) are released through Mendota Dam into Reach 3. Mendota Dam can pass up to 1,500 cfs via manual and automated sluice gates in the dam. The check boards in Mendota Dam are removed to pass flows greater than 1,500 cfs. The O&M manual states that "should the flows exceed 8,000 cfs at the control structures or 10,000 cfs at the latitude of Mendota, the District will operate the control structures at their own discretion with the objective of minimizing damage to the flood control project and protected area" (LSJRFCP 1978).

## 3.3.2 Chowchilla, Eastside, and Mariposa Bypasses

The bypass system for the San Joaquin River begins at the river about 5 miles east of the town of Mendota. Most of the flow from Friant Dam is diverted to the Chowchilla Canal Bypass, which branches off the San Joaquin River about 11 RM upstream of Mendota Dam. The Chowchilla Canal Bypass is designed to carry most of the flood flows from the San Joaquin River at that location if Kings River floodwater (up to 4,750 cfs) is entering downstream through the James Bypass. The bypass system discharges water back to the San Joaquin River at two locations—one at approximately 42 miles and the other at approximately 50 miles downstream from the upstream end of the bypass. Portions of levees already in place along canal banks were rehabilitated, and new reaches of levees were built as part of the bypass system, which includes about 192 miles of levees. Levees along tributary streams were designed with 3 feet of freeboard.

Over time, encroachment of vegetation, substantial sedimentation, and land subsidence have considerably reduced channel capacity. Erosion, seepage, and prolonged high water compromise levee integrity. Downstream of the Chowchilla Canal Bypass, the river is confined by non-project levees and generally carries no more than 1,300 cfs due to sedimentation and seepage impacts. Figure 3-6 shows the Chowchilla Canal Bypass flowing into the Eastside Bypass.

**Figure 3-6. Chowchilla Canal Bypass Flowing into the Eastside Bypass**




*Source: District 2023c.*

There are two bypass control structures, one in each channel, at the junction of the Eastside Bypass and Mariposa Bypass (Figure 3-7). The structures control the flow that is diverted from the Eastside Bypass into the Mariposa Bypass, which discharges back into the San Joaquin River about 4 miles west of the structures. The bypasses were designed to remain dry until they are needed to convey flood flows. The operations of the USBR's San Joaquin River Restoration Program (SJRRP) has introduced fishery flows into the bypasses during non-flood periods and causes excessive vegetation growth that reduces flood flow capacity and significantly increases vegetation management costs.

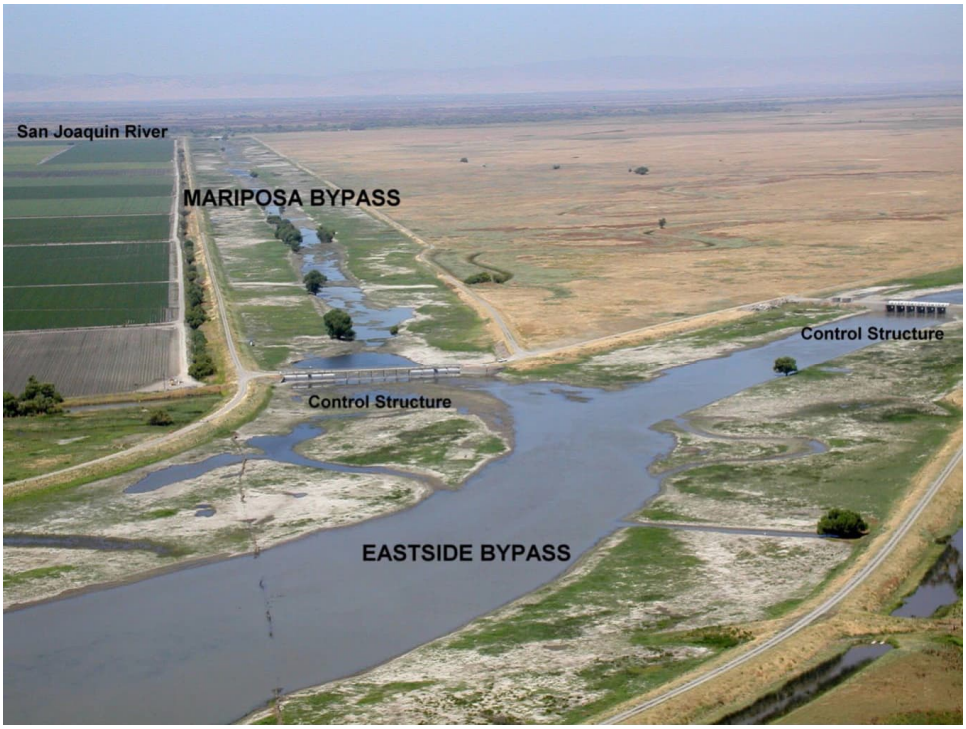
#### 3.3.2.1 Mariposa Bypass Control Structure

The operating rules for the Mariposa Bypass Control Structure require that the structure divert the first 8,500 cfs of flow from the Eastside Bypass into the San Joaquin River. The water remaining in the Eastside Bypass is released into the San Joaquin River via Bear Creek. At high flow levels in the bypass, flows from creeks in the Merced Streams Group (MSG) cannot enter the bypass; therefore, water flows around the levee system along the Eastside Irrigation Canal, which causes flooding problems. The Mariposa Bypass Control Structure consists of 14 bays, each 20 feet wide. The outer four bays on each end (eight total) are fitted with fabricated steel radial gates, and the inner six bays are not gated. The structure includes a reinforced-concrete spillway on the downstream side to dissipate energy from the elevation drop from the Eastside Bypass to the Mariposa Bypass.

#### 3.3.2.2 Eastside Bypass Control Structure

The Eastside Bypass Control Structure consists of six 20-foot-wide bays with fabricated steel radial gates on all bays. The gates are raised and lowered by cable hoists with electric motors. A standby engine-generator set with a propane fuel tank provides backup electrical power to the gate hoists if a power outage occurs. Electrical controls for the gates are located in a concrete-block control building.

Figure 3-7. Control Structure Bifurcation at Eastside Bypass and Mariposa Bypass




*Source: District 2023c.*

*Note: Control structures from left to right: Mariposa Bypass Control Structure, Eastside Bypass Control Structure*

## 3.3.3 Other Control Structures

Other control structures are located at the confluence of the Fresno and San Joaquin Rivers just north of Highway 152, at the Sand Slough interchange where the San Joaquin River intersects the Eastside Bypass channel, at the junction of Owens Creek and the Eastside Canal, and at the junction of Bear Creek and the Eastside Canal.

### 3.3.3.1 Fresno River Drainage Structure

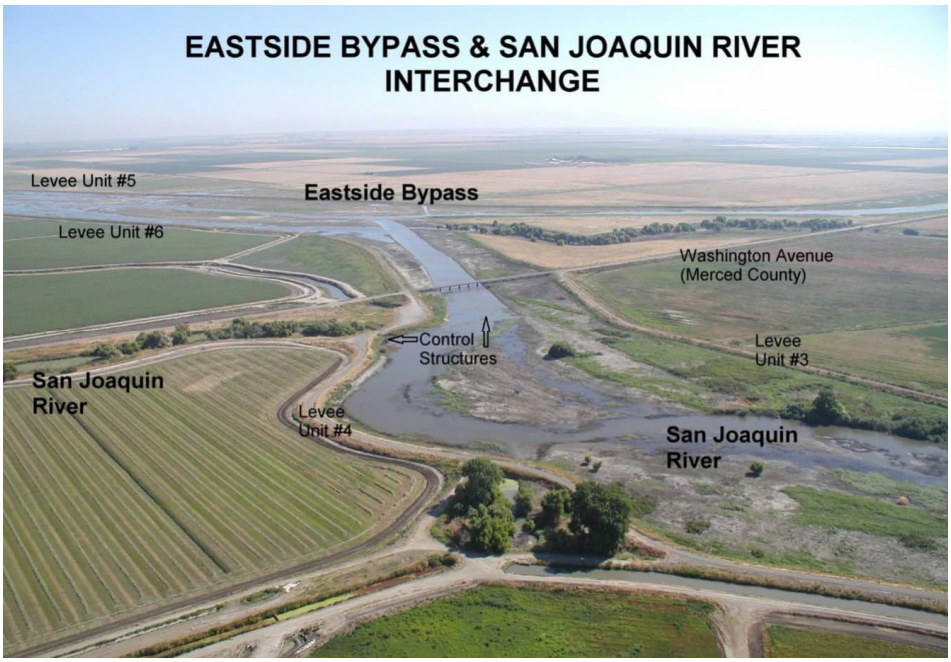
The Fresno River drainage structure is a 4-foot by 6-foot reinforced-concrete box culvert through the right bank levee of the San Joaquin River. Drainage flow is controlled by a slide gate located on the landward side of the San Joaquin River. There is also a levee embankment just east of the gate structure that plugs the Fresno River. The Fresno River Channel between the Eastside Bypass and the San Joaquin River is considered interior drainage and is not part of the Project facilities.

### 3.3.3.2 Sand Slough Control Structure

The Sand Slough Control Structure (Figure 3-8) was originally designed to route up to 3,000 cfs of water into the Eastside Bypass and divert 1,500 cfs into the San Joaquin River. Flows from Reach 4A (San Joaquin River upstream of Sand Slough) have not been diverted into Reach 4B (San Joaquin River downstream of Sand Slough, upstream of Mariposa Bypass) in many years,

including during the 1997 flood, because of vegetation growth and lack of channel hydraulic capacity. The San Joaquin River Structure includes a four-bay reinforced-concrete box culvert through the left bank of the San Joaquin River just south of Washington Road.

### Figure 3-8. San Joaquin River and Sand Slough Control Structures




*Source: District 2023c.*

*Note: Control structures from left to right: San Joaquin River Control Structure, Sand Slough Control Structure*

#### 3.3.3.3 Owens Creek Control Structure

Flow from Owens Creek enters the Eastside Canal through a culvert at the east bank of the canal and can be released into the Eastside Bypass through the control structure. The Owens Creek structure has a reinforced-concrete invert slab, pier walls, end walls, and wing walls, with a 12-foot-wide timber bridge deck for access across Owens Creek along the west bank of the Eastside Canal. There are seven bays with timber flash boards on the upstream side of the structure.

#### 3.3.3.4 Bear Creek Control Structure

The Bear Creek structure has a reinforced-concrete invert slab, pier walls, end walls, and wing walls, with a 3-foot-wide catwalk spanning six bays with flash boards. Bear Creek flows directly into the Eastside Canal, and flow can be released into the Eastside Bypass through the control structure. There is a reinforced-concrete patrol bridge along the west bank of the Eastside Canal about 250 feet downstream of the control structure. The existing Bear Creek diversion weir was built in the 1960s with the original Project. The structure invert is higher than the upstream channel invert, which constrains Bear Creek flood flows entering the Eastside Bypass and causes upstream ponding on Bear Creek. Flows migrate around the Project levee and flood

the land side of the Project levee. Modifying the structure to minimize the flow restriction would allow ponded water to flow to the Eastside Bypass.

### 3.3.4 Drop Structures

Two drop structures with an elevation drop of approximately 4 feet are located in a 0.5-mile section of the Eastside Bypass, just upstream of Road 9. Four drop structures with an elevation drop of approximately 10 feet are in a 1-mile section of Ash Slough. A single drop structure with an elevation drop of approximately 15 feet is at the confluence of the Mariposa Bypass and San Joaquin River. As noted earlier, there is a drop structure at the beginning of the Mariposa Bypass, which is integrated with the control gate structure at that location. Drop structures have reinforced-concrete cutoff walls, crest or head walls, spillway apron slabs, floor blocks, end sills, side walls, and wing walls. Riprap is included upstream and downstream of the drop structures to minimize erosion of the channels and levee slopes.

### 3.3.5 Sediment Basin

A sediment settling basin is included at the upstream end of the Chowchilla Canal Bypass. The basin is designed to store up to 200,000 cubic yards (CY) of sediment. On the land side of both the right and left banks of the bypass channel, there are sediment disposal areas that are about 1.3 miles long.

### 3.3.6 Mendota Pool

Mendota Pool, impounded by Mendota Dam, is a 5,000-acre-foot (AF) reservoir located just outside the city of Mendota on the San Joaquin River. Mendota Dam provides no operational or flood management storage. The function of Mendota Pool is to distribute water from the San Joaquin River or Delta Mendota Canal (DMC) to the various water rights diversions for agricultural irrigation. However, the water level in the pool also functions to maintain water levels in the Mendota Wildlife Management Area. Central California Irrigation District, which owns and operates the dam, maintains water surfaces in Mendota Pool at a level between 14.2 feet and 14.5 feet on the staff gauge at the dam. At levels below 14.2 feet, diversions to the Mendota Wildlife Management Area and to other water users on Fresno Slough are impaired. Operating criteria established by the Division of Safety of Dams limit the maximum water surface to 14.5 feet. Above 14.5 feet, seepage problems begin to occur at the upper end of Mendota Pool.

Mendota Dam contains flow from the San Joaquin River and flood flows from the Kings River via the Fresno Slough and James Bypass. The DMC conveys Delta water to Mendota Pool from the north, and several irrigation channels divert flows from it.

### 3.3.7 Hydrologic Facilities

Hydrologic facilities include staff gauges and water stage recorders that are located at critical locations such as control structures and channel junctions. Staff gauge installations consist of

three timber posts in a line perpendicular to the levee centerline. One post is located in the low-water channel, another on the berm between the low-water channel and the levee, and a third on the levee slope. Enamel-coated metal staff gauges graduated in tenths of a foot are attached to the timber posts and set to a known elevation datum. The District notes that staff gauges might no longer be reliable reference points from one flood event to the next due to the land subsidence that persists throughout the area. Patrollers therefore drive a temporary lath into the levees to monitor water level changes.

Water stage recorders typically consist of a stilling well with an inlet from the channel and a water-level telemetering device in the stilling well. Recorded flows from these wells are monitored by the District, with adjustments made for flow curve corrections due to channel cross-sectional changes. Due to unreliable automatic gate control equipment, the primary control structures described earlier are manually operated.

An additional feature critical to O&M activities is the mile marker. The Project is divided into LUs, and mile markers are included every 0.5 mile of each unit. Signs on the markers indicate the LU number and the mile beginning at the downstream end and proceeding upstream. The signs are visible from vehicles traveling in either direction along the levee patrol roads.

### 3.3.8 Bridges and Low-Water and Dip Crossings

There are 24 bridges and several low-water and dip crossings included in the Project. Bridges are reinforced-concrete structures consisting of piles, deck slabs, and abutments. Patrol and access bridges are 18.3 feet wide, and county road bridges are 30.3 feet wide. The bridge at Highway 152 is 34 feet wide. Embankments for these bridges have riprap slope protection. There are four additional bridges that are integral with the control gate structures at the Bifurcation Structure and the Mariposa Bypass. Low-water and dip crossings are generally gravel surfaced roads that cross the interior of the bypass channels. Low flows pass through culverts under the roads; however, at higher flows, the roads are inundated and cannot be used. There are also reinforced-concrete bridges that cross the low-flow channel and are inundated during high-water conditions.

### 3.3.9 Irrigation and Drainage Structures

Numerous irrigation and drainage structures pass through, under, or over the Project levees. These facilities provide for the passage of water from the flood waterway to the protected area for irrigation or other usage, or from the protected area to the waterway for drainage purposes. The structures are generally corrugated metal, steel, or reinforced-concrete pipes and reinforced-concrete box culverts with reinforced-concrete end walls and head walls. Flow through the culverts is controlled with slide or flap gates. Slide gates are located in riser pipes near the top of the levees; therefore, the gates can be accessed during high-water conditions. Flap gates are attached to culvert ends on the water side of the levees.

## 3.4 Upstream Flood Facilities

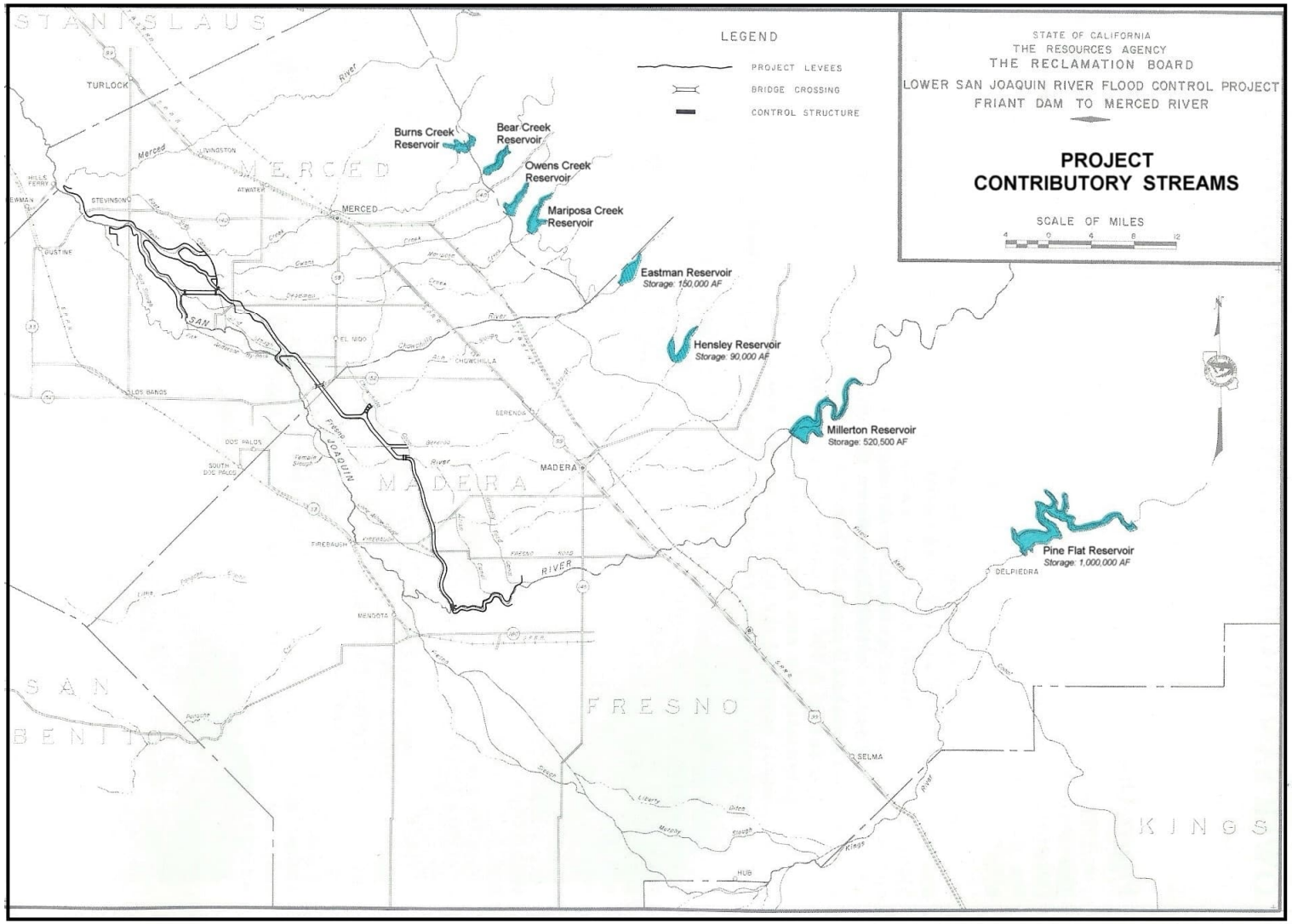
Upstream flood facilities impact the Project but are not part of the Project or operated by the District. The following upstream facilities are shown on Figure 3-9:

- Pine Flat Reservoir
- Millerton Reservoir
- Hensley Reservoir
- Eastman Reservoir
- Mariposa Creek Reservoir
- Owens Creek Reservoir
- Bear Creek Reservoir
- Burns Creek Reservoir

Friant Dam (Figure 3-10), which impounds Millerton Reservoir, provides significant reduction of flood risk in the USJR region. Friant Dam, which Reclamation operates, impounds more than 520,500 AF of water, with a maximum of 170,000 AF reserved for flood storage between November and February. The flood storage space in Millerton Reservoir can be reduced (to allow for more water storage) by transferring up to 85,000 AF of reserved flood control space to Mammoth Pool. Depending on the forecasted unimpaired runoff and irrigation demand, 390,000 AF of supplemental storage space can be reserved during the snowmelt runoff period (from February 1 through July 1). For the remainder of the year, the storage capacity of the reservoir is reserved for water supply storage rather than flood control.

The river channel downstream of Friant Dam has a published design flow rating of 8,000 cfs. When flows exceed 8,000 cfs in the San Joaquin River, the District will operate control structures with the objective of minimizing damage to the Project and surrounding lands. Releases from Friant Dam take 2.5 days to reach the Chowchilla Canal Bypass Bifurcation. At the bifurcation, the flows may be split based on the timing of the event and the magnitude of downstream inflows from other tributaries such as releases from Pine Flat Dam on the Kings River.

## Figure 3-9. Contributory Reservoirs and Streams




*Source: District 2022.*

Figure 3-10. Friant Dam and Millerton Reservoir

*Source: Summers Engineering-provided photo.*

### 3.4.1 Pine Flat Reservoir/Pine Flat Dam/Kings River to San Joaquin River

Pine Flat Reservoir has 1,000,000 AF of storage capacity. The first 4,750 cfs of flood releases are diverted north at Crescent Weir on the Kings River, through the James Bypass, toward Mendota Pool. Releases from Pine Flat Reservoir take approximately 4.5 days to reach Mendota Pool. Flows exceeding 4,750 cfs are diverted toward the Tulare Lake Basin until the release totals 10,000 cfs. The release is then split 50–50.

### 3.4.2 Hensley Reservoir/Hidden Dam/Fresno River to Eastside Bypass

Hensley Reservoir is impounded by Hidden Dam on the Fresno River and has a 90,000-AF storage capacity. The channel rating down the Fresno River is 5,000 cfs before reaching the Eastside Bypass Drop Structure. Releases from Hidden Dam take 1 day to reach the flood system.

### 3.4.3 Eastman Reservoir/Buchanan Dam/Chowchilla River to Eastside Bypass

Eastman Reservoir impounded by Buchanan Dam on the Chowchilla River has a storage capacity of 150,000 AF. Downstream published design flow capacity is 7,000 cfs, with a split of

2,000 cfs into the Berenda Slough channel and 5,000 cfs into Ash Slough. Releases from Buchanan Dam take 1 day to reach the Eastside Bypass.

### 3.4.4 Merced Streams Group

Improvement of the MSG was authorized by the Flood Control Act of 1944 (PL 78-534, 78th Congress) as part of the comprehensive plan for flood control for the Sacramento and San Joaquin River Basins. The following MSG reservoirs and creeks contribute flows to the Eastside Bypass and impact the flood operations of the Project:

- Burns Creek Reservoir/Burns Creek to Bear Creek
- Bear Creek Reservoir/Bear Creek
- Owens Creek Reservoir/Owens Creek
- Mariposa Reservoir/Mariposa Creek

# Chapter 4 Information Resources

## 4.1 Main Information Resources

Best available information was used in the assessment, during which no new data were generated and no new hydraulic flood modeling was performed. Information was compiled from a number of documents, each with differing levels of detail, completeness, and study area boundaries. Some information about infrastructure located upstream or outside the region was provided because the operations of the Project are affected by these areas. This document represents a comprehensive attempt to compile and synthesize available information pertinent to the Project. Table 4-1 summarizes the main information resources used for this assessment. Additional references are listed in Chapter 9.

**Table 4-1. Information Resources**

| Resource | Description | Reference Name |
|---|---|---|
| District Background Presentation | Presentation provides District history, purpose, and major challenges. | District 2022 |
| Current Levee District Issues—Google Earth Map | Each issue has a GPS location and short writeup of date and scope; some issues include pictures. | District 2023a |
| USJR RFMP | This 2015 management plan incorporates regional interests to develop short-term and long-term structural and nonstructural system improvements for flood risk reduction. | SJRFCPA 2015 |
| *2022 Central Valley Flood Protection Plan Update*—Appendix C, *Flood Risk Analysis* | This document provides EAD for impact areas in the District region using the HEC-RAS software and HEC-FDA model. | DWR 2022a |
| *2022 Flood System Status Report Update* (FSSR) | This document provides figures and tables of SPFC flood system deficiencies as part of the 2022 CVFPP Update. Includes capacity deficiencies, as well as levee integrity issues from the NULE Project. | DWR 2022b |
| March 2024 CVFED model from Friant Dam to the Merced River | As part of the CVFED Program, this HEC-RAS model was used to calculate channel capacity at design freeboard using the latest DWR data. | DWR 2024 |
| *Channel Capacity Report 2024 Restoration Year – San Joaquin River Restoration Program* | This Reclamation report provides existing channel capacities by river reaches, which differ from DWR river reaches. | Reclamation 2024 |

| Resource | Description | Reference Name |
|---|---|---|
| *Fall 2022 Levee Maintenance Deficiency Summary Report* (Fall 2022 DWR Inspection Report) | This report summarizes results of annual District levee and structure inspections. Identified issues may include erosion, seepage, vegetation, rodents, and structural deficiencies. | DWR 2022c |
| Draft NULSE | This 2023 evaluation of seepage issues and levee strength was provided by DWR's Flood Maintenance and Operations Branch. | DWR forthcoming |
| Reclamation Subsidence Monitoring | This document provides subsidence in feet per year for the region. | SJRRP 2025 |
| *Flood Releases from Upstream Reservoirs*—Memo | This memo describes operations with high flood releases from upstream reservoirs. | District 2023b |
| *Firebaugh Multi-Benefit Flood Management Project Flood Risk Reduction Feasibility Study* | This is a 2022 feasibility study on flood risk reduction projects for the City of Firebaugh. | Gouveia 2022 |

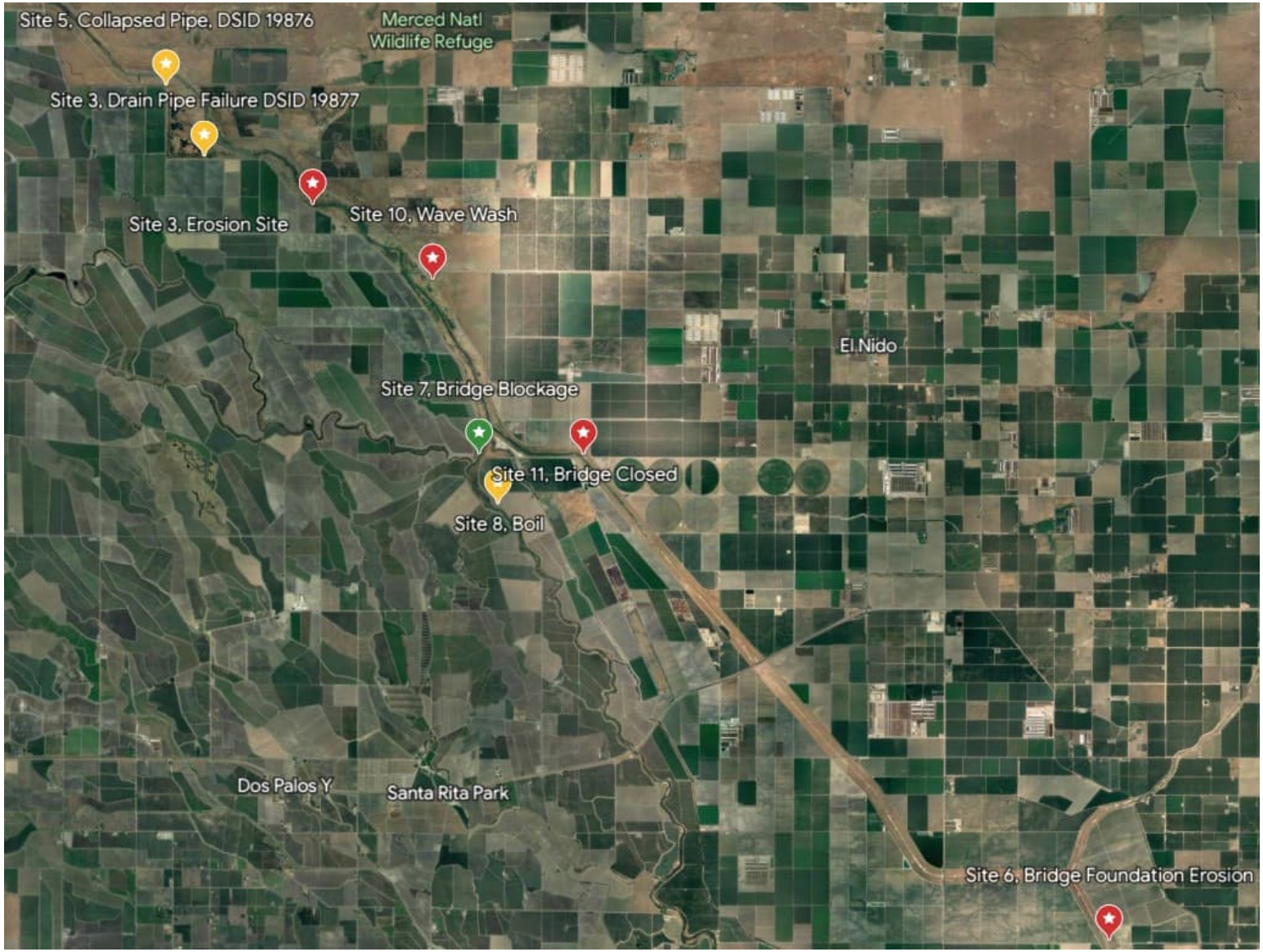
CVFED = Central Valley Floodplain Evaluation and Delineation
CVFPP = Central Valley Flood Protection Plan
EAD = expected annual damage
FSSR = Flood System Status Report
GPS = global positioning system
HEC-RAS = Hydrologic Engineering Center – River Analysis System
NULE = Non-Urban Levee Evaluation
NULSE = Non-Urban Levee Seepage Evaluation

## 4.2 2023 Google Earth Levee District Issues

The 2023 winter storms caused many erosion, seepage, and infrastructure failures within the District system. A Google Earth website constructed by District staff documents these system issues with pictures and response actions (District 2023a).

Figures 4-1 and 4-2 show locations of documented issues for the north and south portions of the system, respectively.

## Figure 4-1. 2023 Water Year Issues—North Portion of the Project



## Figure 4-2. 2023 Water Year Issues—South Portion of the Project

## 4.3 Fall 2022 California Department of Water Resources Inspection Report

The Fall 2022 DWR Inspection Report (DWR 2022c) heavily influences the District's prioritization of O&M needs. DWR provides the District with inspection ratings on their structures as summarized in Table 4-2. Inspection ratings are coded as follows:

- Acceptable (A) – No immediate work is required, other than routine maintenance. The flood protection project will function as designed and intended with a high degree of reliability, and necessary cyclical maintenance is being performed adequately.
- Minimally Acceptable (M) – One or more deficient conditions exist in the flood protection project that need to be improved or corrected. However, the project will essentially function as designed with a lesser degree of reliability than what the project could provide.
- Unacceptable (U) – One or more deficient conditions exist that may prevent the project from functioning as designed, intended, or required.

**Table 4-2. California Department of Water Resources Structure Inspection Summary**

| Levee Units | Overall Rating |
|---|---|
| Ash Slough Drop Structure 1 | A |
| Ash Slough Drop Structure 2 | A |
| Ash Slough Drop Structure 3 | M[a] |
| Ash Slough Drop Structure 4 | A |
| Bear Creek Diversion Structure | A |
| Chowchilla Canal Bypass Control Structure | A |
| Eastside Bypass Drop Structure 1 | A |
| Eastside Bypass Drop Structure 2 | A |
| Fresno River Drainage Structure | A |
| Mariposa Bypass Control Structure | A |
| Mariposa Bypass Drop Structure | A |
| Owens Creek Control Structure | A[b] |
| Owens Creek Overflow Structure | A |
| San Joaquin River Bypass Control Structure | A |
| San Joaquin River Structure | M |
| Sand Slough Structure | M |

*Source: DWR 2022c.*

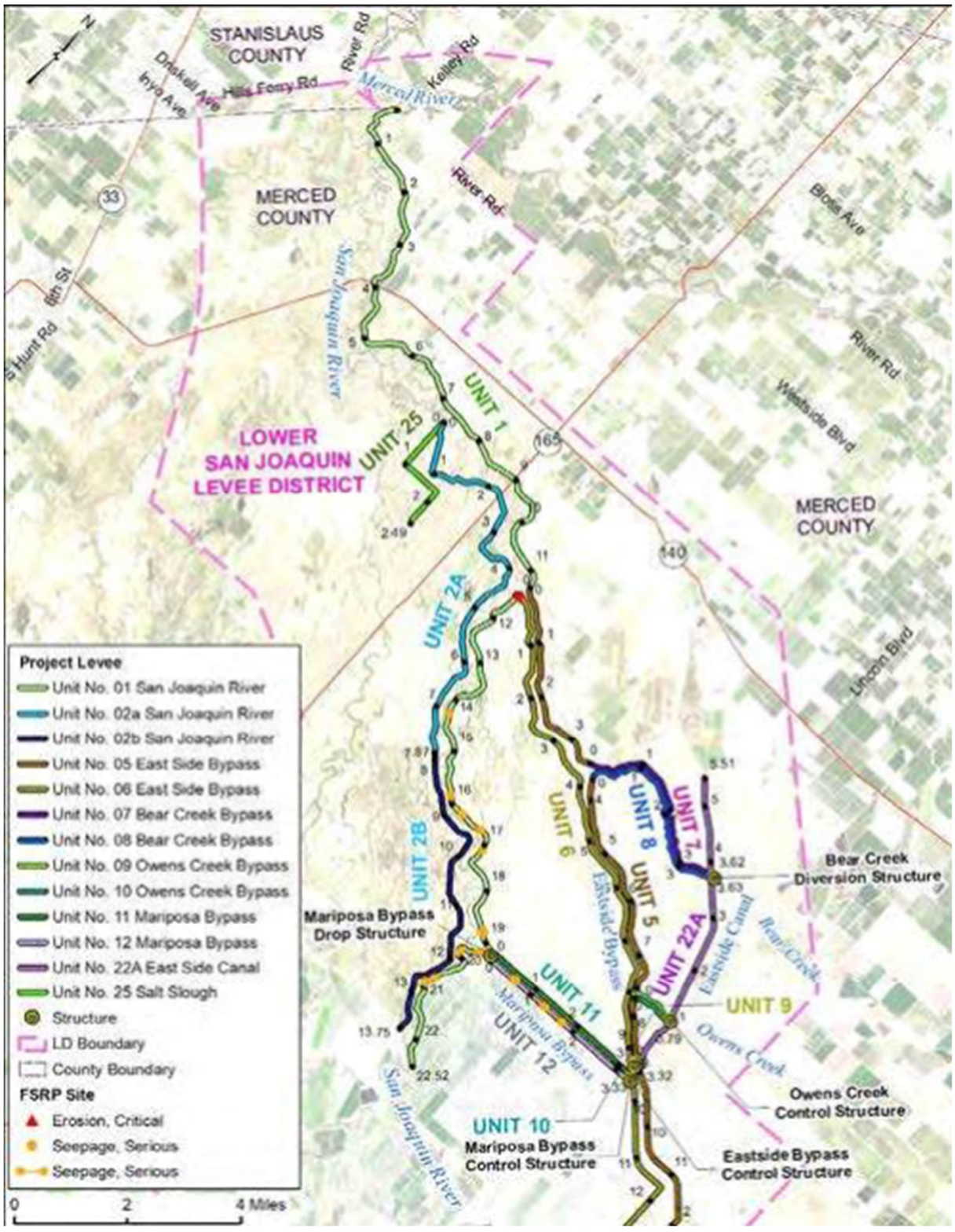
[a] The *Fall 2023 Levee Maintenance Deficiency Summary Report* (Fall 2023 DWR Inspection Report; DWR 2023) became available at the end of conducting this assessment. Of all the inspection results, including erosion and seepage, the Ash Slough Drop Structure 3 rating is the only difference. Even though it is now rated as A – Acceptable, the District still deems it as deficient.

[b] The District has determined that the Owens Creek Control Structure needs replacement.

The report also includes documentation for projects from the Flood System Repair Program (FSRP), administered by DWR. The FSRP uses Proposition 1E funds to address critical levee problems and improve SPFC infrastructure in non-urban areas.

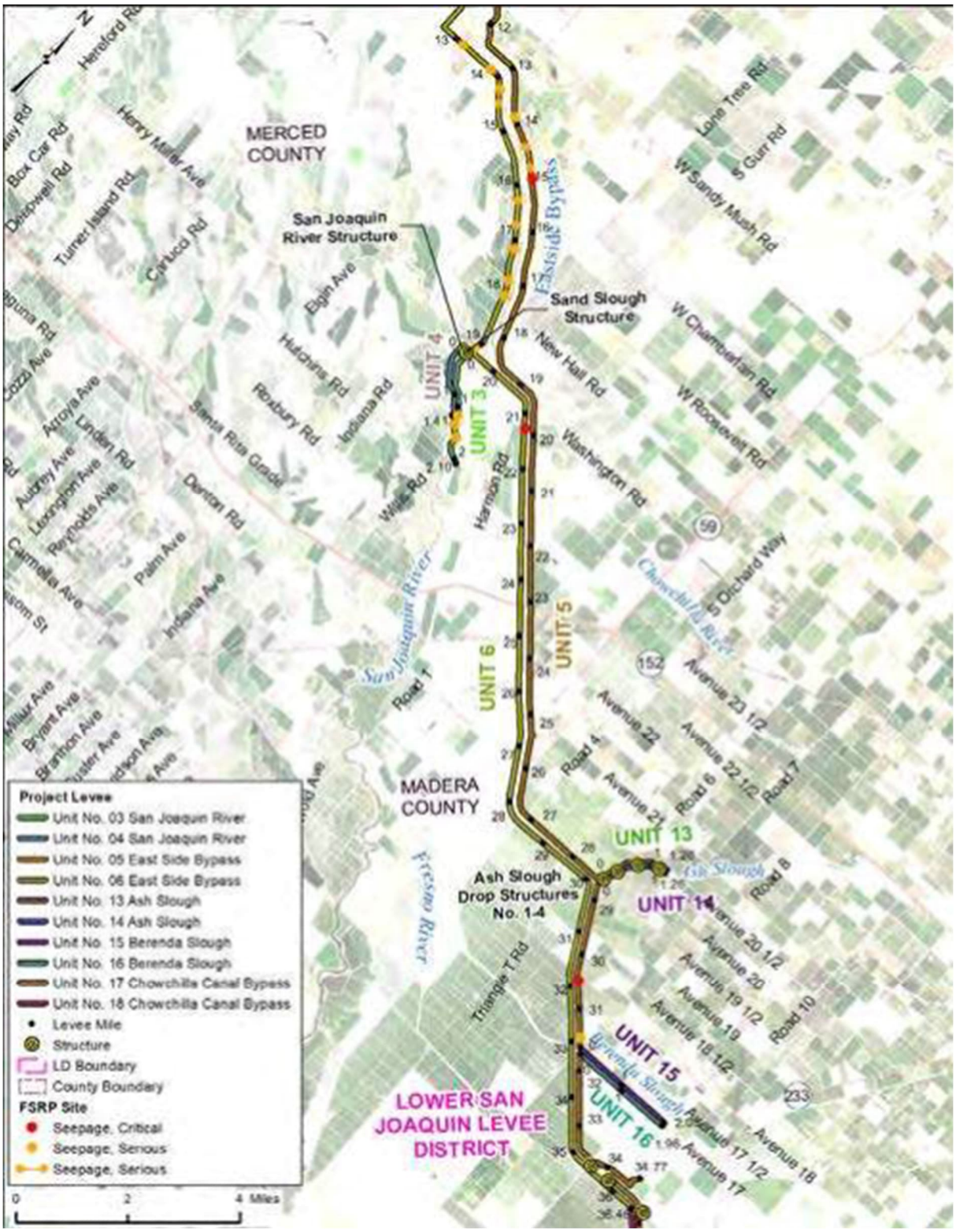
Maps of the District levees with erosion and seepage sites identified as part of the FSRP are shown on Figure 4-3 through Figure 4-5. These sites are tabulated in Appendix A. DWR gives a summary of unacceptable erosion sections in the District, as summarized in Section 5.2.8. The Fall 2023 DWR Inspection Report (DWR 2023) was released shortly before the release of this assessment. The only difference between the Fall 2023 and Fall 2022 DWR Inspection Reports (DWR 2023, 2022c) is an acceptable rating in the 2023 report for Ash Slough Drop Structure 3. However, the District would like to pursue further condition evaluation of this structure.

## Figure 4-3. DWR Flood System Repair Program Erosion and Seepage Sites—North Portion of the Project



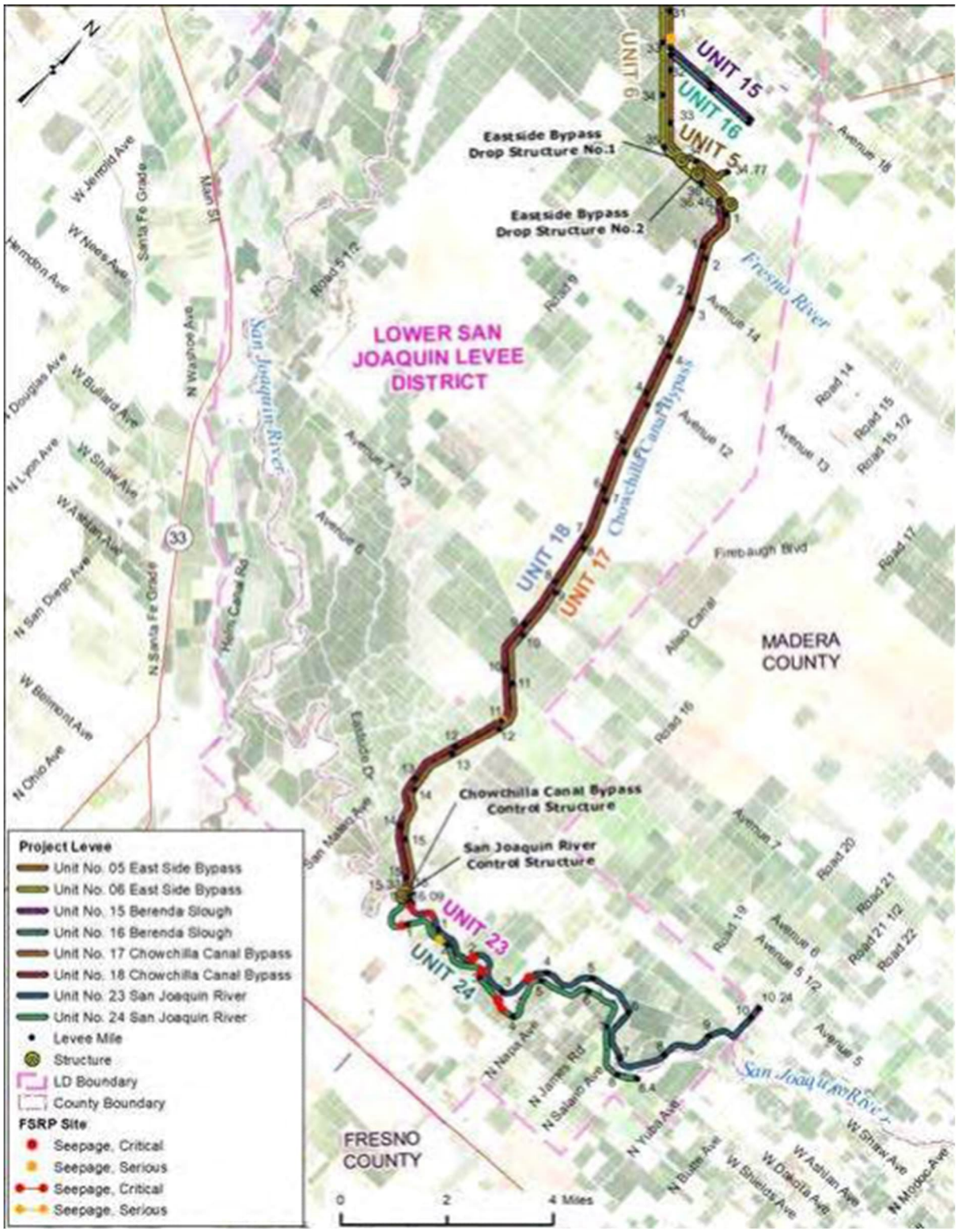

*Source: DWR 2022c.*

## Figure 4-4. DWR Flood System Repair Program Erosion and Seepage Sites—Middle Portion of the Project




*Source: DWR 2022c.*

## Figure 4-5. DWR Flood System Repair Program Erosion and Seepage Sites—South Portion of the Project




*Source: DWR 2022c.*

## 4.4 California Department of Water Resources 2022 Flood System Status Report Update

DWR prepared the 2022 FSSR (DWR 2022b) to meet the legislative requirements of *California Water Code* Section 9120 and the *Central Valley Flood Protection Act of 2008* and to contribute to development of the CVFPP. The CVFPP guides future State investments through projects to address identified problems in the SPFC.

### 4.4.1 Capacity Issues and Deficiencies

SPFC channel conveyance capacity was estimated based on the ability of a channel to pass published design flood flows. Original published design flows were derived from the *Report on Control of Floods, San Joaquin River and Tributaries Between Friant Dam and Merced River* (DWR 1954) and later changed to reflect the 1955 design profile for the San Joaquin River, as shown in *Design Memorandum 1, San Joaquin River Levees, Lower San Joaquin River and Tributaries Project* (USACE 1955). This design memorandum is referred to as the "55/57 design flows"[2] in the following figures, though the District typically refers to the 1964 Plan design flows shown on Figure 2-1.

Current capacities were estimated using data from the *State Plan of Flood Control Existing Channel Capacity Assessment Combined Technical Memorandum* (CVFED Program 2009), and the *Channel Capacity Evaluation for the Sacramento and San Joaquin River Systems,* 2015 Administrative Draft (DWR 2015). Current channel capacities were determined as the flow rate possible based on design freeboard requirements.

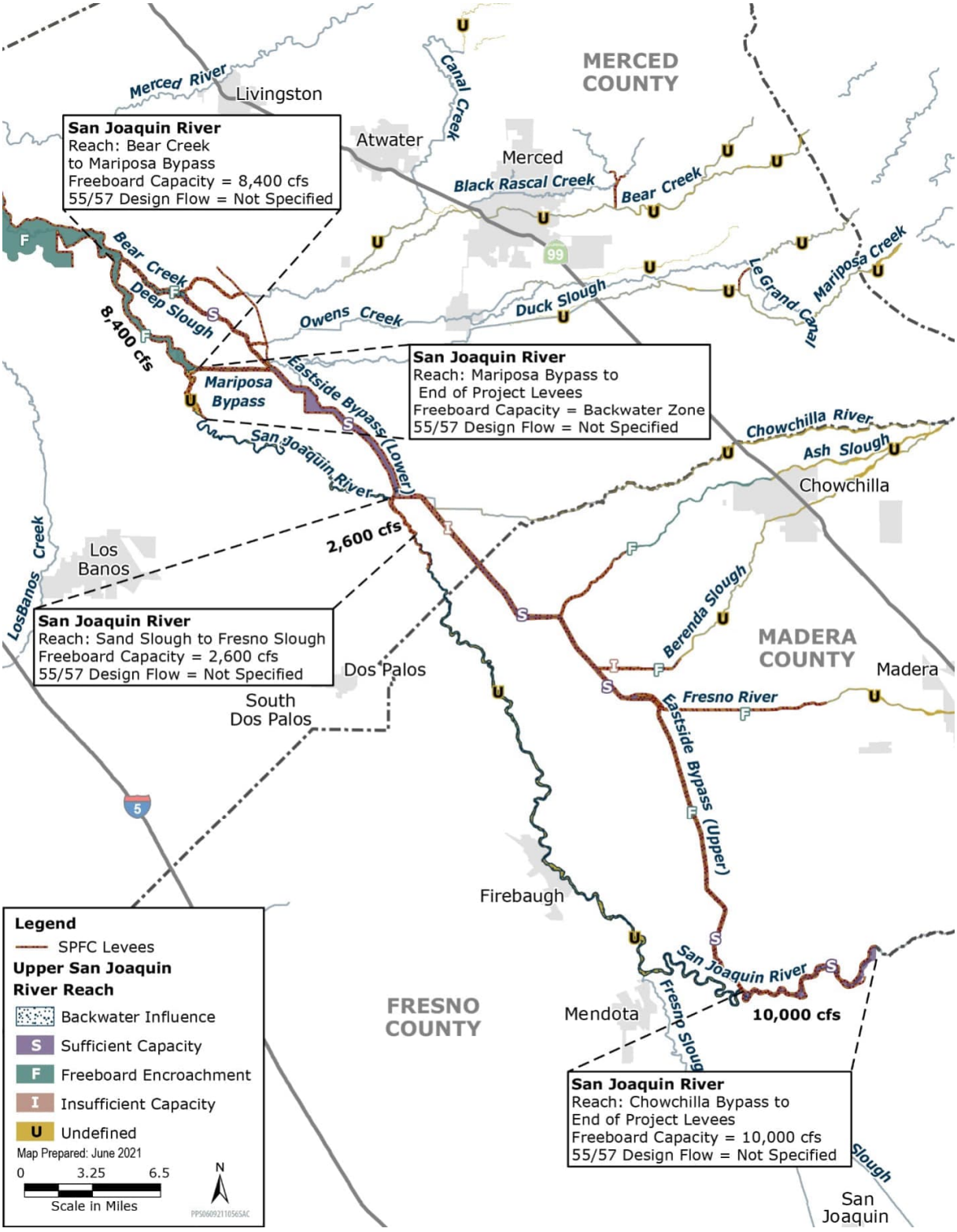
The following 2022 FSSR criteria (DWR 2022b) were used to determine whether estimated current capacities of the SPFC channels were sufficient to safely convey identified design capacities in applicable O&M manuals or design capacities calculated from design profiles:

- If the estimated current channel capacity was greater than both the published design capacity reported in the O&M manual and the published design capacity based on the design profile, the channel status was reported as "Sufficient Capacity."
- If the estimated current channel capacity was less than the published design capacity reported in the O&M manual, the published design capacity based on the design profile, or both, the channel status was reported as "Freeboard Encroachment."

Figures 4-6 through 4-9 show channel capacity ratings throughout the District.

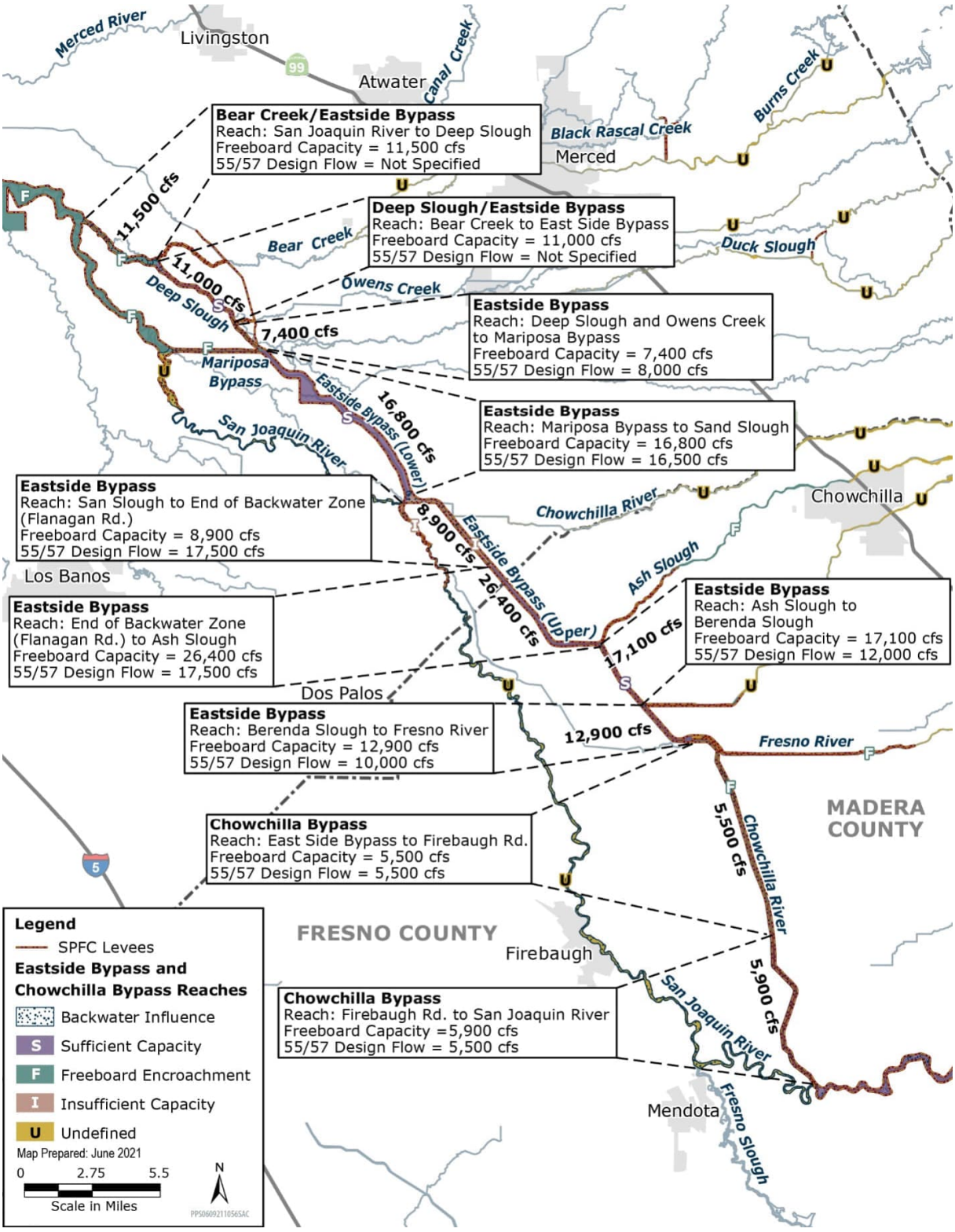
[2] USACE developed an equivalent document for the Sacramento River in 1957, hence the "55/57 design flows" for design flows measured in 1955 for the San Joaquin River system and in 1957 for the Sacramento River.

## Figure 4-6. 2022 Flood System Status Report Update Upper San Joaquin River Capacity Reach Map



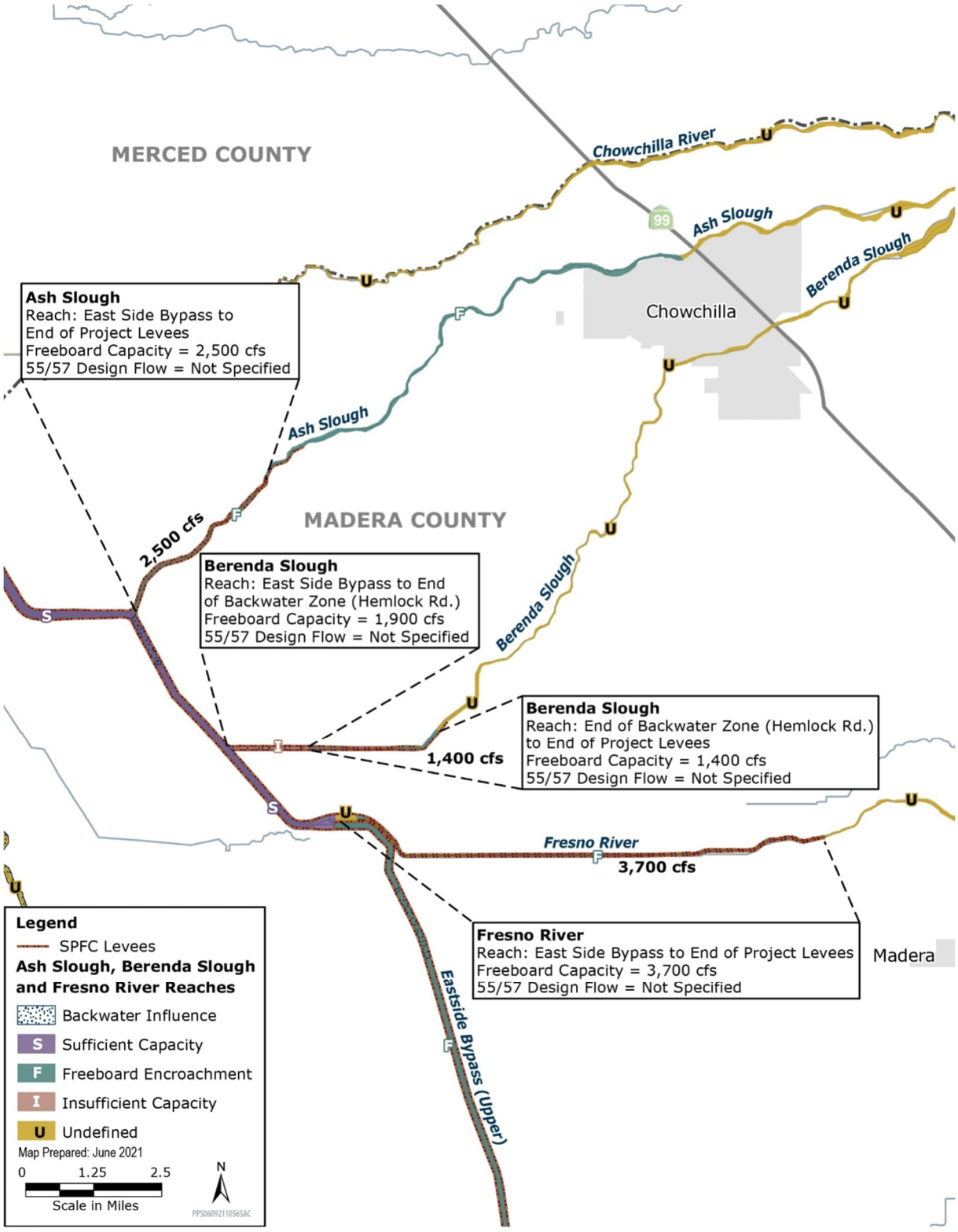

*Source: DWR 2022b.*

## Figure 4-7. 2022 Flood System Status Report Update Eastside Bypass and Chowchilla Bypass Capacity Reach Map



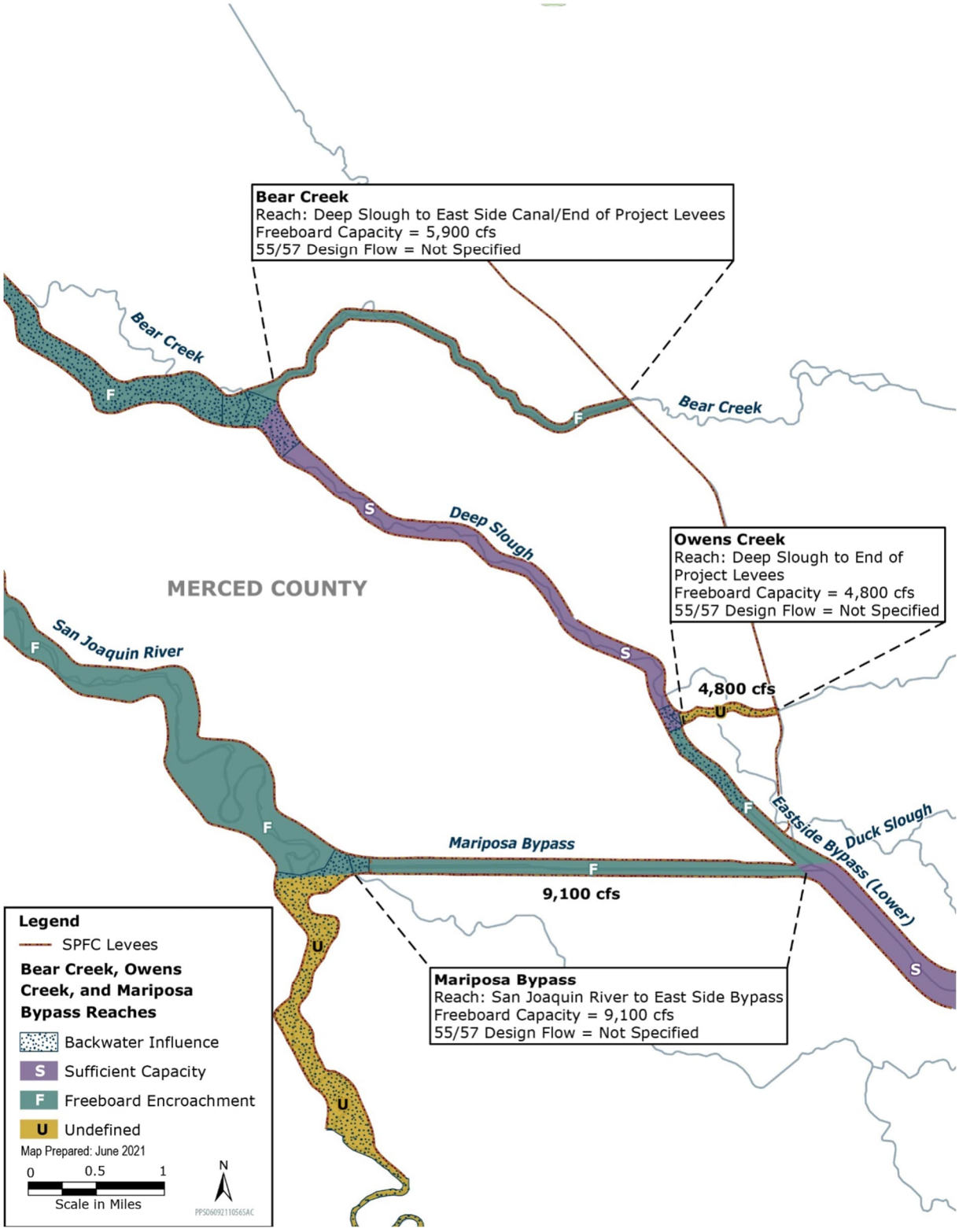

*Source: DWR 2022b.*

## Figure 4-8. 2022 Flood System Status Report Update Ash Slough, Berenda Slough, and Fresno River Capacity Reach Map




*Source: DWR 2022b.*

## Figure 4-9. 2022 Flood System Status Report Update Bear Creek, Owens Creek, and Mariposa Bypass Capacity Reach Map




*Source: DWR 2022b.*

### 4.4.2 Physical Condition Issues and Deficiencies

The 2022 FSSR (DWR 2022b) describes the current physical condition of SPFC facilities at a system-wide level to support monitoring and tracking of metrics related to performance of the CVFPP over time.

DWR has been conducting SPFC levee evaluations of failure modes against current criteria in coordination with USACE and other partner agencies since 2007. SPFC levee conditions are rated using a combination of data from the DWR Levee Evaluations Program and DWR inspection data. As part of the system-wide analysis, information about rural and non-SPFC levees is also included in DWR's NULE Project.

To facilitate a consistent assessment approach, DWR's Levee Assessment Tool was developed for the NULE Project (DWR 2010a). The Levee Assessment Tool assigns a hazard classification based on a combination of geotechnical data and past levee performance. The Levee Assessment Tool allows for a systematic, repeatable assessment of levee hazard indicators.

Hazard categories represent a preliminary analysis of levee conditions. During the NULE Project, DWR helped guide subsequent field activities and prepare preliminary remedial alternatives (and associated cost estimates) necessary for levee repairs and improvements to attain acceptable levee performance. During levee assessments, each levee segment was assigned one of the following hazard categories for each failure mode:

- Meets Criteria – When water reaches the assessment water surface elevation, the performance criteria for the failure modes is met.
- Does Not Meet Criteria – When water reaches the assessment water surface elevation, the performance criteria for the failure modes is not met.
- Not Assessed – There was no evaluation completed for a given levee segment, or the information obtained was insufficient to complete a determination of Meets Criteria or Does Not Meet Criteria.

## 4.5 2024 Central Valley Floodplain Evaluation and Delineation Modeling Data from Friant Dam to the Merced River

The latest hydraulic modeling conducted by DWR's CVFED Program was requested to perform an analysis of current channel and bypass conveyance capacities. The data were received in March 2024 with files dated February 29, 2024. Like the 2022 FSSR (DWR 2022b), which used 2009 data, estimated current channel capacities were determined as the flow rate that occurs when the water surface encroaches into the design freeboard. Current capacities were estimated using profile plots from HEC-RAS modeling results (DWR 2024). The estimated current capacities are compared to original published design flows in Table 5-1. The results show a significant decrease in the estimated flow capacities as compared to the original published design capacities, with reductions of up to 67% in critical reaches of the flood system.

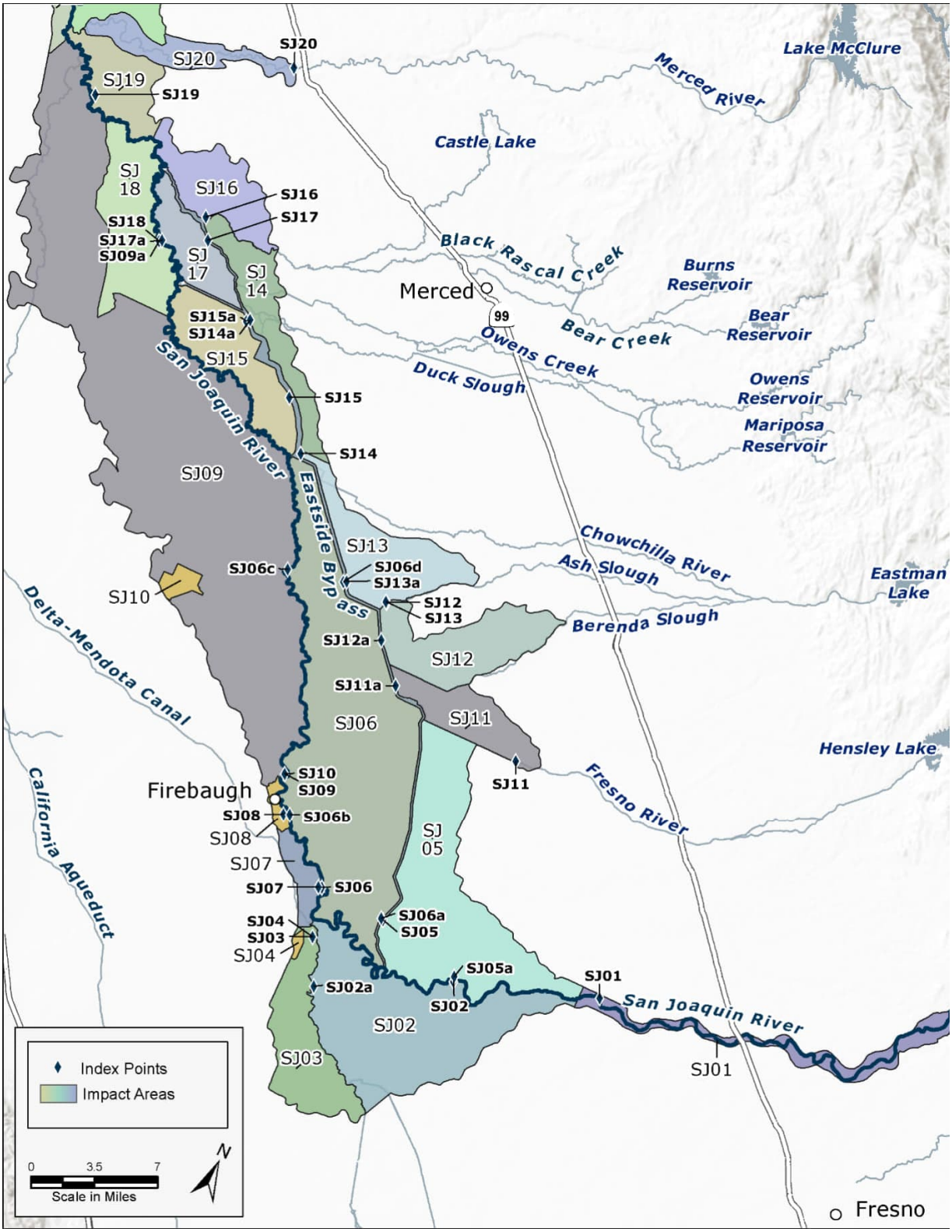
## 4.6 2024 Channel Capacity Report by the San Joaquin River Restoration Program

Reclamation publishes a Channel Capacity Technical Report (CCTR) for the SJRRP every few years. The 2024 report was reviewed as part of this system assessment. The reports are designed to determine the amount of water that Reclamation can release through the system, for the SJRRP program, without causing seepage problems. Though estimates on channel capacity are provided in the 2024 report, these estimates are only applicable for restoration program flows, not flood management releases, and are often much less than the flows the channels will convey during flood events. In this assessment, estimates of flood flow capacity, which are based on freeboard criteria, generally exceed the levee seepage and slope stability criteria that define the SJRRP existing capacity limits. Therefore, the capacity information from the CCTR was not considered relevant to this assessment.

## 4.7 Flood Risk Analysis in 2022 Central Valley Flood Protection Plan Update, Appendix C

The 2022 CVFPP Update, Appendix C (DWR 2022a) documents a flood risk analysis that was conducted to simulate EAD from flood scenarios. Flood risk is computed at an index point, which is a simulated levee breach location that creates flooding at a corresponding impact area. The index points and impact areas used in the analysis of the USJR region are shown on Figure 4-10. Nearly all of the impact areas fall within the Project. The EAD is highest for areas that include the west side of the Chowchilla Bypass, the community of Firebaugh, and the east side of the Chowchilla Bypass.

## Figure 4-10. Upper San Joaquin River Index Points and Impact Areas




*Source: DWR 2022b.*

## 4.8 2023 California Department of Water Resources Non-Urban Levee Seepage Evaluation

DWR's draft NULSE (DWR forthcoming) contains figures showing collected data and observations about seepage and levee strength. The draft NULSE is not finalized, but for the purposes of this assessment, the draft NULSE was used to identify key seepage and levee strength issues in the District and compare with similar data from the 2015 USJR RFMP (SJRFCPA 2015), the Fall 2022 DWR Inspection Report (DWR 2022c), the 2022 CVFPP Update (DWR 2022a), and the 2022 FSSR (DWR 2022b).

In the report, DWR developed performance index (PI) scores that evaluate the performance of a levee segment for under-seepage, through-seepage, and suspected seepage-related slope stability deficiencies. The PI is a function of two components, which were developed during DWR's NULE program and FSRP and are as follows:

- Weighted Hazard Indicator Score – This score is mathematically estimated based on geotechnical and geologic conditions, levee geometry, piping potential, and water head at the design water level. The presence of a waterside blanket, penetrations, animal burrows and landside excavations or ditches were also considered.
- Past Performance Rating – This rating is based on documented historical levee performance issues, such as seepage, boils, cracks, slumps, breaches, or other conditions.

Additionally, a risk exposure study for each levee segment considered population, the percentage of impacted area containing disadvantaged communities, agricultural and structural values, critical infrastructure, transportation infrastructure, and other essential facilities.

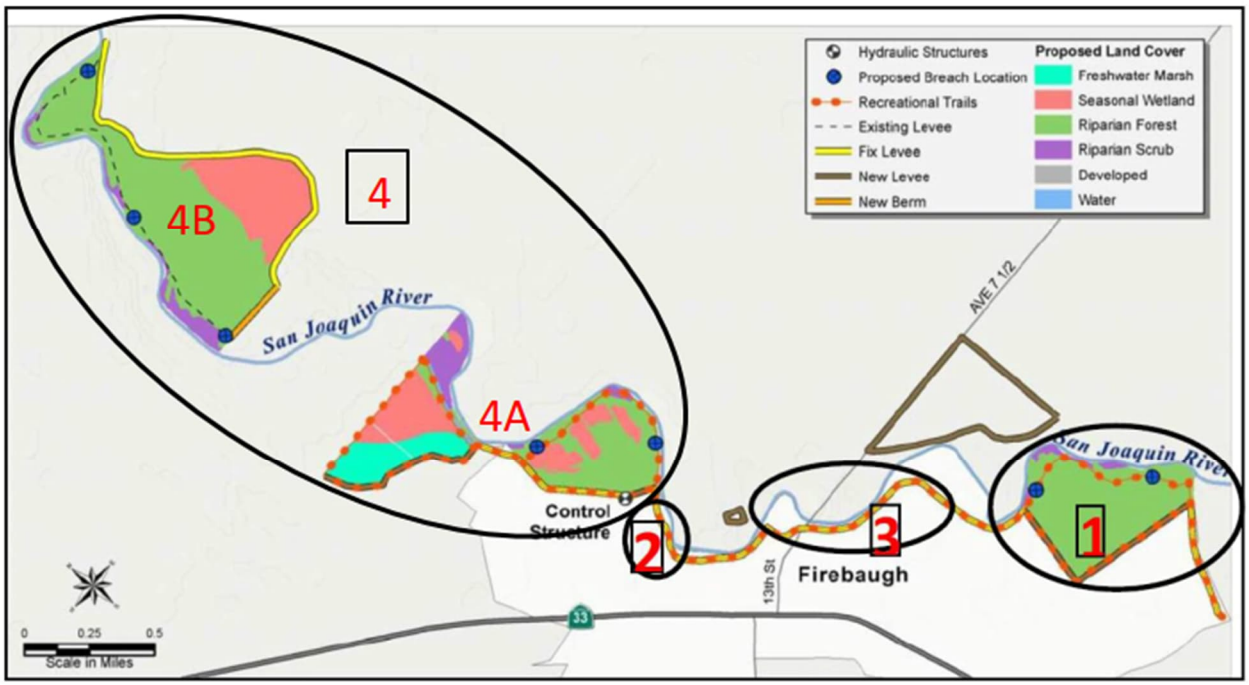
## 4.9 Firebaugh Multi-Benefit Flood Management Project Flood Risk Reduction Feasibility Study

The city of Firebaugh is a disadvantaged community with a history of flooding. Establishing 100-year flood protection for Firebaugh could combine structural flood protection (that is, levee improvements) with potential levee setbacks and ecosystem restoration. In June 2022, a feasibility study was finalized, titled *Firebaugh Multi-Benefit Flood Management Project Flood Risk Reduction Feasibility Study* (Gouveia 2022). Projects, identified in the feasibility study, involve levee improvements to protect vulnerable areas and critical facilities in the city of Firebaugh through levee setbacks on parcels adjacent to and near Firebaugh. The projects are shown on Figure 4-11 as follows:

- Project Area 1 – Setback levee and riparian restoration at wastewater treatment plant
- Project Area 2 – Stabilization of eroding bank at sharp bend in river
- Project Area 3 – Setback levee segment to protect water treatment plant/rodeo grounds
- Project Area 4 – Ecosystem restoration projects

These projects would provide expanded channel capacity and decreased velocities in high-risk areas, as well as opportunities for ecosystem restoration and recreation. This multi-benefit approach could provide reduced residual flood risk and improved system resilience in Firebaugh while also restoring natural processes such as channel meander, floodplain inundation, and restoration of critical wildlife habitat. Adding trails and enhancing recreation in and adjacent to Firebaugh could also be possible.

## Figure 4-11. Firebaugh Feasibility Study Area

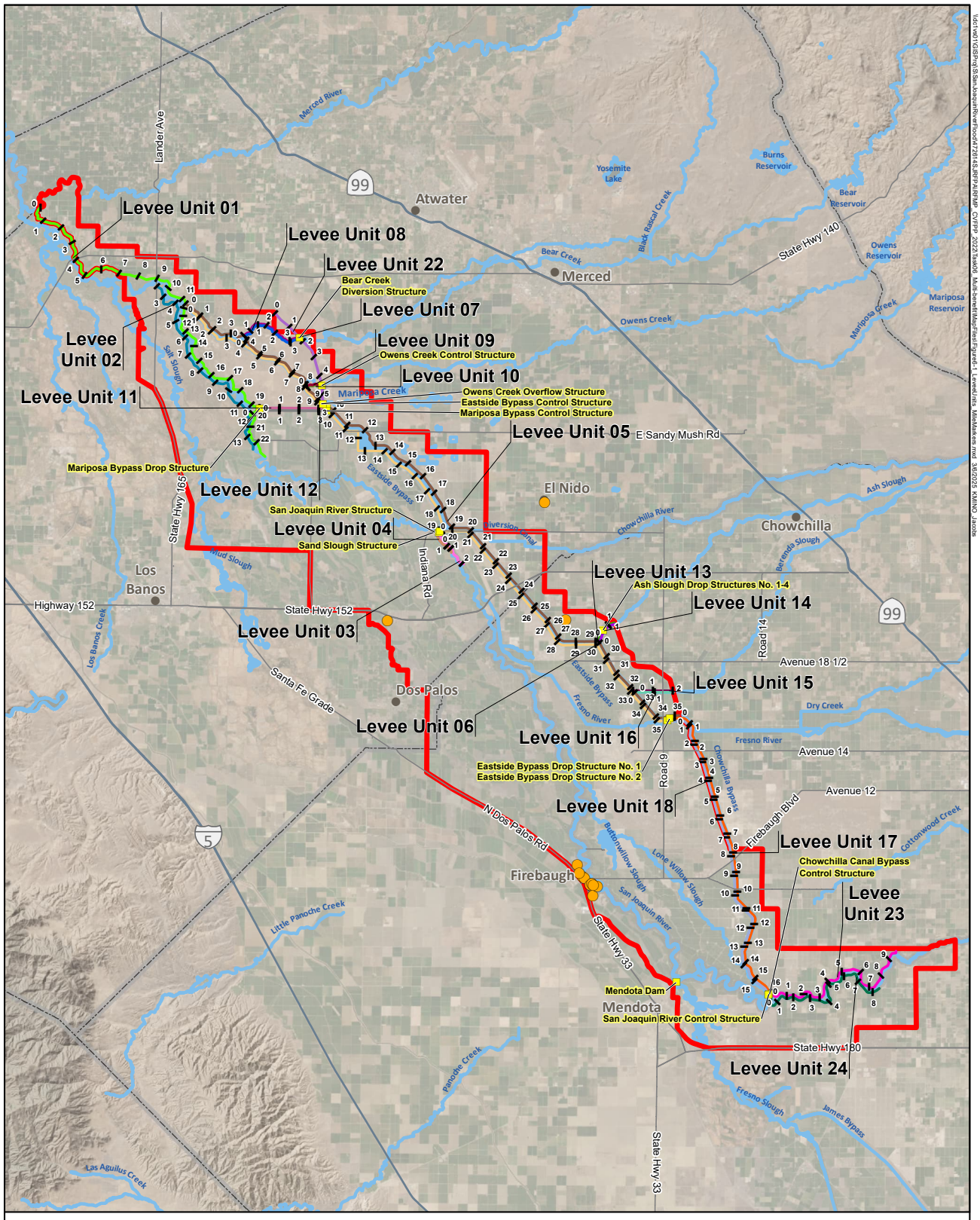



*Source: Gouveia 2022.*

# Chapter 5 Flood Management Issues and System Deficiencies

This chapter synthesizes data from Chapter 4 into a concise summary of District flood management issues. Figure 5-1 shows the overall District boundary with LU mileage, District facilities, and essential facilities (such as schools and hospitals). Figure 5-2 shows the same basemap overlaid with all levee integrity issues. Because there are numerous deficiencies that overlap, Figures 5-3 through 5-11 show more focused maps organized by LU group so the viewer may better differentiate between levee integrity issues. Appendix B documents symbols or linework that may be difficult to perceive on the detailed maps and tabulates all data from Chapter 4.

In addition, a map of essential facilities in the city of Firebaugh is provided on Figure 5-12. A limited amount of data on levee integrity issues was available for the Firebaugh area, as the levees along the San Joaquin River in the city of Firebaugh are not within the SPFC.



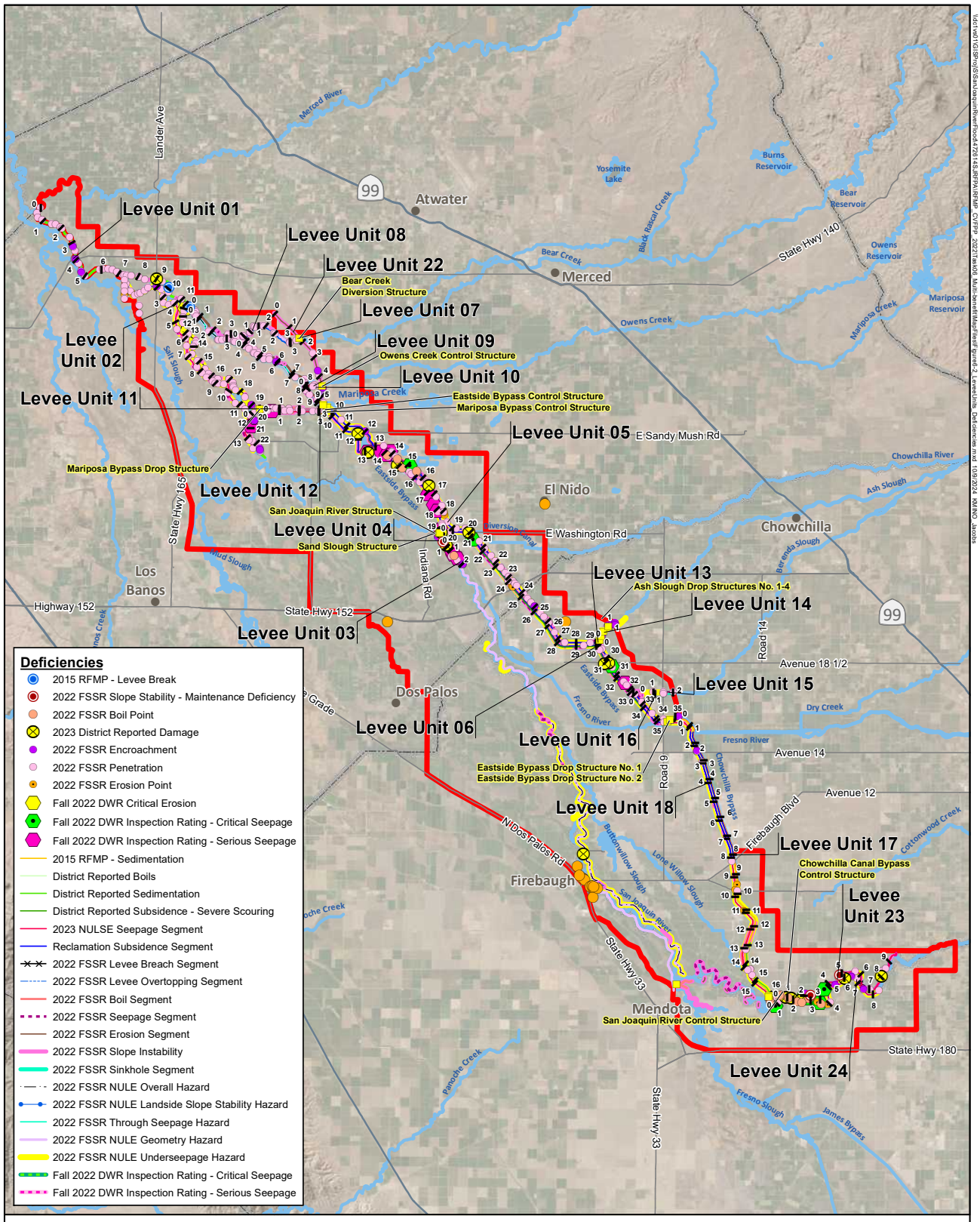

**LEGEND**

- Mile Marker
- City
- Levee Unit 01
- Levee Unit 02
- Levee Unit 03
- Levee Unit 04
- Levee Unit 05
- Levee Unit 06
- Levee Unit 07
- Levee Unit 08
- Levee Unit 09
- Levee Unit 10
- Levee Unit 11
- Levee Unit 12
- Levee Unit 13
- Levee Unit 14
- Levee Unit 15
- Levee Unit 16
- Levee Unit 17
- Levee Unit 18
- Levee Unit 22
- Levee Unit 23
- Levee Unit 24
- Essential Facilities
- LSJLD facilities
- Lower San Joaquin Levee District
- County
- Highway, Interstate

0 4.75 9.5 Miles

N

**FIGURE 5-1**
**All Levee Units with River Miles**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*



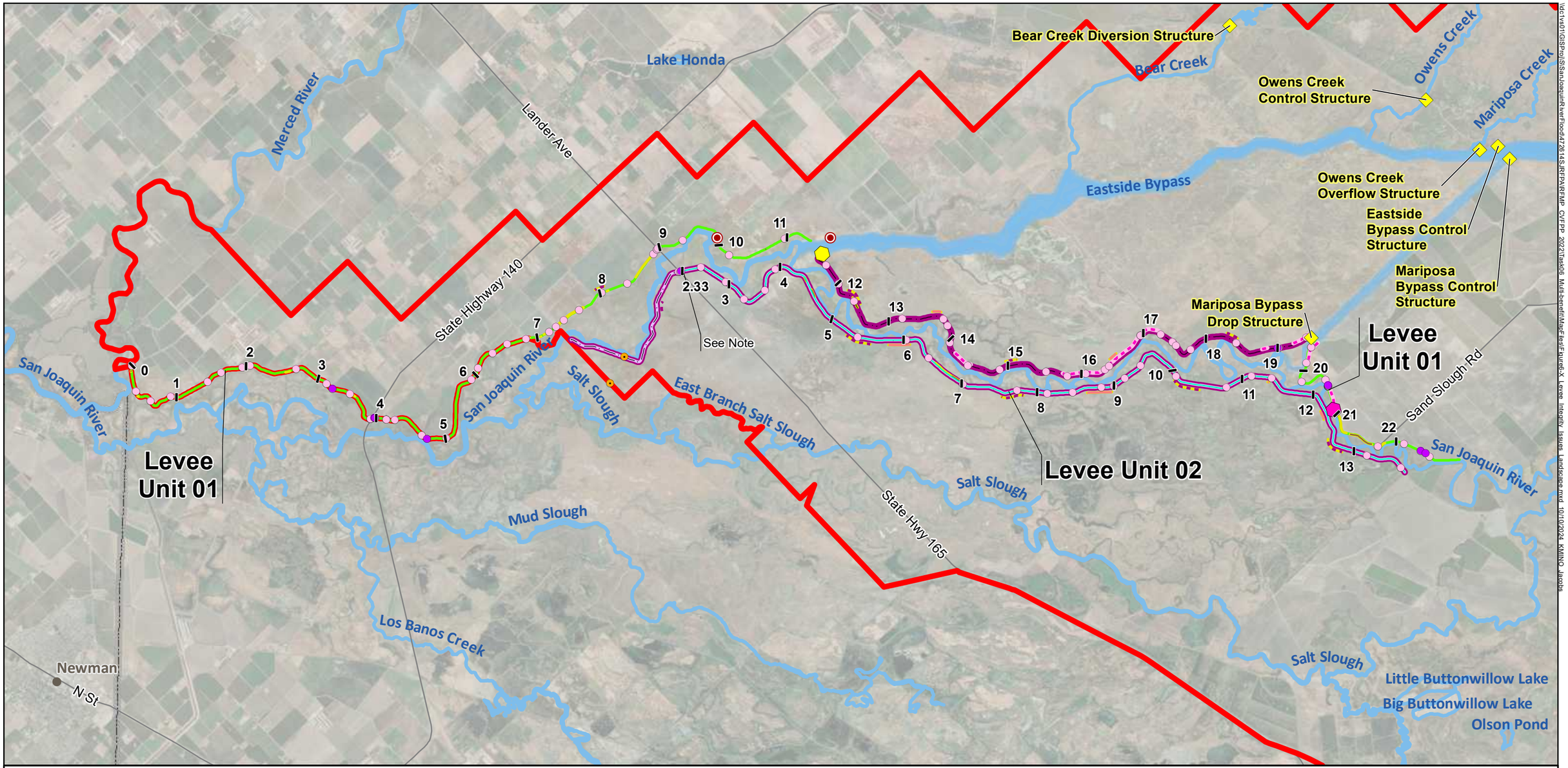

**LEGEND**

- Mile Marker
- City
- Levee Unit 01
- Levee Unit 02
- Levee Unit 03
- Levee Unit 04
- Levee Unit 05
- Levee Unit 06
- Levee Unit 07
- Levee Unit 08
- Levee Unit 09
- Levee Unit 10
- Levee Unit 11
- Levee Unit 12
- Levee Unit 13
- Levee Unit 14
- Levee Unit 15
- Levee Unit 16
- Levee Unit 17
- Levee Unit 18
- Levee Unit 22
- Levee Unit 23
- Levee Unit 24
- Essential Facilities
- LSJLD facilities
- Lower San Joaquin Levee District
- County
- Highway, Interstate

0 4.75 9.5 Miles

N

**FIGURE 5-2**
**All Levee Unit Deficiences with River Miles**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*




**LEGEND**

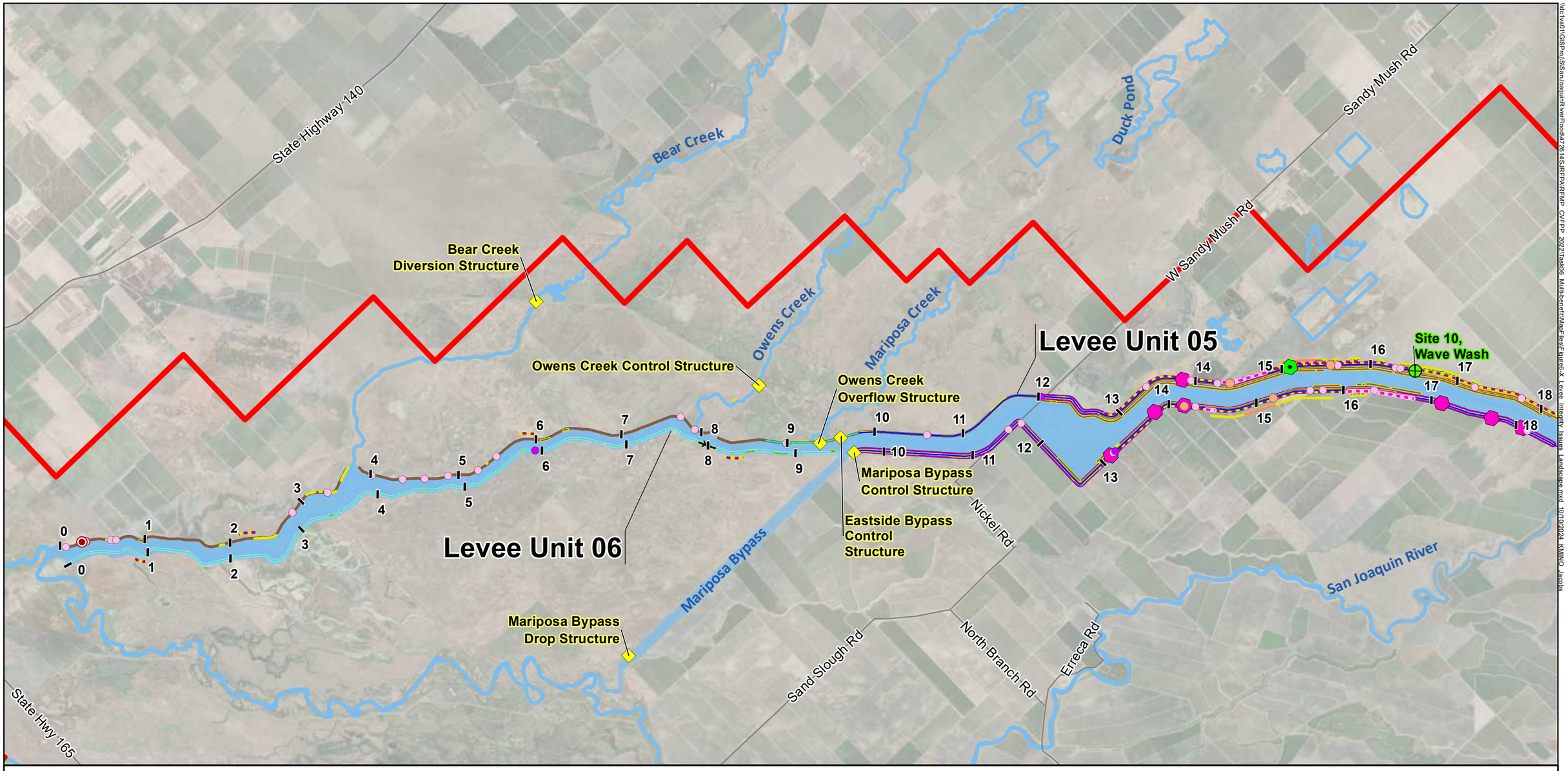
- Fall 2022 DWR Critical Erosion
- Fall 2022 DWR Inspection Rating - Serious Seepage
- 2022 FSSR Encroachment
- 2022 FSSR Penetration
- 2022 FSSR Erosion Point
- 2015 RFMP - Levee Break
- LSJLD facilities
- Mile Marker
- 2023 NULSE Seepage Segment
- Fall 2022 DWR Inspection Rating - Serious Seepage
- 2022 FSSR Boil Segment
- 2022 FSSR Seepage Segment
- 2022 FSSR Erosion Segment
- 2022 FSSR Slope Instability
- 2022 FSSR NULE Overall Hazard
- 2022 FSSR NULE Geometry Hazard
- 2022 FSSR NULE Underseepage Hazard
- Levee Unit 01
- Levee Unit 02
- Lower San Joaquin Levee District
- County

**Note:**
Levee Unit River Mile 0-2.33 removed from O&M Manual

0 2.25
Miles

1 inch = 1.25 miles

**FIGURE 5-3**
**Levee Unit 01, 02**
**Levee Integrity Issues**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*



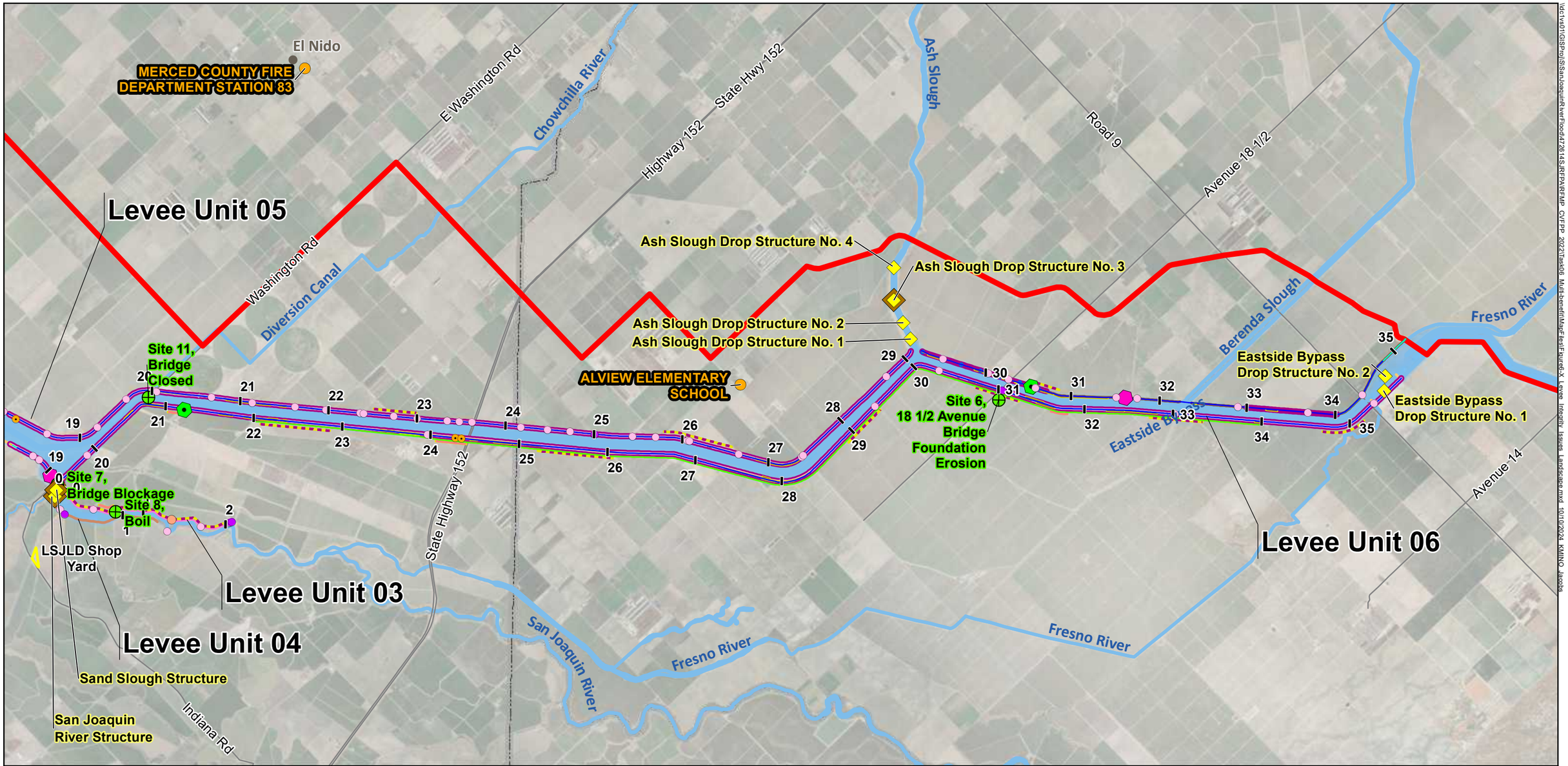

**LEGEND**

- Fall 2022 DWR Inspection Rating - Critical Seepage
- Fall 2022 DWR Inspection Rating - Serious Seepage
- 2022 FSSR Encroachment
- 2022 FSSR Penetration
- 2023 District Reported Damage
- 2022 FSSR Erosion Point
- 2015 RFMP - Levee Break
- 2022 FSSR Boil Point
- LSJLD facilities
- Mile Marker
- 2015 RFMP - Sedimentation
- 2023 NULSE Seepage Segment
- Reclamation Subsidence Segment
- Fall 2022 DWR Inspection Rating - Serious Seepage
- 2022 FSSR Levee Breach Segment
- 2022 FSSR Levee Overtopping Segment
- 2022 FSSR Boil Segment
- 2022 FSSR Seepage Segment
- 2022 FSSR Erosion Segment
- 2022 FSSR Slope Instability
- 2022 FSSR NULE Overall Hazard
- 2022 FSSR Through Seepage Hazard
- 2022 FSSR NULE Geometry Hazard
- 2022 FSSR NULE Underseepage Hazard
- Levee Unit 05
- Levee Unit 06
- Lower San Joaquin Levee District
- County

0 2
Miles

1 inch = 1.1 miles

**FIGURE 5-4**
**Map A - Levee Unit 05, 06**
**Levee Integrity Issues**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*




**LEGEND**

- Fall 2022 DWR Inspection Rating - Critical Seepage
- Fall 2022 DWR Inspection Rating - Serious Seepage
- 2022 FSSR Encroachment
- 2022 FSSR Penetration
- 2023 District Reported Damage
- 2022 FSSR Erosion Point
- Essential Facilities
- 2022 FSSR Boil Point
- LSJLD facilities
- Fall 2022 DWR Inspection Rating - Minimally Acceptable
- Mile Marker
- 2015 RFMP - Sedimentation
- 2023 NULSE Seepage Segment
- Reclamation Subsidence Segment
- District Reported Subsidence - Severe Scouring*
- 2022 FSSR Boil Segment
- 2022 FSSR Seepage Segment
- 2022 FSSR Erosion Segment
- 2022 FSSR Slope Instability
- 2022 FSSR NULE Overall Hazard
- 2022 FSSR NULE Landside Slope Stability Hazard
- 2022 FSSR Through Seepage Hazard
- 2022 FSSR NULE Geometry Hazard
- 2022 FSSR NULE Underseepage Hazard
- Levee Unit 03
- Levee Unit 04
- Levee Unit 05
- Levee Unit 06
- Lower San Joaquin Levee District
- County

*District reported that subsidence is so deep in this area that large flood water will not hit the toe of levee

0 2
Miles

1 inch = 1.1 miles

**FIGURE 5-5**
**Map B - Levee Unit 03, 04, 05, 06**
**Levee Integrity Issues**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*

Levee Unit 07
Levee Unit 08
Levee Unit 09
Levee Unit 10
Levee Unit 11
Levee Unit 12
Levee Unit 22
Bear Creek
Bear Creek Diversion Structure
Owens Creek
Owens Creek Control Structure
Owens Creek Overflow Structure
Mariposa Creek
Eastside Bypass
Eastside Bypass Control Structure
Mariposa Bypass
Mariposa Bypass Control Structure
Mariposa Bypass Drop Structure
Sand Slough Rd

**LEGEND**

- Fall 2022 DWR Inspection Rating - Serious Seepage
- 2022 FSSR Encroachment
- 2022 FSSR Penetration
- 2022 FSSR Erosion Point
- LSJLD facilities
- Mile Marker
- 2023 NULSE Seepage Segment
- Fall 2022 DWR Inspection Rating - Serious Seepage
- 2022 FSSR Boil Segment
- 2022 FSSR Erosion Segment
- 2022 FSSR Slope Instability
- 2022 FSSR NULE Geometry Hazard
- Levee Unit 07
- Levee Unit 08
- Levee Unit 09
- Levee Unit 10
- Levee Unit 11
- Levee Unit 12
- Levee Unit 22
- Lower San Joaquin Levee District
- County

**FIGURE 5-6**
**Levee Units 07, 08, 09, 10, 11, 12, 22**
**Levee Integrity Issues**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*

0 1
Miles

1 inch = 0.6 miles

Eastside Bypass

Eastside Bypass

Site 7,
Bridge
Blockage

and Slough Structure

0

0

Washington Rd

San Joaquin
River Structure

Site 8,
Boil

1

1

Levee Unit 03

Levee Unit 04

2

San Joaquin River

Indiana Ave

LSJLD
Shop Yard

Indiana Rd

**LEGEND**

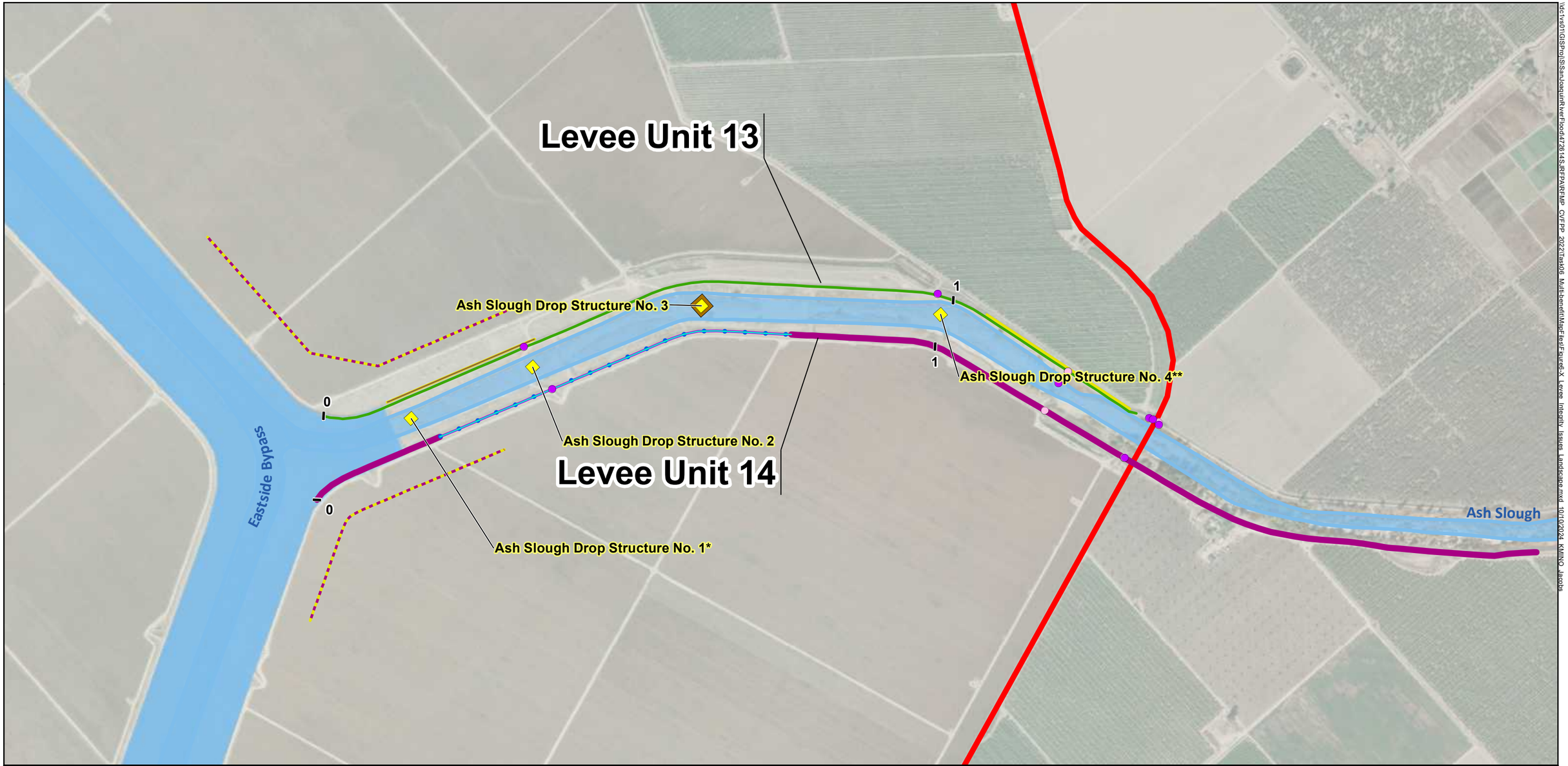
- Fall 2022 DWR Inspection Rating - Serious Seepage
- 2022 FSSR Encroachment
- 2022 FSSR Penetration
- 2023 District Reported Damage
- 2022 FSSR Boil Point
- LSJLD facilities
- Fall 2022 DWR Inspection Rating - Minimally Acceptable
- Mile Marker
- 2022 FSSR Boil Segment
- 2022 FSSR Seepage Segment
- 2022 FSSR Slope Instability
- Levee Unit 03
- Levee Unit 04
- Lower San Joaquin Levee District
- County

**FIGURE 5-7**
**Levee Units 03, 04**
**Levee Integrity Issues**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*

0 0.4
Miles

1 inch = 0.2 miles

\\dc1vs01\GISProj\SJSanJoaquinRiverFlood\472614SJRFPA\REMP_CVFPP_2022\Task06_MultiBenefitMapFiles\Figure6.X_Levee_Integrity_Issues_Landscape.mxd 10/10/2024 KMINO Jacobs




**LEGEND**

- 2022 FSSR Encroachment
- 2022 FSSR Penetration
- LSJLD facilities
- Fall 2022 DWR Inspection Rating - Minimally Acceptable
- Mile Marker
- 2022 FSSR Seepage Segment
- 2022 FSSR Erosion Segment
- 2022 FSSR Slope Instability
- 2022 FSSR NULE Landside Slope Stability Hazard
- 2022 FSSR Through Seepage Hazard
- 2022 FSSR NULE Underseepage Hazard
- Levee Unit 13
- Levee Unit 14
- Lower San Joaquin Levee District
- County

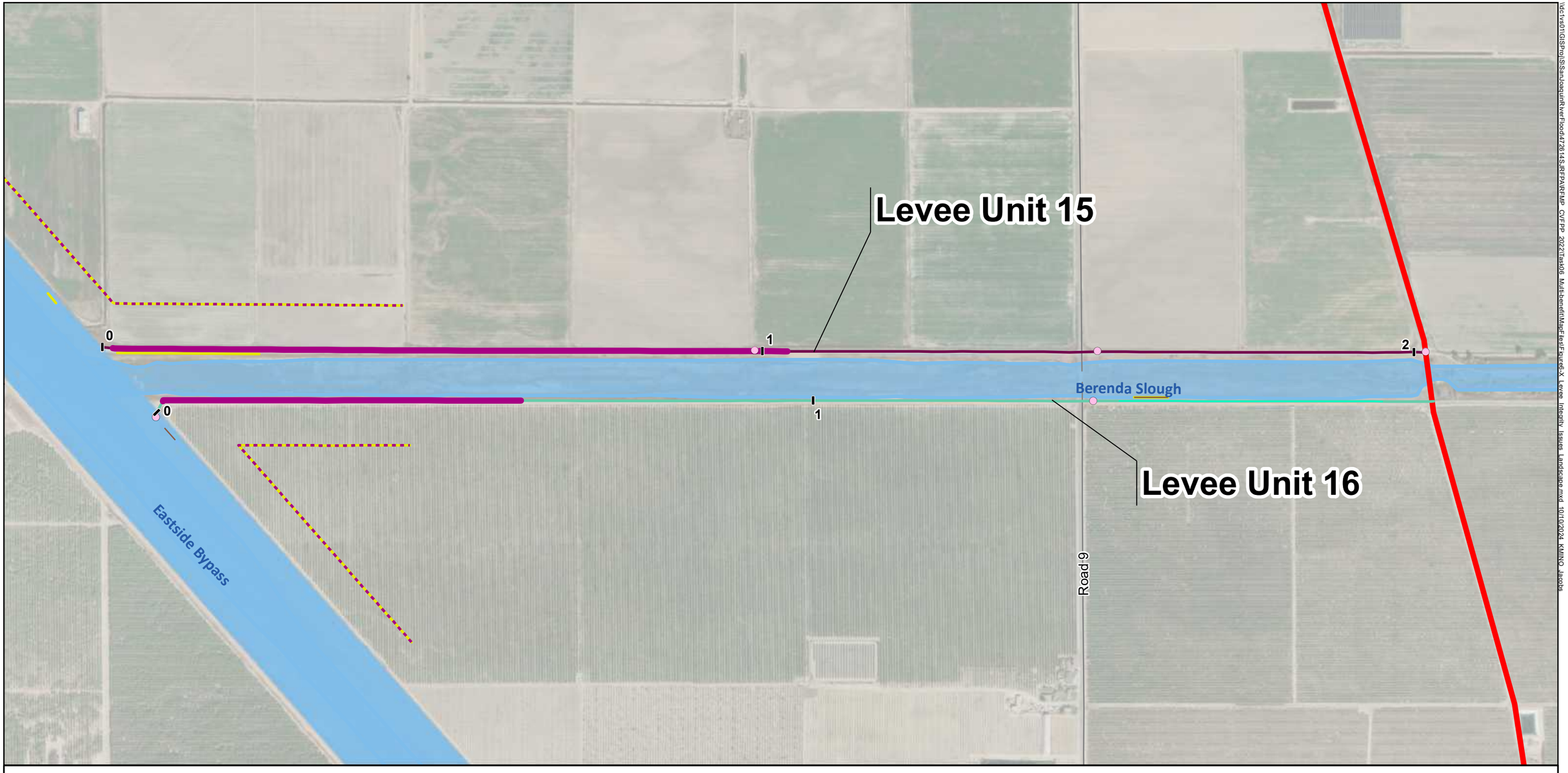
*DWR inspection is monitoring movement of drop structure

**District reported sedimentation Issues at Ash Slough Drop Structure No. 4.

**FIGURE 5-8**
**Levee Units 13, 14**
**Levee Integrity Issues**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*

0 0.3
Miles

1 inch = 0.15 miles




**LEGEND**

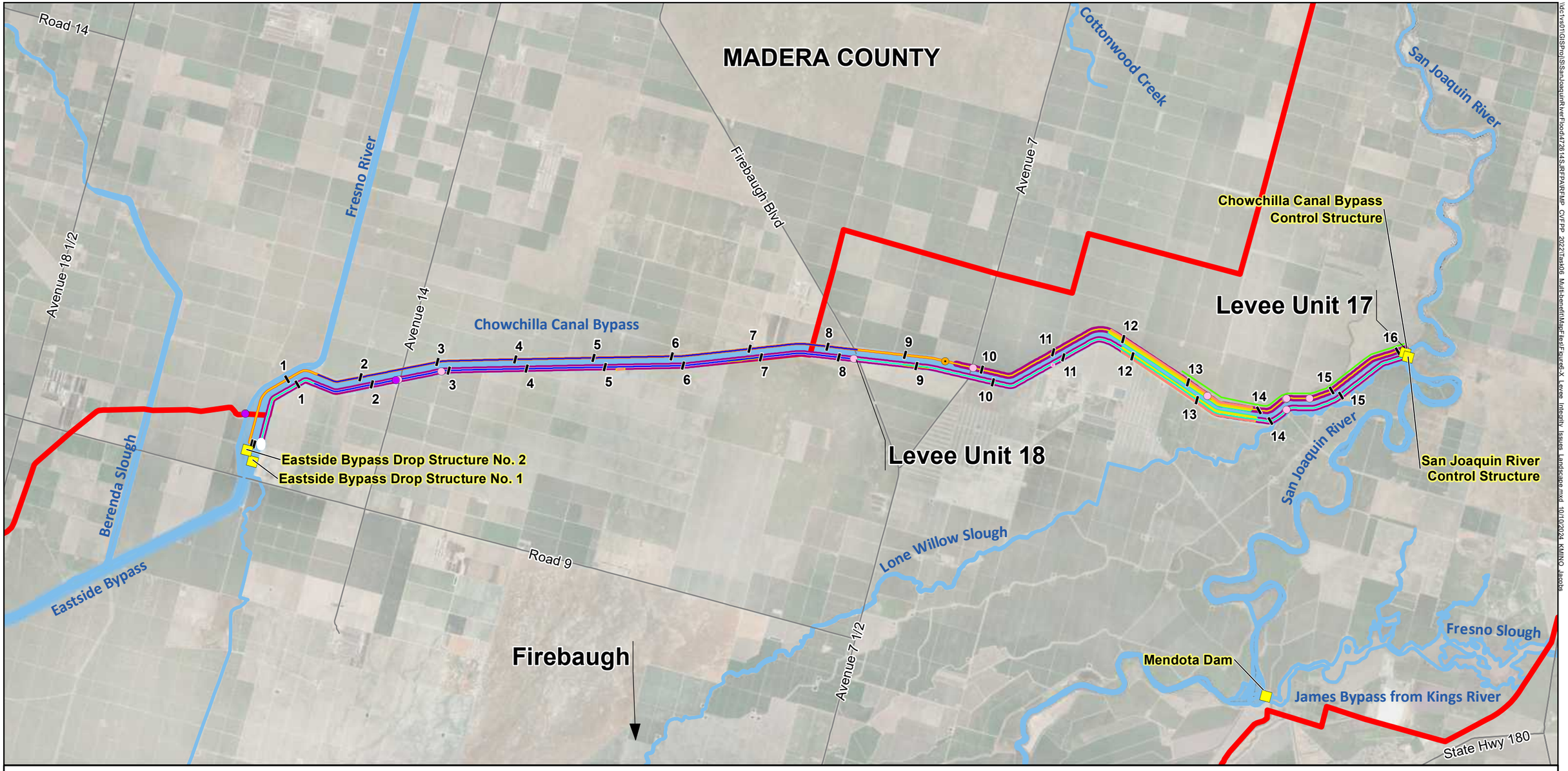
- 2022 FSSR Penetration
- Mile Marker
- 2022 FSSR Seepage Segment
- 2022 FSSR Erosion Segment
- 2022 FSSR Slope Instability
- 2022 FSSR Through Seepage Hazard
- 2022 FSSR NULE Underseepage Hazard
- Levee Unit 15
- Levee Unit 16
- Lower San Joaquin Levee District
- County

**FIGURE 5-9**
**Levee Units 15, 16**
**Levee Integrity Issues**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*

0 0.3
Miles

1 inch = 0.15 miles

N



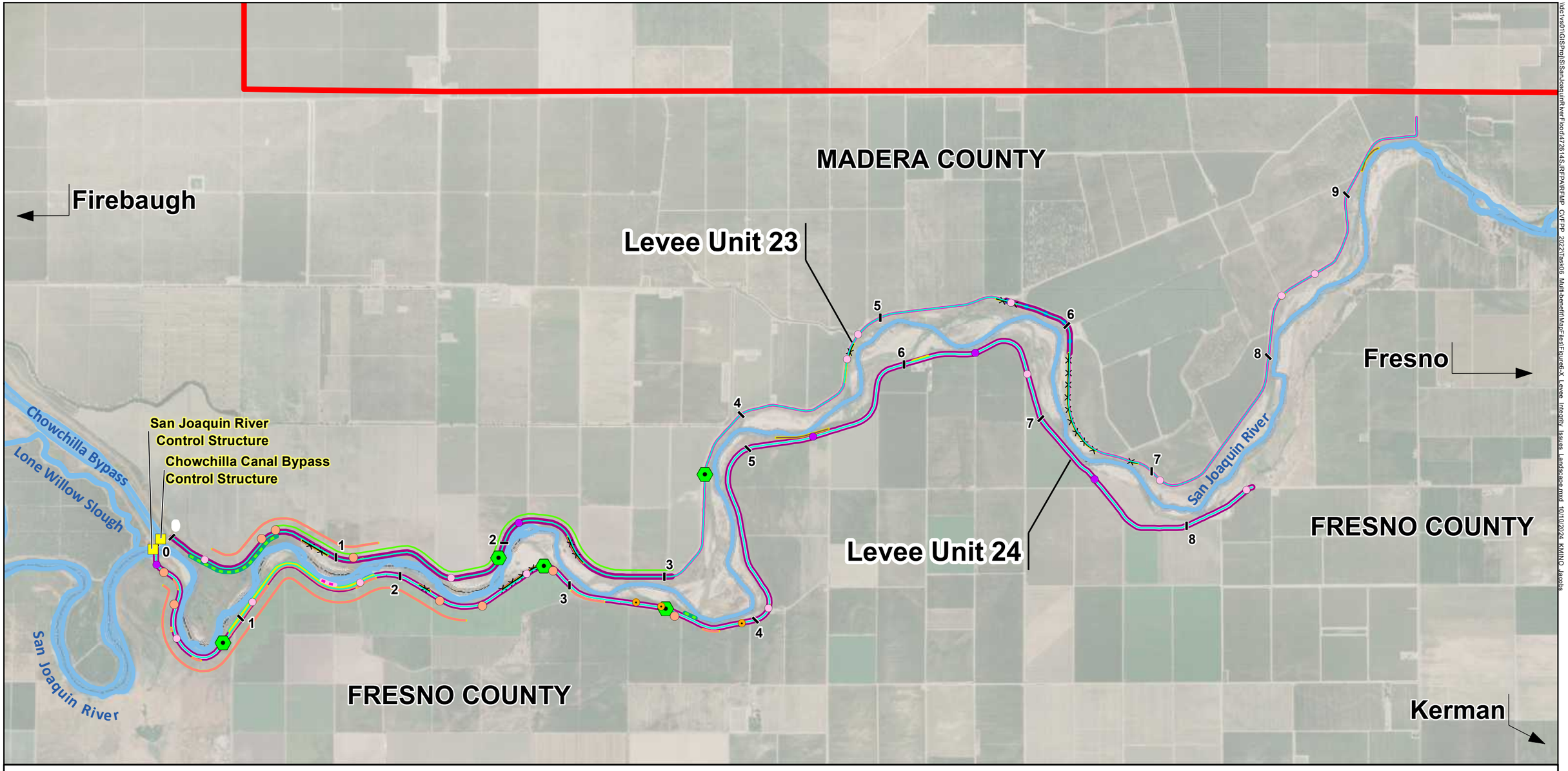

**LEGEND**

- 2022 FSSR Encroachment
- 2022 FSSR Penetration
- 2022 FSSR Erosion Point
- LSJLD facilities
- Mile Marker
- 2015 RFMP - Sedimentation
- 2023 NULSE Seepage Segment
- Reclamation Subsidence Segment
- District Reported Sedimentation
- Fall 2022 DWR Inspection Rating - Serious Seepage
- 2022 FSSR Boil Segment
- 2022 FSSR Erosion Segment
- 2022 FSSR Slope Instability
- 2022 FSSR Sinkhole Segment
- 2022 FSSR NULE Overall Hazard
- 2022 FSSR Through Seepage Hazard
- 2022 FSSR NULE Geometry Hazard
- 2022 FSSR NULE Underseepage Hazard
- Levee Unit 17
- Levee Unit 18
- Lower San Joaquin Levee District
- County

**FIGURE 5-10**
**Levee Units 17, 18**
**Levee Integrity Issues**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*

0 2.25
Miles

1 inch = 1.25 miles




**LEGEND**

- Fall 2022 DWR Inspection Rating - Critical Seepage
- 2022 FSSR Encroachment
- 2022 FSSR Penetration
- 2022 FSSR Erosion Point
- 2022 FSSR Boil Point
- LSJLD facilities
- Mile Marker
- 2023 NULSE Seepage Segment
- District Reported Boils*
- Fall 2022 DWR Inspection Rating - Serious Seepage
- Fall 2022 DWR Inspection Rating - Critical Seepage
- 2022 FSSR Levee Breach Segment
- 2022 FSSR Boil Segment
- 2022 FSSR Seepage Segment
- 2022 FSSR Erosion Segment
- 2022 FSSR Slope Instability
- 2022 FSSR Sinkhole Segment
- 2022 FSSR NULE Overall Hazard
- 2022 FSSR NULE Landside Slope Stability Hazard
- 2022 FSSR Through Seepage Hazard
- 2022 FSSR NULE Geometry Hazard
- 2022 FSSR NULE Underseepage Hazard
- Levee Unit 23
- Levee Unit 24
- Lower San Joaquin Levee District
- County

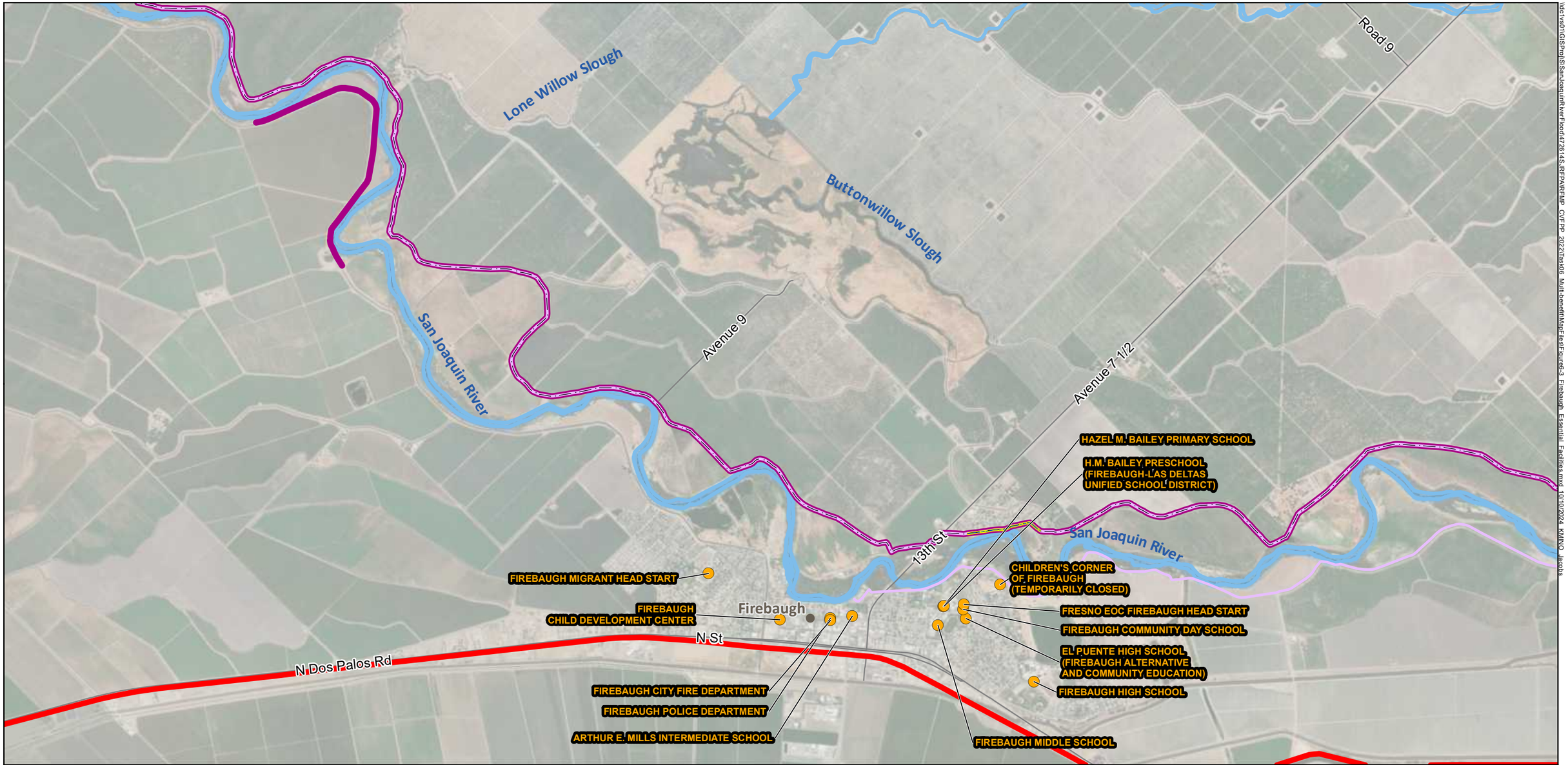
*Dozens of boils on levee slope and 10 feet away from toe of levee.
2 locations had response from Cal Office of Emergency Services in 2023 storm.

0 1
Miles

1 inch = 0.5 miles

N

**FIGURE 5-11**
**Levee Units 23, 24**
**Levee Integrity Issues**
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*




**LEGEND**

- Essential Facilities
- 2022 FSSR Levee Overtopping Segment
- 2022 FSSR Slope Instability
- 2022 FSSR NULE Overall Hazard
- 2022 FSSR NULE Geometry Hazard
- 2022 FSSR NULE Underseepage Hazard
- Lower San Joaquin Levee District
- County

Note:
*While 2022 FSSR data was readily available, no further data was added in the Firebaugh area as the levees are not under LSJLD jurisdiction. For more visuals on Firebaugh levee issues, see the June 2022 Firebaugh Multi-benefit Flood Management Project Flood Risk Reduction Feasibility Study.

0 1
Miles
1 inch = 0.5 miles

**FIGURE 5-12**
**City of Firebaugh Essential Facilities and Levee Integrity Issues***
Regional Flood Management Plan
*Lower San Joaquin Levee District System Assessment and Recommendations*

## 5.1 Channel Capacity Issues

The 2023 water year demonstrated that the District has flow capacity restrictions, and capital improvement projects are needed for system facilities to properly function according to their original published design. This section documents the evaluation of capacity constraints on river channel and bypass flood flow based on hydraulic modeling results, District observation, and reported issues.

### 5.1.1 Hydraulic Model Results

Hydraulic modeling results were used along with 2022 FSSR information (DWR 2022b) to provide estimates of existing system conveyance capacity by system reach. The results show a maximum capacity loss of 67% in the Eastside Bypass and nine reaches with a reduction in flow capacity of equal to or greater than 25%. Table 5-1 compares the original design flows from the 1964 Plan Published Designs (Figure 2-1) to the estimated current flow capacity at design freeboard (3 feet for rivers, 4 feet for rivers and streams). Current capacity was estimated from either the 2022 FSSR (Section 4.4.1) or recent HEC-RAS modeling results from the 2024 CVFED data (DWR 2024) (Section 4.5). Because the 2022 FSSR relies on CVFED Program (2009) data, the more recent 2024 HEC-RAS modeling results take precedence. For the remaining levee sections where 2024 HEC-RAS modeling results were not available, results from the 2022 FSSR are shown. Reaches with increased capacity may be caused by channel deepening due to high flow velocities causing channel scour or channel reaches exhibiting increased gradients from subsidence. Reaches with reduced flow capacity may be caused by subsidence reducing channel gradients and resulting sediment buildup.

**Table 5-1. Original Published Design Flow Capacity Versus Estimated Current Capacity at Design Freeboard**

| Levee Unit | Location (Levee Mile) | Bypass or River | Location | Source Document | Published Design Flow Capacity (cfs) | Estimated Current Flow Capacity (cfs) | Reduced (-) and Increased (+) Flow Percentage |
|---|---|---|---|---|---|---|---|
| 1 / 2 | LMs[a] 0 to 11.5 | San Joaquin River | d/s - Merced River<br>u/s - Eastside Bypass | 2022 FSSR (DWR 2022b) | 26,000 | 19,000 | -27% |
| | LMs[a] 11.5 to 19.5 | San Joaquin River | d/s - Eastside Bypass<br>u/s - Mariposa Bypass Drop Structure | 2022 FSSR (DWR 2022b) | 10,000 | 8,400 | -16% |
| | LMs[a] 19.5 to end | San Joaquin River | d/s - Mariposa Bypass Drop Structure<br>u/s - End of Project Levees | 2022 FSSR (DWR 2022b) | 1,500 | 1,100 | -27% |
| 3 / 4 | All | San Joaquin River | d/s - Sand Slough Control Structure<br>u/s - End of Project Levees | 2022 FSSR (DWR 2022b) | 4,500 | 2,600 | -42% |
| 5 / 6 | LMs[b] 0 to 3.7 | Eastside Bypass | d/s - San Joaquin River<br>u/s - Bear Creek | 2024 HEC-RAS Results (DWR 2024) | 18,500 | 6,100 | -67% |
| | LMs[b] 3.7 to 7.9 | Eastside Bypass | d/s - Bear Creek<br>u/s - Owens Creek | 2024 HEC-RAS Results (DWR 2024) | 13,500 | 8,200 | -39% |
| | LMs[b] 7.9 to 9.8 | Eastside Bypass | d/s - Owens Creek<br>u/s - Mariposa Bypass | 2024 HEC-RAS Results (DWR 2024) | 12,000 | 9,200 | -23% |
| | LMs[b] 9.8 to 18.7 | Eastside Bypass | d/s - Mariposa Bypass<br>u/s - Sand Slough Control Structure | 2024 HEC-RAS Results (DWR 2024) | 16,500 | 10,900 | -34% |
| | LMs[b] 18.7 to 29.1 | Eastside Bypass | d/s - Sand Slough Control Structure<br>u/s - Ash Slough | 2024 HEC-RAS Results (DWR 2024) | 17,500 | 9,600 | -45% |
| | LMs[b] 29.1 to 32.2 | Eastside Bypass | d/s - Ash Slough<br>u/s - Berenda Slough | 2024 HEC-RAS Results (DWR 2024) | 12,000 | 15,200 | +27% |
| | LMs[b] 32.2 to 35.2 | Eastside Bypass | d/s - Berenda Slough<br>u/s - Fresno River | 2024 HEC-RAS Results (DWR 2024) | 10,000 | 11,200 | +12% |
| 7 / 8 | All | Bear Creek | d/s - Eastside Bypass<br>u/s - End of Project Levees | 2022 FSSR (DWR 2022b) | 7,000 | 5,900 | -16% |
| 9 / 10 | All | Owens Creek | d/s - Eastside Bypass<br>u/s - End of Project Levees | 2022 FSSR (DWR 2022b) | 2,000 | 4,800 | +140% |
| 11 / 12 | All | Mariposa Bypass | d/s - San Joaquin River<br>u/s - Eastside Bypass | 2024 HEC-RAS Results (DWR 2024) | 8,500 | 6,400 | -25% |
| 13 / 14 | All | Ash Slough | d/s - Eastside Bypass<br>u/s - End of Project Levees | 2022 FSSR (DWR 2022b) | 5,000 | 2,500 | -50% |
| 15 / 16 | All | Berenda Slough | d/s - Eastside Bypass<br>u/s - End of Project Levees | 2022 FSSR (DWR 2022b) | 2,000 | 1,900 | -5% |
| 17 / 18 | All | Chowchilla Canal Bypass | d/s - Eastside Bypass<br>u/s - San Joaquin River | 2024 HEC-RAS Results (DWR 2024) | 5,500 | 5,500 | 0% |
| 23 / 24 | All | San Joaquin River | d/s - Chowchilla Bypass<br>u/s - End of Project Levees | 2024 HEC-RAS Results (DWR 2024) | 8,000 | 8,000 | 0% |

[a] LM according to LU 1—location applies to channel between LUs 1 and 2.
[b] LM according to LU 5—location applies to channel between LUs 5 and 6.
d/s = downstream
u/s = upstream

## 5.1.2 Observed 2023 Channel Capacity Issues

In a March 2023 memo to CVFPB, the District described scenarios under which the system would not meet capacity needs of projected upstream releases (District 2023b). Later in the water year, these large upstream releases occurred, and although there were no levee breaches or overtopping incidents, significant damage was caused to the system. On June 2, 2023, due to reservoir overfilling at Millerton Reservoir, USACE provided approval to Reclamation to increase releases to 10,000 cfs. DWR's California Data Exchange Center showed 7,557 cfs flowing at the Chowchilla Bypass gauge (5,400 cfs estimated current flow capacity/5,500 cfs published design flow capacity) and 9,301 cfs flowing at the San Joaquin River at Gravelly Ford (9,000 cfs estimated current flow capacity/8,000 cfs published design flow capacity).

Although the Eastside Bypass has an original published design capacity of 16,500 cfs at Sandy Mush Road, the road and bridge were close to overtopping on May 18, 2023 (Figure 5-13) at a measured 10,000 cfs.

**Figure 5-13. Sandy Mush Road Close to Overtopping at 10,000 cfs**

*Source: District staff photo taken on May 18, 2023.*

An additional capacity issue occurred at the Eastside Bypass and San Joaquin River interchange, where the Washington Road Bridge was blocked on January 11, 2023, on the San Joaquin River; the bridge was closed over the Eastside Bypass on March 30, 2023.

The District believes there would have been at least 20 more flood-related issues in the 2023 water year had the District not released more water down the San Joaquin River to the

Mendota Pool. The Mendota Dam is 106 years old, and it is difficult for operators to manually pull dam boards to allow an increased flow of up to 2,000 cfs into the pool.

## 5.2 Levee Deficiencies

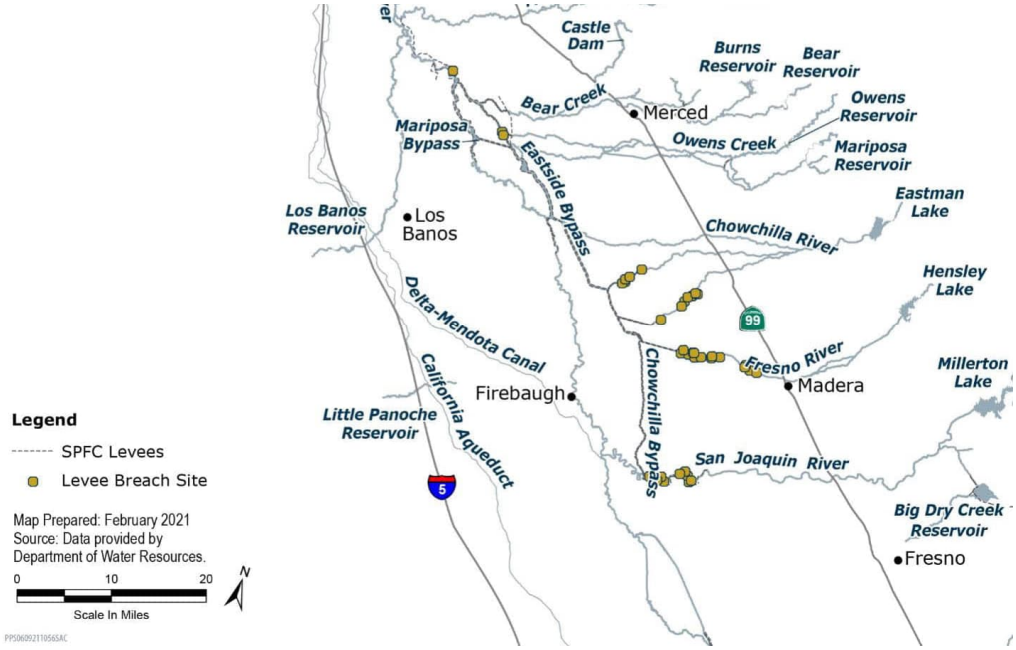
This section documents and synthesizes available levee deficiency information for different types of critical levee deficiencies warranting capital system improvements. Deficiencies include levee breaching, overtopping, subsidence, sedimentation, seepage, sand boils, erosion, sinkholes, geometry, levee freeboard, and structural and slope instability, all of which are summarized in the FSSR NULE hazard classifications. LUs showing multiple types of physical deficiencies and flow capacity constraints warrant higher-priority capital improvement classifications.

### 5.2.1 Breaching

Levee breaching occurs when water in a channel breaks through a levee, flooding adjacent land, at a weak spot potentially caused by poor erosion protection, poorly constructed levee penetrations, deficiencies in levee materials or construction, or other reasons. The District cites 14 breach events during the 1997 water year. The 2023 water year did not result in any levee breaches in the District system, but according to the District's 2023 Google Earth resources (District 2023a), there was a private levee break.

The 2015 USJR RFMP (SJRFCPA 2015) identified that Project levees breached at LU 1 (RM 9.90) and at LU 5 (RM 0.25). USACE inspections rated these LUs as unacceptable and suggested installing new structures to allow the Project to operate as intended. The 2022 FSSR (DWR 2022b) shows historical breach sites (Figure 5-14). The FSSR NULE overall hazard classifications, described in Section 5.2.13, can be helpful in identifying potential breach sites.

## Figure 5-14. Historical Breach Sites

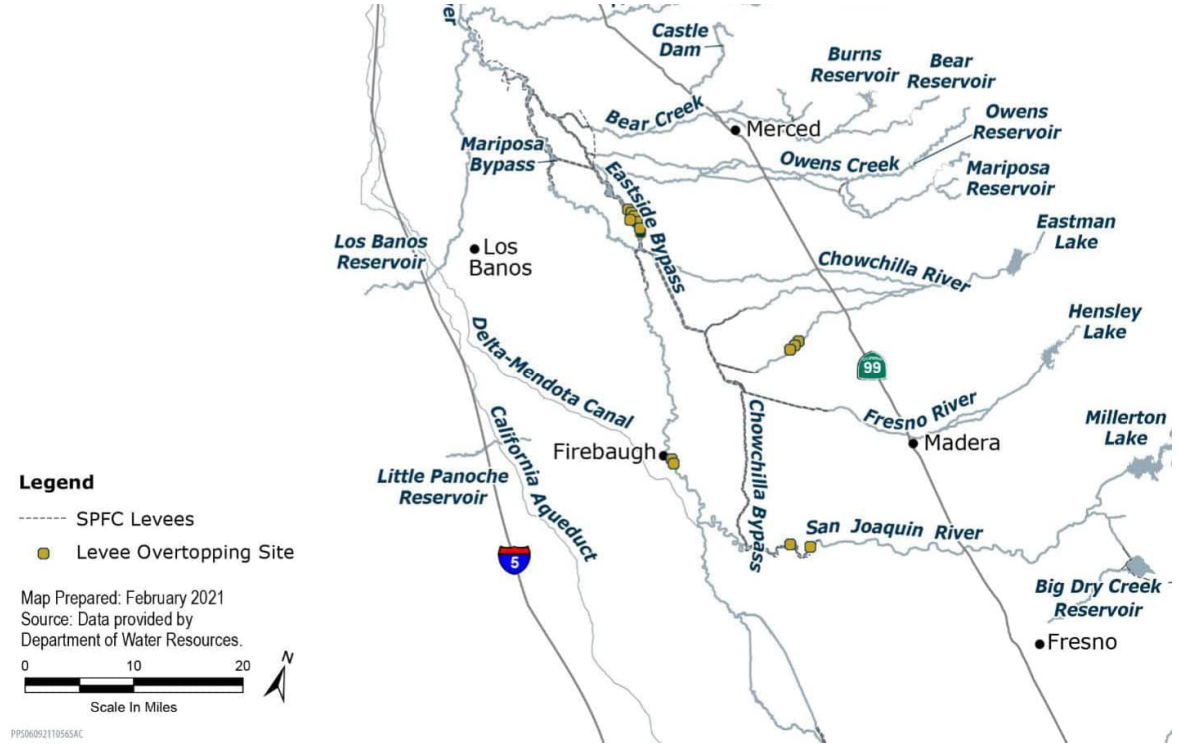



*Source: DWR 2022b.*

## 5.2.2 Overtopping

Overtopping occurs when water in a channel exceeds flow capacity and water flows over the levee, flooding adjacent land. Figure 5-15 shows historical levee overtopping sites from the 2022 FSSR (DWR 2022b).

Figure 5-15. Historical Levee Overtopping




*Source: DWR 2022b.*

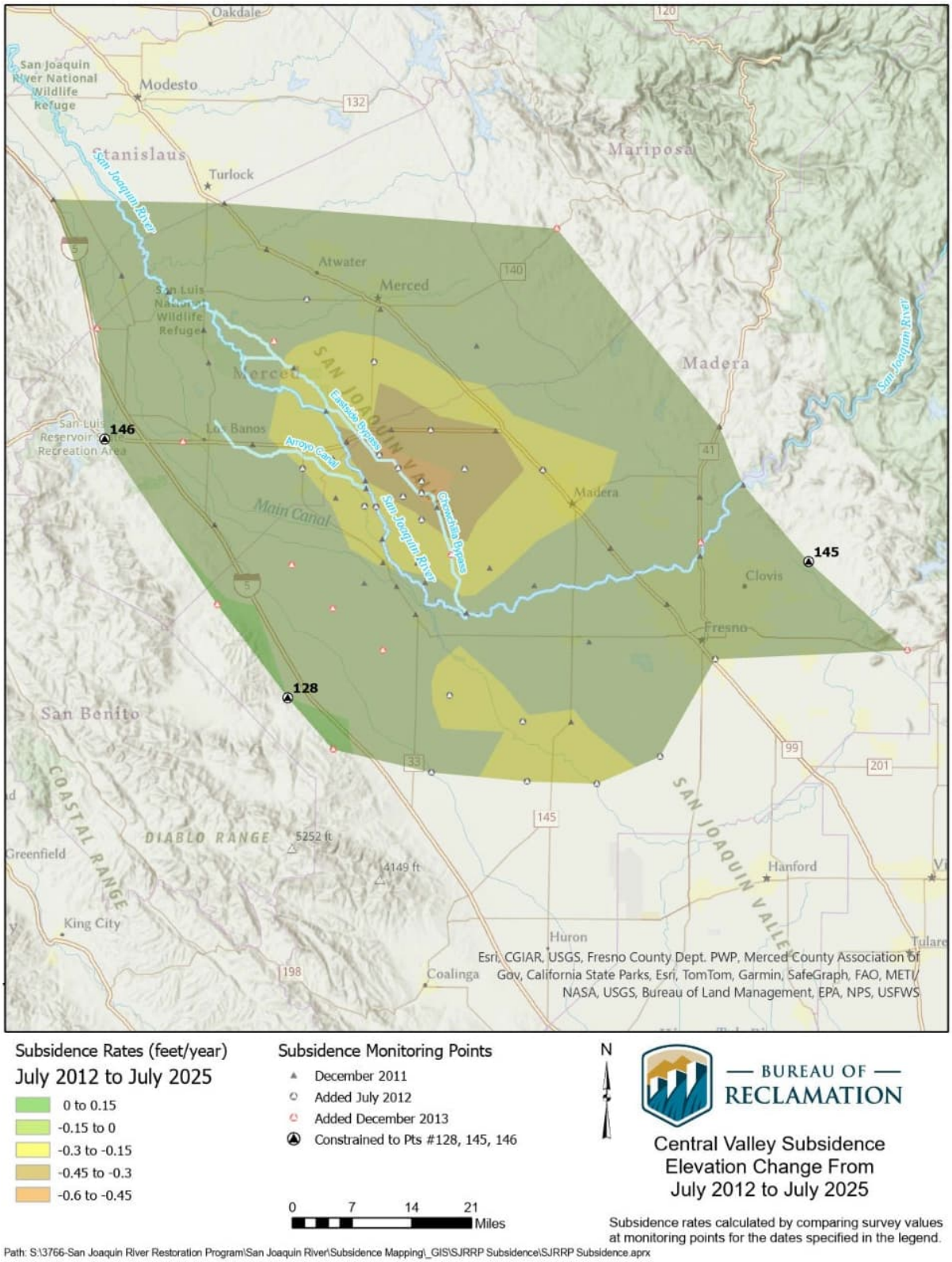
## 5.2.3 Subsidence

Land subsidence occurs as a result of large amounts of groundwater being withdrawn from certain types of geologic formations, such as fine-grained sediments without sufficient groundwater recharge. Over time, as water is removed from an area, the ground level sinks. Land subsidence can lead to many problems, including damage to structures such as canals, levees, and buildings. Infrastructure such as roads, wells, and pipelines may also be damaged by subsidence. Additionally, subsidence can increase the floodplain area. Subsidence also increases scour problems by increasing channel slope, which causes higher flow velocities and incision of a low-flow channel around bridge infrastructure.

For the District, subsidence is a significant issue along the Chowchilla Bypass to the Eastside Bypass from Avenue 7 in Merced County up to Washington Avenue in Merced County, and along the Eastside Bypass from the Washington Avenue area northward to the Mariposa Bypass. The USBR subsidence map, shown on Figure 5-16, shows historical subsidence rates for July 2012 to July 2025. The highest subsidence rates occur in the Chowchilla Canal Bypass and Eastside Bypass, ranging from -0.6 to -0.45 foot/year. Figure 5-17 shows subsidence from July 2024 to July 2025, demonstrating that the highest subsidence rates still occur in the Chowchilla Canal Bypass and Eastside Bypass, with rates ranging from -0.6 to -0.45 foot/year. Subsidence may increase channel gradients that increase flow velocities and cause channel deepening due to erosion of the channel bed. Subsidence may also decrease channel gradients, thereby

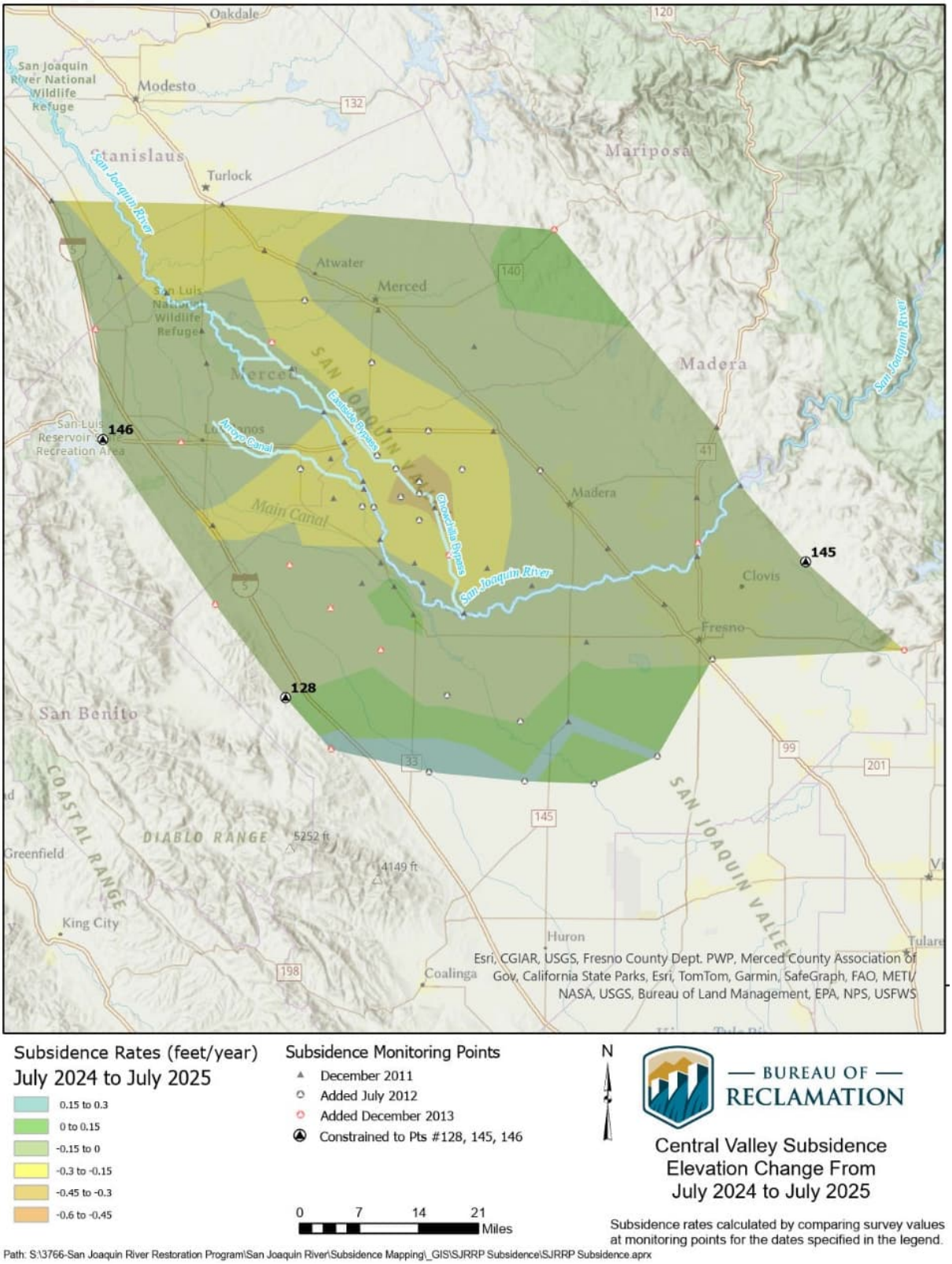
reducing flow velocities, causing suspended sediment to settle out, and ultimately resulting in sediment buildup and reduced flow capacity. Subsidence also reduces the ground level and levee elevation, making the system more susceptible to overtopping at low points that have reduced freeboard capacity.

## Figure 5-16. Subsidence Rates in the District – July 2012 to July 2025




*Source: SJRRP 2025.*

## Figure 5-17. Subsidence Rates in the District – July 2024 to July 2025




*Source: SJRRP 2025.*

## 5.2.4 Sedimentation

Sedimentation is a buildup of river deposits such as soil, sand, and other debris that causes a reduction in design flow capacities in river and bypass channels. For the District, sedimentation is a significant problem at flow control structures, in bypasses, and within river reaches. The District does not have equipment for large sediment removal work. The 2015 USJR RFMP (SJRFCPA 2015) determined that the largest sedimentation issues are located in the Eastside Bypass from Berenda Slough to Mariposa Bypass, and that the District needs additional financial resources to remove and dispose of extreme volumes of deposited sediment. The District has observed that the largest area of sedimentation is located at West Washington Road, where the Eastside Bypass channel bottom rises following the subsidence area upstream.

In addition to the Eastside Bypass, the District needs sediment removal in the Chowchilla Bypass (Figure 5-18). The District is starting to observe moving sediment, and sandbars are appearing downstream where they have not historically been present. The District has also observed sediment appearing on the sides of the pilot channel, further constricting flow to the middle section and causing sediment buildup upstream of county bridges. In addition, many flap gates are filled with sediment.

**Figure 5-18. Sedimentation in Chowchilla Bypass Downstream of the Chowchilla Canal Bypass Control Structure**

*Source: District-provided photo.*

## 5.2.5 System Vegetation Management

Levee vegetation management is part of normal annual O&M procedures as prescribed in the O&M manual (LSJRFCP 1978) and is covered by District funds. However, when in-channel vegetation growth becomes excessive, it can decrease channel conveyance capacity by increasing channel roughness, sedimentation, and buildup of floating debris during flood events. The cost of this type of large-scale channel vegetation management exceeds the normal maintenance costs of pesticide application and mowing. The District spent $30,000 on large-scale vegetation removal over approximately 2022 to 2024 in an area with excessive vegetation growth caused by high water levels throughout the year due to SJRRP flow releases into the flood bypasses. In-channel vegetation management was performed downstream of West Washington Road, and recently a large amount of vegetation was removed near the Merced National Wildlife Refuge near Sandy Mush Road and along Eastside Bypass (LUs 5 and 6). A levee breach or overtopping may have occurred if this vegetation had not been removed from the channel prior to the series of large 2023 storm events. The continued presence of water in the river channel year round or for extended periods of time as part of the SJRRP has significantly increased the cost of channel vegetation maintenance. New sources of funding need to be dedicated to this type of in-channel vegetation management that is beyond the capabilities of the District in terms of funding and staffing.

## 5.2.6 Seepage

Seepage may be caused by any of the following:

- Hydraulic head differential between the water surface in a river channel and adjacent groundwater levels
- Pervious sandy and gravelly layers in a levee or levee foundation
- Poor construction practices
- Lack of seepage design criteria at the time of construction

Many Project levees were built by local contractors without the benefit of current design criteria or construction practices. These levees were typically constructed with limited consideration for foundation stability, suitability of levee material, or placement procedures. Many older levees were constructed using sandy materials and were placed on top of riverine deposits that often contained pervious sandy or gravelly layers.

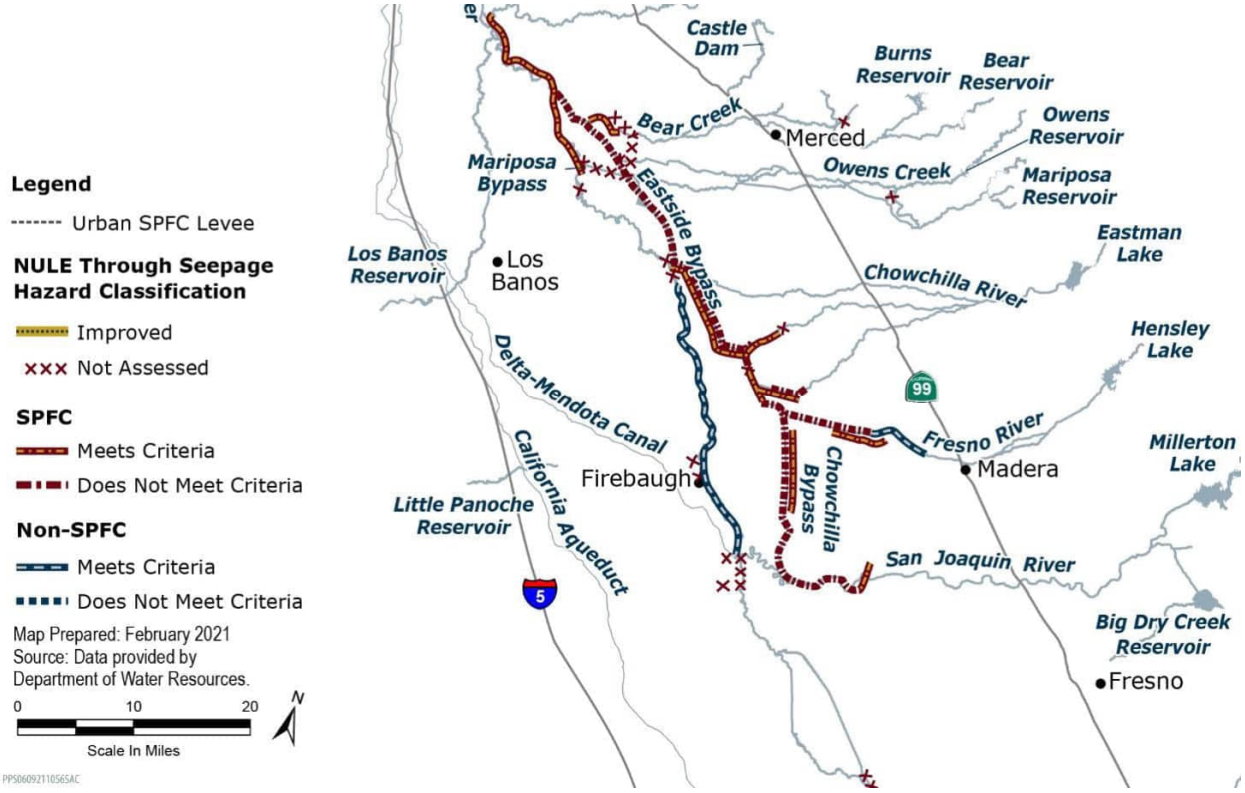
The levees upstream of the Chowchilla Canal Bypass Control Structure are porous. During each high-water year, and over time, additional levee material has eroded out of the embankments. In 2006, the District conducted levee repair work where filter blankets were installed. In 2011, seepage and boils occurred, but no major work was performed. In 2017, water was in the river for more of the water year than usual and seepage, boils, and erosion occurred, but there were no major issues. In 2023, issues occurred early in the year. These may have been caused by the accumulated impact of previous flood events moving levee material. Figure 5-19 shows recent seepage during a 10,000-cfs flow event that exceeded the original published design capacity of 8,000 cfs.

## Figure 5-19. Seepage from San Joaquin River Upstream of Chowchilla Canal Bypass Control Structure–10,000 cfs

*Source: District-provided photo.*

Through-seepage occurs when water moves from a waterway through a levee. When water moving through or under a levee carries foundation soil or levee materials, piping action may result in settlement or erosion of a levee's landside toe or slope. This may cause a levee to breach during high-water events. Figure 5-20 shows the 2022 FSSR NULE Project through-seepage ratings where "Does Not Meet Criteria" is considered hazardous, as well as potential for levee failure. Table C-1 (Appendix C) summarizes this information and shows that most of the levee system along Chowchilla Bypass and the Eastside Bypass does not meet criteria.

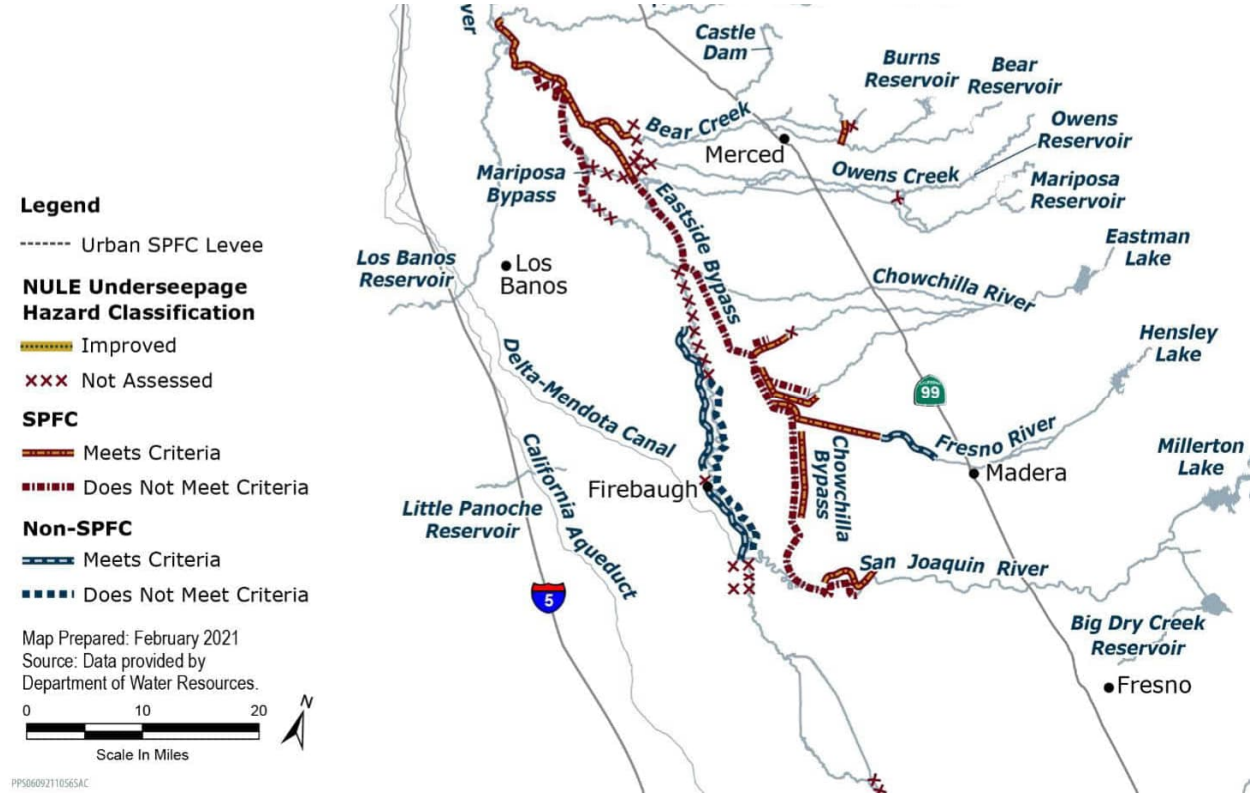
## Figure 5-20. Non-Urban Levee Evaluation Project Through-seepage Hazard Classifications




*Source: DWR 2022b.*

Under-seepage occurs when permeable foundation material or native soils beneath the base of a levee present a pathway for water to move under a levee and exit at the surface near or beyond the landside levee toe. Figure 5-21 shows 2022 FSSR NULE Project under-seepage ratings where "Does Not Meet Criteria" is considered hazardous, as well as potential for levee failure. Table C-1 (Appendix C) summarizes this information. Most of the levees along Chowchilla Bypass and the Eastside Bypass do not meet criteria.

Figure 5-21. Non-Urban Levee Evaluations Project Under-Seepage Hazard Classification Results




*Source: DWR 2022b.*

The Fall 2022 DWR Inspection Report (DWR 2022c) includes documented seepage failures. Maps of serious and critical seepage sites are shown on Figures 4-3 through 4-5. Table A-1 (Appendix A) lists seepage sites by LU, location, point of interest (POI) number, and start/end LMs that correspond to the sites shown on these figures.

## 5.2.7 Sand Boils

Boils are an upward disturbance in a small, permeable section of an otherwise relatively impermeable surface layer. In the 2023 water year, the District reported four boil sites. Figure 5-22 shows the 2022 FSSR historical boil and seepage sites (DWR 2022b).

Figure 5-22. Historical Boil and Seepage Sites


*Source: DWR 2022b.*

## 5.2.8 Erosion

Levee erosion problems are primarily the result of a lack of modern engineering criteria and construction standards for levees at the time of construction, resulting in unsuitable levee materials and narrow levee alignments in many locations. The Project levees, built in the 1960s, were not engineered to meet modern criteria and were constructed with readily available materials dredged from the adjacent river.

During the 2023 water year, the District reported five erosion sites primarily upstream of the Chowchilla Canal Bypass Control Structure. The District states that some of the erosion issues may have been due to high flows and rapid changes in water levels caused by changes in SJRRP flow releases. Rapid changes in flows and water surface elevations can cause increased levee erosion. Additionally, during the 2023 water year, the Avenue 18½ bridge was severely impacted by bank erosion, as shown on Figure 5-23.

## Figure 5-23. Avenue 18 1/2 Bank Erosion

*Source: District-provided photo.*

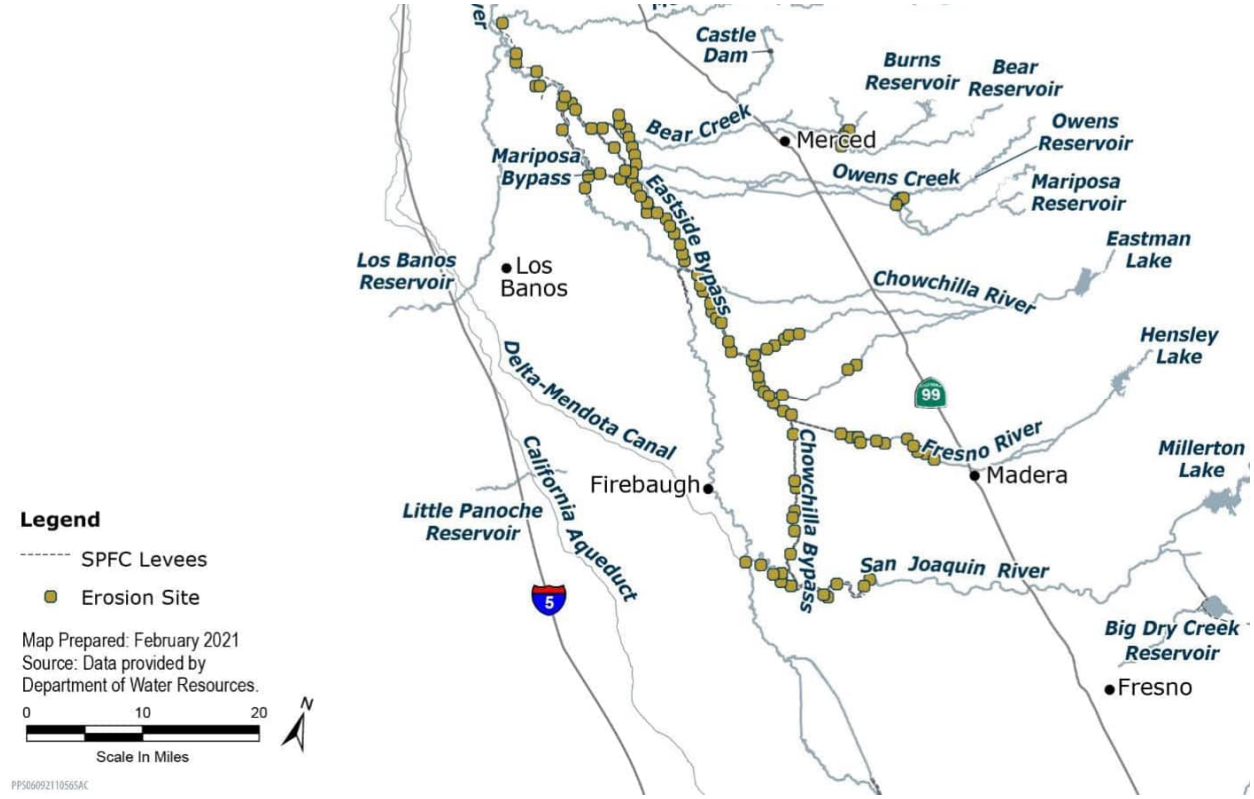
The Fall 2022 DWR Inspection Report (DWR 2022c) documented erosion failures. Maps of critical erosion sites are shown on Figures 4-3 through 4-5. Table 5-2 summarizes unacceptable erosion sections on the San Joaquin River. Additionally, the Fall 2022 DWR Inspection Report identified critical erosion at LU 6. The 2022 FSSR (DWR 2022b) identifies historical erosion sites, as shown on Figure 5-24.

## Table 5-2. River Erosion Sites

| Location | Start LM | End LM | Status |
|---|---|---|---|
| Unit 02A San Joaquin River, left bank | 0.68 | 0.74 | Existing Site |
| Unit 06 Eastside Bypass, left bank | 0.10 | 0.14 | New Site |
| | 2.61 | 2.68 | New Site |
| | 14.93 | 14.97 | New Site |

*Source: DWR 2022b.*

## Figure 5-24. Historical Erosion Sites




*Source: DWR 2022b.*

The 2015 USJR RFMP (SJRFCPA 2015) identified that the District needs additional financial resources to secure temporary construction easements to repair and stabilize levee erosion sites. At the end of the 2023 winter storm season, in March 2023, LU 23 received emergency repairs for extensive erosion (Figure 5-25).

Figure 5-25. Emergency Erosion Repair - March 2023

*Source: District-provided photo.*

## 5.2.9 Sinkholes

A sinkhole is a cavity in the ground caused initially by water erosion, and later by a drop in the groundwater table. During the 2023 water year, the District reported one sinkhole site. Figure 5-26 shows the locations of historical sinkholes and subsidence distresses as documented in the 2022 FSSR (DWR 2022b).

Figure 5-26. Historical Sinkholes and Subsidence Distresses


*Source: DWR 2022b.*

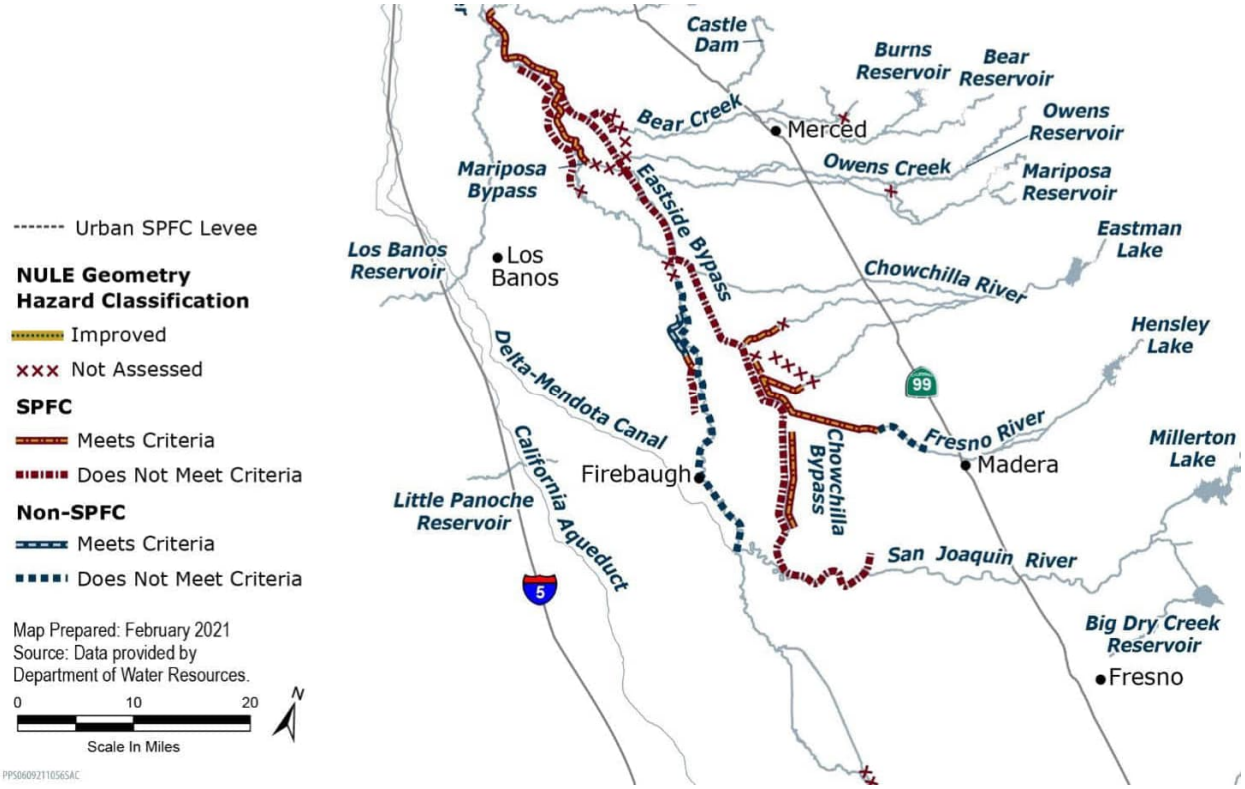
## 5.2.10 Geometry

Although physical processes such as erosion may alter levee geometry, many SPFC levees do not comply with current minimum geometry criteria due to the variation in levee geometry criteria at the time of construction. The following are the 2022 FSSR criteria for levee geometry (DWR 2022b):

- A standard prism with a 12-foot-wide crown
- Waterside slopes with a 3-to-1 ratio
- Landside slopes with a 2-to-1 ratio

Results from the 2022 FSSR (DWR 2022b) evaluation are shown on Figure 5-27 and are summarized in Table C-1 (Appendix C) in the geometry column. “Does Not Meet Criteria” is considered hazardous and shows the potential for levee failure.

Figure 5-27. Non-Urban Levee Evaluation Project Levee Geometry Checks in the District Area



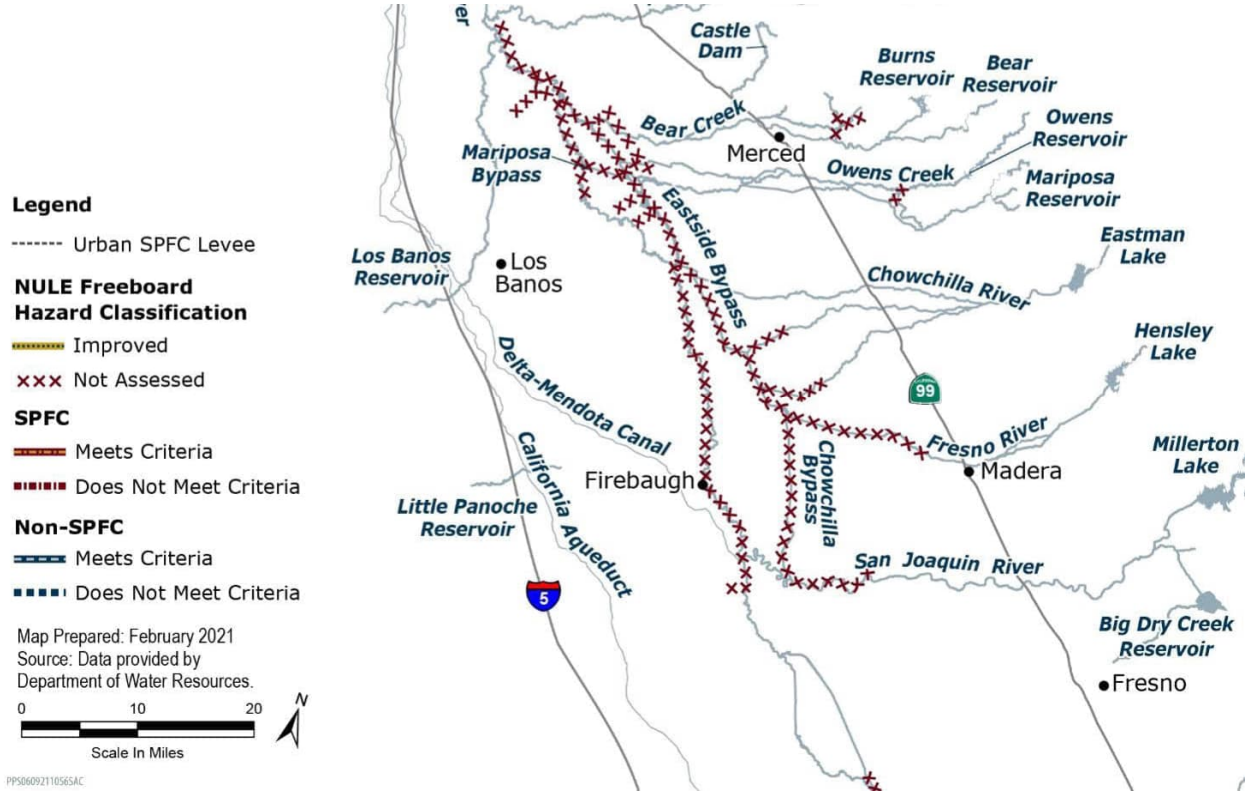

*Source: DWR 2022b.*

## 5.2.11 Freeboard

Levee freeboard is defined as the difference between the top of the levee elevation and the water surface elevation. Levees in the SPFC were designed with a specified levee freeboard based on a design water surface elevation at the Project design flow. Lack of levee freeboard can be caused by a variety of factors, such as levee settlement, channel sediment deposition, or channel vegetation.

The criteria are 3 feet of freeboard above design water surface elevation for riverine levees and 4 feet of freeboard for bypass levees. Results for the 2022 FSSR evaluation (DWR 2022b) are shown on Figure 5-28 and are summarized in Table C-1 (Appendix C) in the freeboard column. "Does Not Meet Criteria" means less than 3 feet of freeboard for riverine levees and less than 4 feet of freeboard for bypass levees.

Figure 5-28. Non-Urban Levee Evaluation Project Freeboard Check Results




*Source: DWR 2022b.*

## 5.2.12 Structural and Slope Instability

Levee structural instability is characterized by slides, sloughs, cracking, slope depressions, or bulges that could pose a threat to levee integrity. Structural instability is often associated with soft soils in a levee or its foundation, or with older design and construction practices. New stability analyses may be necessary on existing levees, particularly on older levees constructed before adoption of current criteria. Table 5-3 lists DWR inspection ratings. Areas with the most slope instability are in the San Joaquin River upstream of the Chowchilla Canal Bypass Control Structure and the Chowchilla Bypass near the Fresno River. There is also a minimally acceptable rating on the Eastside Bypass and San Joaquin River interchange. Figure 5-29 shows slope stability inspection rating results.

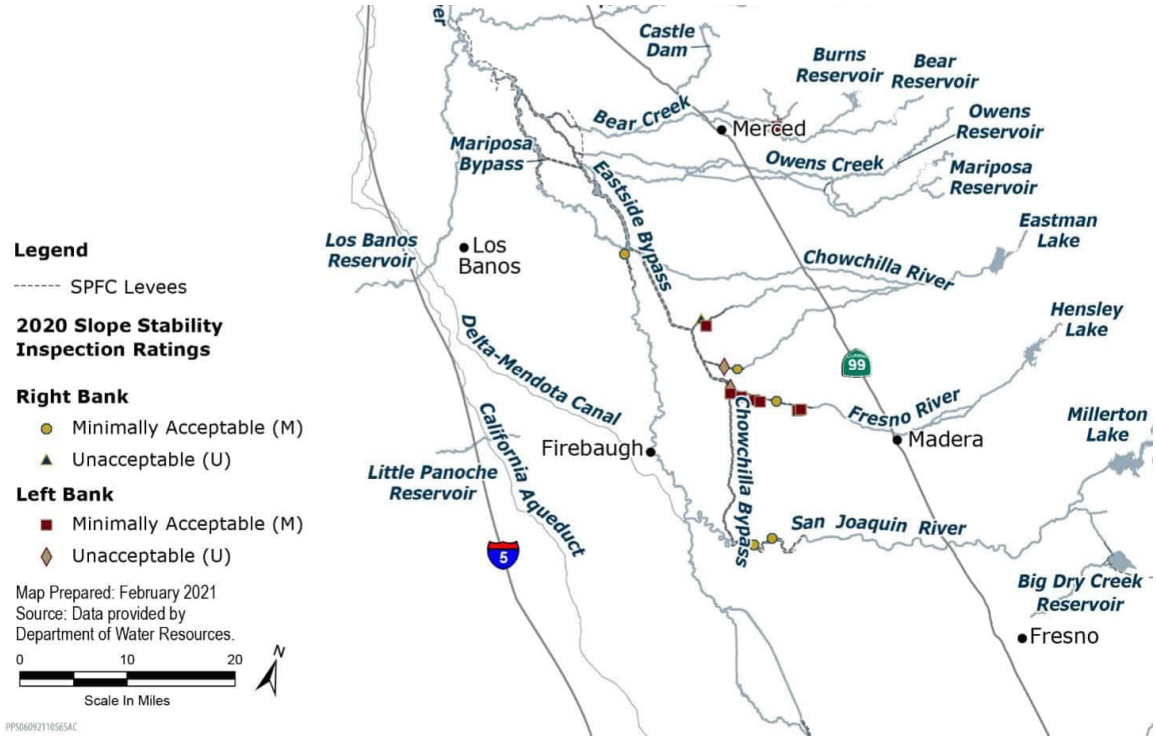
Table 5-3. Levee Inspection Ratings for Slope Stability on Earthen Levees

| Inspection Rating | Rating Description |
|---|---|
| Acceptable | The slope does not show any separation of soil, caving, soil movement, or other signs of an unstable slope. |
| Minimally Acceptable | A separation of soil can be seen; caving was observed on the slope or crown; or tension cracks due to a slip, a slide, or depressions in the slope were observed. |

| Inspection Rating | Rating Description |
|---|---|
| Unacceptable | A crack or depression deeper than 1 inch and longer than 200 feet was observed. A bulge in the slope or at the toe due to upward movement of the soil was observed. |

*Source: DWR 2022b.*

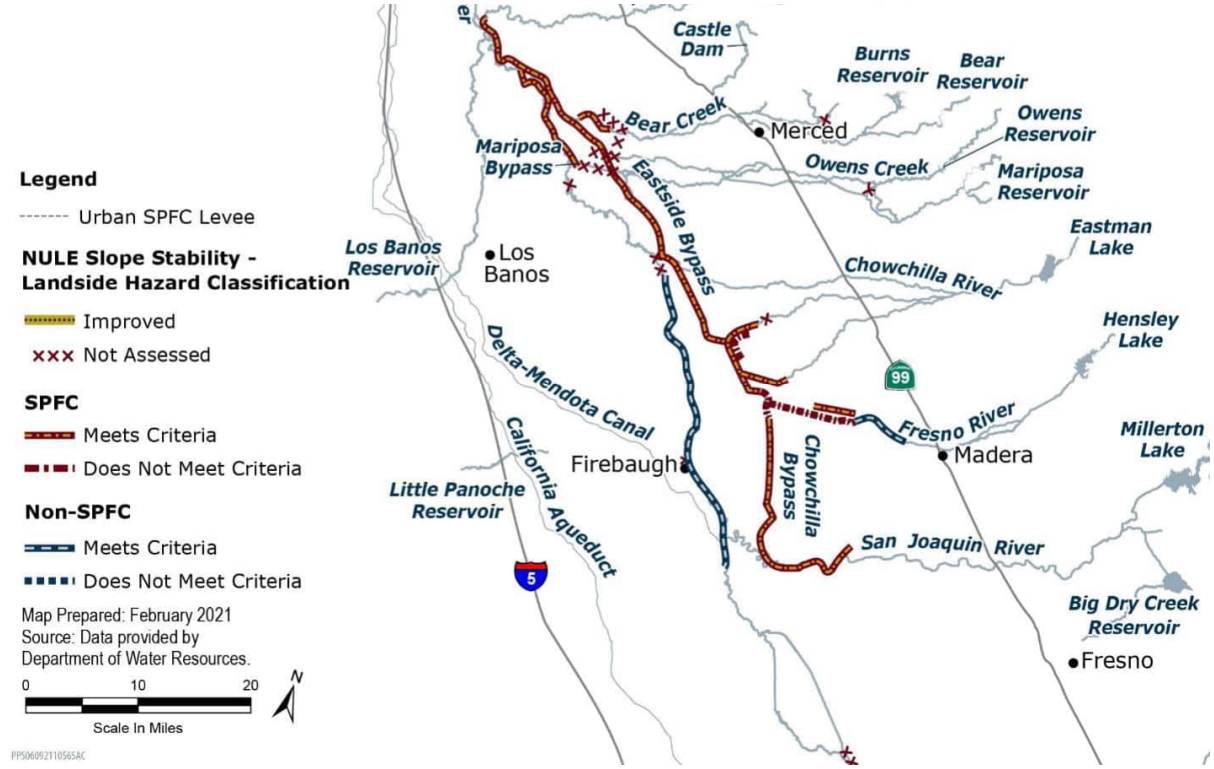
## Figure 5-29. Slope Stability Inspection Rating Results




*Source: DWR 2022b.*

Hazard categories represent a preliminary analysis of levee conditions. During the NULE Project, the hazard categories helped guide subsequent field activities and prepare preliminary remedial alternatives (and associated cost estimates) necessary for levee repairs and improvements to attain acceptable levee performance. Figure 5-30 shows results of FSSR NULE landside slope stability hazard classification. The majority of District sections meet criteria, with a small section on Ash Slough and the Fresno River having conditions that do not meet criteria. "Does Not Meet Criteria" is considered hazardous and shows potential for levee failure.

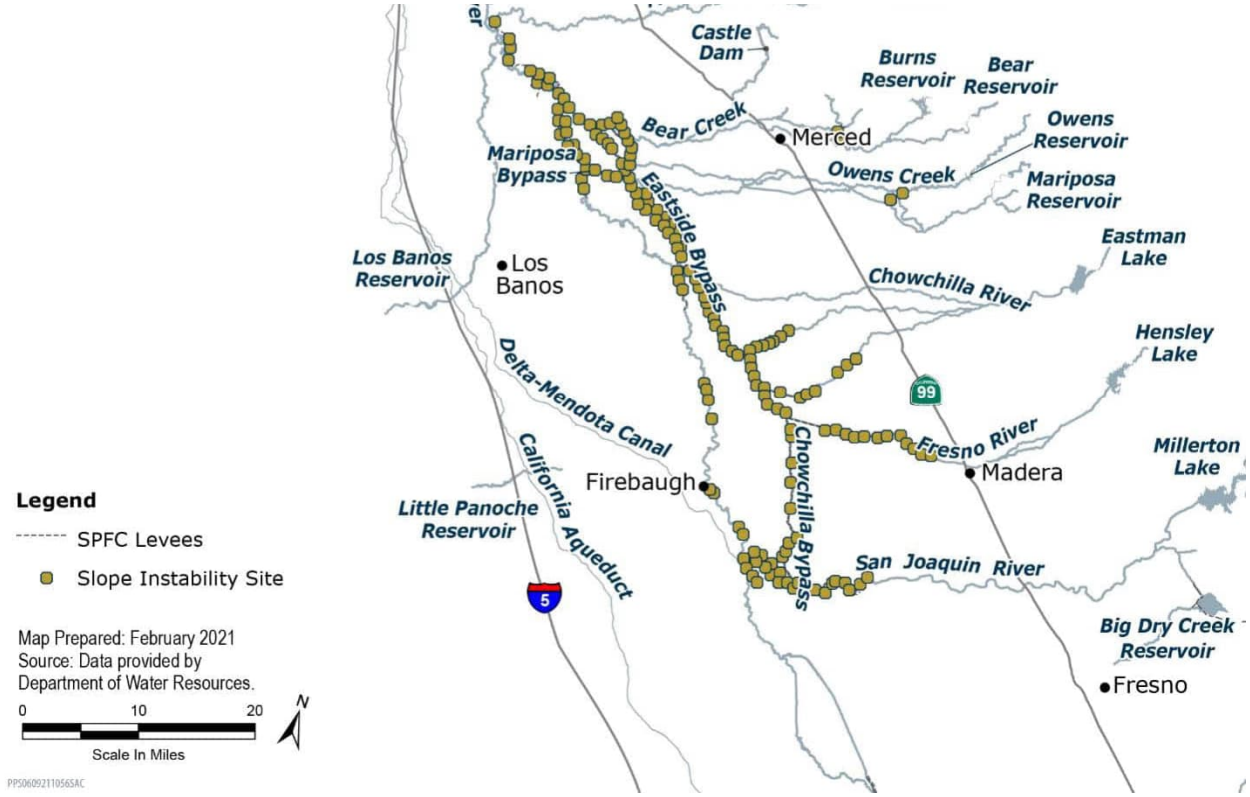
## Figure 5-30. Non-Urban Levee Evaluation Project Landside Slope Stability Hazard Classifications




*Source: DWR 2022b.*

Figure 5-31 depicts locations of historical slope instability. Locations are spread throughout the system, with the Chowchilla Bypass having less historical slope stability. DWR has installed revetment and riprap through DWR's Levee Repairs Program for a portion of the sites that have been identified.

Figure 5-31. Historical Slope Instability

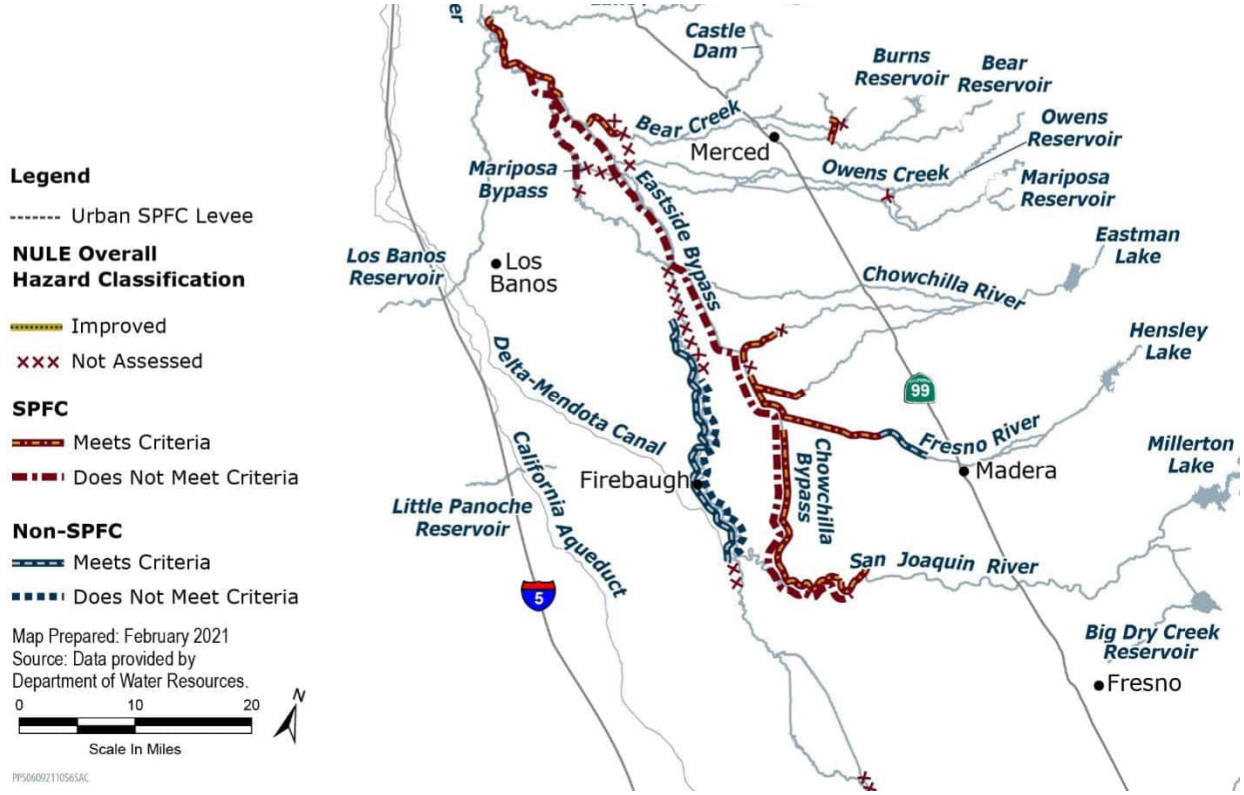



*Source: DWR 2022b.*

## 5.2.13 Flood System Status Report Non-Urban Levee Evaluation Overall Hazard Classification

The 2022 FSSR (DWR 2022b) reported the NULE overall hazard classifications that DWR previously developed using a Levee Assessment Tool to assign a hazard classification based on a combination of geotechnical data and past levee performance. Figure 5-32 shows the District's overall hazard classification and incorporates geometry, freeboard, seepage, and slope stability ratings. "Does Not Meet Criteria" is considered hazardous and shows the potential for levee failure. Table C-1 (Appendix C) summarizes this information. The majority of the system does not meet criteria, with the exception of the right bank from the Eastside Bypass at Ash Slough upstream to the start of the District system on the San Joaquin River.

Figure 5-32. Overall Hazard Classifications in the District




*Source: DWR 2022b.*

## 5.3 Facilities

Facilities constructed between 1959 and 1967 are reaching the end of their expected service life, and many District facilities need upgrades to meet current criteria. Facility deficiencies are described within this section.

### 5.3.1 Structures

The 2015 USJR RFMP (SJRFCPA 2015) identified the need to enlarge the control structure at the headworks of the Chowchilla Bypass with two additional gate bays to increase operational flexibility to control flows into the channel. Settlement has occurred at the San Joaquin River Control Structure (Figure 5-33), resulting in the wing walls separating from the structure. The joint has been temporarily filled, but it continues to widen. The wing wall backfill could be excavated and voids grouted under the spread footings, or spread footings could be added or enlarged to minimize further settlement. Erosion of the structural concrete is minimal, and no repairs of this type are currently needed.

## Figure 5-33. San Joaquin River Structure

*Source: District-provided photo.*

As listed in Table 4-2, the following structures are identified by DWR as minimally acceptable, where one or more deficient conditions exist that need to be improved or corrected:

- Ash Slough Drop Structure 3
- San Joaquin River Structure
- Sand Slough Structure

The District completed reinforcement work on Ash Slough Drop Structure 3 in 2021, but the installed riprap has moved. The District noted similar issues with rock movement around Ash Slough Drop Structure 1 (Figure 5-34), as well as subsidence issues. If there is no backwater in the bypass, high flows can transport riprap down the channel. The structures are close to 60 years old and should be evaluated at the foundation level. In addition, the District reported sedimentation buildup at Ash Slough Drop Structure 4.

The District owns Owens Creek Bridge, which is also a control structure (Figure 5-35). The District deems this structure in need of replacement.

## Figure 5-34. Ash Slough Drop Structure 1

*Source: District-provided photo.*

## Figure 5-35. Owens Creek Bridge and Control Structure

*Source: District-provided photo.*

### 5.3.2 Gates

Minimal information is available for gate conditions on system control structures. District staff indicated that vibration problems developed on the radial gates at the Chowchilla Canal Bypass Control Structure after DWR modified them in 2012 to allow all flow to go down the river during dry periods. Reinforcement was installed, which changed the frequency to reduce vibration, but the gate is not completely fixed. The District would like to fully resolve this issue in the near future.

## 5.4 Summary of Deficiencies and System Improvements

Table 5-4 summarizes major concerns, such as channel capacity and levee integrity issues, and system improvements to address these issues for each LU. This table is built on the comprehensive information on capacity and levee integrity issues (summarized in this chapter) that warrant capital projects. Appendix D notes additional flood management issues and system deficiencies that do not warrant capital system improvements.

**Table 5-4. Deficiencies and System Improvements by Levee Unit**

<table>
<tr><th>Levee Unit No.</th><th>Major Concerns</th><th>System Improvements</th></tr>
<tr><td>1</td><td>
<ul>
<li>The following table summarizes the reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.
<table>
<tr><th>Location</th><th>Published Design Flow Capacity (cfs)</th><th>Estimated Current Flow Capacity (cfs)</th><th>Reduced Flow Percentage</th></tr>
<tr><td>LM 0 to 11.5</td><td>26,000</td><td>19,000</td><td>-27%</td></tr>
<tr><td>LM 11.5 to 19.5</td><td>10,000</td><td>8,400</td><td>-16%</td></tr>
<tr><td>LM 19.5 to end of levee</td><td>1,500</td><td>1,100</td><td>-27%</td></tr>
</table>
</li>
<li>The Fall 2022 DWR Inspection Report identified serious seepage sites at LMs 4 to 11.4, 14.2 to 14.5, 15.7 to 17.3, 18.8, 19.3 to 19.8, and 20.5 to 21.1 (DWR 2022c). Seepage issues and under-seepage hazards were also noted in the 2022 FSSR (DWR 2022b) and NULE Project, respectively.</li>
<li>A historical levee breach at LM 9.9 was identified in the 2015 USJR RFMP (SJRFCPA 2015).</li>
<li>The Fall 2022 DWR Inspection Report identified fewer than five historical erosion sites throughout the levee (DWR 2022c).</li>
</ul>
</td><td>
<ul>
<li>Levee improvements at location of historical levee breach (LM 9.9)</li>
<li>Excavation of sedimentation areas to reduce the water surface elevation to allow conveyance of design flows at freeboard requirements</li>
<li>Slurry wall installation (10.5 miles) from LMs 4 to 11.4, 14.2 to 14.5, 15.7 to 17.3, 18.8, 19.3 to 19.8, and 20.5 to 21.1</li>
</ul>
</td></tr>
<tr><td>2</td><td>
<ul>
<li>Refer to LU 1 for reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.</li>
<li>Serious seepage[a] along the entire levee according to draft NULSE. The District indicated that boils and both under-seepage and through-seepage occur during high-water events and that under-seepage is more of a concern. Fewer than five historical seepage sites were identified in the 2022 FSSR (DWR 2022b), and the entire levee does not meet criteria for NULE under-seepage hazard.</li>
<li>Levee does not meet criteria for overall hazard classification per 2022 FSSR NULE, which considers geometry, freeboard, seepage, and slope stability ratings.</li>
<li>The Washington St. Bridge was blocked and closed due to high flows in the 2023 storms (District-identified issue Site 7). Repairs are under the County jurisdiction. Hyacinth was causing a backup/damming.</li>
</ul>
</td><td>
<ul>
<li>Refer to LU 1 for channel-related projects.</li>
<li>Slurry wall installation (11.5 miles) from LMs 2.3 to 13.8</li>
</ul>
</td></tr>
<tr><td>3</td><td>
<ul>
<li>The following table summarizes the reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.
<table>
<tr><th>Location</th><th>Published Design Flow Capacity (cfs)</th><th>Estimated Current Flow Capacity (cfs)</th><th>Reduced Flow Percentage</th></tr>
<tr><td>All</td><td>4,500</td><td>2,600</td><td>-42%</td></tr>
</table>
</li>
<li>The Fall 2022 DWR Inspection Report identified three serious seepage sites from LMs 1 to 2 (DWR 2022c). The 2022 FSSR identified fewer than five historical seepage sites (DWR 2022b).</li>
</ul>
</td><td>
<ul>
<li>Sand Slough Control Structure Removal</li>
<li>Excavation of sedimentation areas to reduce the water surface elevation to allow conveyance of design flows at freeboard requirements</li>
<li>Slurry wall installation (0.4 mile) from LMs 1.2 to 1.6.</li>
</ul>
</td></tr>
<tr><td>4</td><td>The gates in the San Joaquin River Control Structure, an SPFC facility, are inoperable. DWR inspectors have marked this feature as unacceptable for the past 10 years.</td><td>Refer to LU 3 for channel-related projects.</td></tr>
<tr><td>5</td><td>
<ul>
<li>The following table summarizes the reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.
<table>
<tr><th>Location</th><th>Published Design Flow Capacity (cfs)</th><th>Estimated Current Flow Capacity (cfs)</th><th>Reduced Flow Percentage</th></tr>
<tr><td>LMs 0 to 3.7</td><td>18,500</td><td>6,100</td><td>-67%</td></tr>
<tr><td>LMs 3.7 to 7.9</td><td>13,500</td><td>8,200</td><td>-39%</td></tr>
<tr><td>LMs 7.9 to 9.8</td><td>12,000</td><td>9,200</td><td>-23%</td></tr>
<tr><td>LMs 9.8 to 18.7</td><td>16,500</td><td>10,900</td><td>-34%</td></tr>
<tr><td>LMs 18.7 to 30.0[b]</td><td>17,500</td><td>5,900</td><td>-66%</td></tr>
</table>
</li>
</ul>
</td><td>
<ul>
<li>Bridge enlargement over the Eastside Bypass at Sandy Mush Rd.</li>
<li>Levee improvements at historical levee breach (LM 0.25)</li>
<li>Sediment removal in the Eastside Bypass near W. Washington Rd.</li>
<li>Levee improvements in subsidence area (El Nido Crossing to Sandy Mush Rd.)</li>
<li>Excavation of sedimentation areas to reduce the water surface elevation to allow conveyance of design flows at freeboard requirements</li>
</ul>
</td></tr>
</table>

<table>
<tr><th>Levee Unit No.</th><th>Major Concerns</th><th>System Improvements</th></tr>
<tr><td></td><td>
<ul>
<li>The District identified severe subsidence and scouring from approximately LM 19 to the end of the levee, which affects channel capacity.</li>
<li>The 2015 USJR RFMP (SJRFCPA 2015) identified a historical levee breach at LM 0.25.</li>
<li>The 2015 USJR RFMP (SJRFCPA 2015) identified sedimentation issues from Berenda Slough to Mariposa Bypass.</li>
<li>USBR identified fewer than five subsidence sites from Chowchilla Bypass to Mariposa Bypass.</li>
<li>Alview Elementary School is a nearby critical facility.</li>
<li>The 2022 FSSR identified historical levee overtopping (fewer than five sites) upstream of Mariposa Bypass (between Sandy Mush Rd. and Washington Rd.) (DWR 2022b).</li>
<li>Draft NULSE reports serious seepage exists at LMs 8.8 to 28.6. This segment has experienced seepage and boils from LMs 21.1 to 26.5. The boils were observed on the landside slope and near the landside toe, indicating both through-seepage and under-seepage may be a concern. The District indicated that the segment experiences chronic boils and seepage during high-water events. The preliminary repair length is assumed to be 5.4 miles from LM 21.1 to LM 26.5. The 2022 FSSR identified more than five historical boil sites and more than five historical seepage sites along the levee (DWR 2022b). Three serious and two critical seepage sites were identified in the Fall 2022 DWR Inspection Report (DWR 2022c). From Mariposa Bypass to Ash Slough, the levee does not meet criteria for NULE through-seepage hazard. From the Chowchilla Canal Bypass to Mariposa Bypass, the levee does not meet criteria for NULE under-seepage hazard.</li>
<li>The Washington Rd. Bridge was closed over the Eastside Bypass due to high flows in 2023 storms (District-identified issue Site 7). Any repairs are under the County jurisdiction.</li>
<li>The 18½ Ave. bridge has foundation erosion due to high flows in 2023 storms (District-identified issue Site 6). Repairs are under the County jurisdiction.</li>
<li>A wave wash occurred at LM 16.5 for approximately 4 miles (District-identified issue Site 10).</li>
</ul>
</td><td>
<ul>
<li>Slurry wall installation (19.8 miles) within LMs 8.8 to 28.6 to address seepage issue sites</li>
<li>Construction of a series of drop structures in the Eastside Bypass to aid in addressing seepage, sedimentation, and capacity issues from LMs 8.8 to 28.6, which includes Sandy Mush Rd. to Washington Rd. (LMs 12 to 20)</li>
</ul>
</td></tr>
<tr><td>6</td><td>
<ul>
<li>Refer to LU 5 for a reduction in flow capacity at the design freeboard per the latest DWR HEC-RAS model.</li>
<li>The District identified severe subsidence and scouring from approximately LM 19 to the end of the levee, which affects channel capacity.</li>
<li>The 2022 FSSR identified a historical levee breach site (LM 8) (DWR 2022b).</li>
<li>The 2022 FSSR identified a historical levee overtopping site upstream of Mariposa (between Sandy Mush Rd. and Washington Rd.) (DWR 2022b).</li>
<li>The Fall 2022 DWR Inspection Report identified four erosion sites (LMs 0 to 15) (DWR 2022c). More than five historical erosion sites were identified in the 2022 FSSR (DWR 2022b).</li>
<li>Critical seepage issues exist from LMs 0 to 9.6 according to draft NULSE. The District indicates that both under-seepage and through-seepage occur during high-water events. The levee does not meet criteria for NULE through-seepage hazard from the San Joaquin River to the Chowchilla River and does not meet criteria for NULE under-seepage hazard from Chowchilla Canal Bypass to Mariposa Bypass. The Fall 2022 DWR Inspection Report identified nine serious and two critical seepage sites (LMs 18 to 21.4) (DWR 2022c). The 2022 FSSR identified more than five historical seepage sites along the levee (DWR 2022b).</li>
<li>Entire levee does not meet criteria for NULE overall hazard classification, which considers geometry, freeboard, seepage, and slope stability ratings.</li>
</ul>
</td><td>
<ul>
<li>Refer to LU 5 for channel-related projects.</li>
<li>Raising part of left bank of LU 6 (Sandy Mush Rd. to downstream end of levee)</li>
<li>Slurry wall installation (13.0 miles) for LMs 0 to 9.6 and LMs 18 to 21.4</li>
</ul>
</td></tr>
<tr><td>7</td><td>
<ul>
<li>The following table summarizes the reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model. The District has reported a slight backup where Bear Creek flows into Eastside Bypass.</li>
</ul>
<table>
<tr><th>Location</th><th>Published Design Flow Capacity (cfs)</th><th>Estimated Current Flow Capacity (cfs)</th><th>Reduced Flow Percentage</th></tr>
<tr><td>All</td><td>7,000</td><td>5,900</td><td>-16%</td></tr>
</table>
</td><td>Excavation of sedimentation areas to reduce the water surface elevation to allow conveyance of design flows at freeboard requirements</td></tr>
</table>

<table>
<tr><th>Levee Unit No.</th><th>Major Concerns</th><th>System Improvements</th></tr>
<tr><td></td><td>• Entire levee does not meet criteria for the NULE levee geometry hazard.</td><td></td></tr>
<tr><td>8</td><td>Refer to LU 7 for reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.</td><td>Refer to LU 7 for channel-related projects.</td></tr>
<tr><td>9</td><td>None identified</td><td>None identified</td></tr>
<tr><td>10</td><td>None identified</td><td>None identified</td></tr>
<tr><td>11</td><td>• The following table summarizes the reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.<table><tr><th>Location</th><th>Published Design Flow Capacity (cfs)</th><th>Estimated Current Flow Capacity (cfs)</th><th>Reduced Flow Percentage</th></tr><tr><td>All</td><td>8,500</td><td>6,400</td><td>-25%</td></tr></table>• The District has noted that seepage issues from LU 1 could be causing issues at LU 11.<br>• The District identified the need to add a new gaging station on Mariposa Bypass.</td><td>• Excavation of sedimentation areas to reduce the water surface elevation to allow conveyance of design flows at freeboard requirements<br>• Installation of new gaging station (Mariposa Bypass)</td></tr>
<tr><td>12</td><td>• Refer to LU 11 for reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.<br>• Draft NULSE reports serious seepage issues. The entire levee experiences seepage and boils during high-water events according to the District. Under-seepage has been identified as a greater concern than through-seepage. The Fall 2022 DWR Inspection Report identified two serious seepage sites (DWR 2022c).</td><td>• Refer to LU 11 for channel-related projects.<br>• Slurry wall installation for entire levee (3.4 miles) to address seepage issues cited in draft NULSE and the Fall 2022 DWR Inspection Report (DWR 2022c)</td></tr>
<tr><td>13</td><td>• The following table summarizes the reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.<table><tr><th>Location</th><th>Published Design Flow Capacity (cfs)</th><th>Estimated Current Flow Capacity (cfs)</th><th>Reduced Flow Percentage</th></tr><tr><td>All</td><td>5,000</td><td>2,500</td><td>-50%</td></tr></table>• The Fall 2022 DWR Inspection Report identified Ash Slough Drop Structure 3 as minimally acceptable (DWR 2022c). The District reports sedimentation issues at Ash Slough Drop Structures 3 and 4.</td><td>• Evaluation of all existing Ash Slough drop structures<br>• Installation of new gaging station (Ash Slough)<br>• Excavation of sedimentation areas to reduce the water surface elevation to allow conveyance of design flows at freeboard requirements</td></tr>
<tr><td>14</td><td>• Refer to LU 13 for reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.<br>• 2022 FSSR identified fewer than five historical seepage sites (DWR 2022b). NULE identified that approximately 5 miles of the levee near the Eastside Bypass confluence does not meet criteria for under-seepage hazard.<br>• NULE identified that the entire levee does not meet criteria for landside slope stability hazard.</td><td>Refer to LU 13 for channel-related projects.</td></tr>
<tr><td>15</td><td>• The following table summarizes the reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.<table><tr><th>Location</th><th>Published Design Flow Capacity (cfs)</th><th>Estimated Current Flow Capacity (cfs)</th><th>Reduced Flow Percentage</th></tr><tr><td>All</td><td>2,000</td><td>1,900</td><td>-5%</td></tr></table>• NULE identified that LMs 0 to 1.2 do not meet criteria for under-seepage hazard.<br>• The District identified the need for a new gaging station at Berenda Slough.</td><td>• Excavation of sedimentation areas to reduce the water surface elevation to allow conveyance of design flows at freeboard requirements<br>• Installation of new gaging station (Berenda Slough)</td></tr>
<tr><td>16</td><td>• Refer to LU 15 for reduction in flow capacity at design freeboard per the latest DWR HEC-RAS model.</td><td>Refer to LU 15 for channel-related projects.</td></tr>
</table>

| Levee Unit No. | Major Concerns | System Improvements |
|---|---|---|
| | • NULE identified that LMs 0 to 0.5 do not meet criteria for under-seepage hazard. The 2022 FSSR identified fewer than five historical seepage sites (DWR 2022b). | |
| 17 | • The 2015 USJR RFMP (SJRFCPA 2015) identified significant sedimentation issues along the entire levee length. The District identified sedimentation from approximately LM 13 to the end of the levee, which affects channel capacity.<br>• The 2022 FSSR identified fewer than five historical erosion sites. LSJLD has confirmed erosion issues (DWR 2022b).<br>• USBR identified significant subsidence issues (LMs 1.5 to 8.5).<br>• The 2022 FSSR cited fewer than five historical sinkhole sites along the levee length (DWR 2022b). | • Sediment removal in the Chowchilla Canal Bypass Settling Basin<br>• Installation of new gaging station (Fresno River)<br>• Excavation of sedimentation areas to reduce the water surface elevation to allow conveyance of design flows at freeboard requirements |
| 18 | • The 2015 USJR RFMP (SJRFCPA 2015) identified significant sedimentation issues along the entire levee length. The District identified sedimentation from approximately LM 13 to the end of the levee, which affects channel capacity.<br>• The 2022 FSSR identified fewer than five historical erosion sites. The District has confirmed erosion issues (DWR 2022b).<br>• Serious seepage issues exist according to draft NULSE. This segment has experienced boils, piping, and seepage at LM 1.5, LM 4.9, and LM 8.4 in 1997 and 2006. Subsequently, seepage berms were constructed at three locations between approximately LM 12.5 and LM 15.3, under the PL 8499 program. These repairs do not cover the previously documented locations, and according to the District, the segment still experiences seepage issues. The preliminary repair length is assumed to be 6.9 miles, between LM 1.5 and LM 8.4. NULE identified that the entire levee does not meet criteria for through-seepage or under-seepage hazard.<br>• NULE identified that the entire levee does not meet criteria for overall hazard classification, which considers geometry, freeboard, seepage, and slope stability ratings.<br>• The 2022 FSSR cited fewer than five historical sinkhole sites (DWR 2022b).<br>• USBR identified significant subsidence issues (LMs 1.2 to 8.2). | • Refer to LU 17 for channel-related projects.<br>• Slurry wall installation (6.9 miles) for LMs 1.5 to 8.4 |
| 22 | • The 2022 FSSR reported more than five historical erosion sites (DWR 2022b).<br>• The District identified the need for evaluation of the Owens Creek Control Structure (including the Owens Creek Bridge, which spans the control structure).<br>• The District has identified freeboard issues and livestock erosion. | None identified |
| 23 | • The District identifies seepage as the most significant issue and cited 20+ years of seepage issues for the entire levee. Draft NULSE reports critical seepage issues for the entire levee length of LMs 0 to 10.2. This segment has experienced boils and seepage at multiple locations in 1997, between approximately LM 0.5 and LM 1.8. A seepage berm was constructed under the PL84-99 program, between LM 0.6 and LM 1.5. However, the District reports that the segment still experiences chronic boils and seepage during high-water events. Through-seepage is generally not as significant of a problem as under-seepage. The Fall 2022 DWR Inspection Report cites three critical seepage sites located at LMs 0.2 to 0.6, 1.9, and 3.6 (DWR 2022c). NULE states that the entire levee does not meet criteria for through-seepage hazard.<br>• The District reports dozens of boils on levee slope and up to 10 feet off of the levee toe from approximately LMs 0.5 to 3.<br>• The 2022 FSSR identified fewer than five historical boil sites from LMs 0.3 to 1.2 (DWR 2022b).<br>• The 2022 FSSR noted six historical levee breach sites (DWR 2022b).<br>• The 2022 FSSR identified one levee overtopping segment (DWR 2022b). | • LUs 23 and 24 Reach Study—Upstream of Chowchilla Canal Bypass Control Structure<br>• Enlargement of Chowchilla Canal Bypass Control Structure<br>• Sediment removal at the Chowchilla Canal Bypass Control Structure<br>• Sediment removal upstream of Chowchilla Canal Bypass Control Structure (entire length of LUs 23 and 24)<br>• Rehabilitation of the San Joaquin River Control Structure<br>• Slurry wall installation (10.2 miles) within LMs 0 to 10.2 (entire length) to address seepage issue sites identified by draft NULSE, the Fall 2022 DWR Inspection Report (DWR 2022c), and the 2022 FSSR (DWR 2022b) |

| Levee Unit No. | Major Concerns | System Improvements |
|---|---|---|
| 24 | • The District identifies seepage as the most significant issue and cites 20+ years of seepage issues for the entire levee. Draft NULSE reports critical seepage issues for the entire levee length from LMs 0 to 8.3. This segment has experienced extensive under-seepage and boils at multiple locations approximately between LM 0.0 and LM 3.9. Seepage has historically been observed along the landside toe, which indicates under-seepage issues may be of more significant concern. Previous site reconnaissance indicates seepage berms have been placed in some of the previously identified locations; however, the District reports that the levee experiences chronic boils and seepage during high-water events. The Fall 2022 DWR Inspection Report identifies four critical and one serious seepage sites at LMs 0.8, 1.6, 1.7, 2.8, and 3.6 to 3.8 (DWR 2022c). NULE states that the entire levee does not meet criteria for through-seepage or under-seepage hazard.<br>• NULE identified that the entire levee does not meet criteria for overall hazard classification, which considers geometry, freeboard, seepage, and slope stability ratings.<br>• The 2022 FSSR identifies more than five historical boil sites from LMs 0.3 to 1.2 (DWR 2022b).<br>• The 2022 FSSR noted two historical levee breach sites (DWR 2022b).<br>• The 2022 FSSR identified one levee overtopping segment (DWR 2022b). | • Refer to LU 23 for channel-related projects.<br>• Slurry wall installation (8.3 miles) within LMs 0 to 8.3 (entire length) to address seepage issue sites identified by draft NULSE, the Fall 2022 DWR Inspection Report (DWR 2022c), and the 2022 FSSR (DWR 2022b) |

[a] For each of the seven levees identified by draft NULSE, a score between 1 and 100 was given. Three levees, with scores above 80, were categorized as critical, and the remaining four levees were categorized as serious.
[b] For this channel segment, LMs 19.4 to 30.0 of LU 6 are the more constricting for flow capacity as opposed to LU 5. For a conservative estimate in flow capacity reduction, the estimated current flow capacity at design freeboard for LU 6 is used.

# Chapter 6 System Improvements and Prioritization

Chapter 5 documents the major concerns and potential system improvements identified for each LU to restore the system to original published design capacity. This chapter provides a list of prioritized system improvements based on information in the DWR FSSR, NULE, draft NULSE, USJR RFMP, and field observations from the 2023 and 2024 flood seasons. These system improvements are for assessment purposes only and are reconnaissance-level concepts developed during the desktop study system evaluation. Therefore, the planning-level costs developed were not used as a basis for evaluation and ranking. The following subsections outline how the criteria were developed and ranked and present results from the evaluation.

## 6.1 System Improvements Prioritization

System improvement prioritization was guided by a focus on public safety and flood risk reduction. During the 2015 USJR RFMP effort (SJRFCPA 2015), extensive stakeholder outreach was conducted in the form of a series of public meetings addressing many of the flood management issues and system deficiencies summarized in Chapter 5. During the 2015 effort, the following objectives were used for scoring and prioritization for the District and other regional flood management partners:

- Public safety
- Environmental stewardship
- Economic stability
- Regional issues

Similar to the 2015 USJR RFMP, the system improvements are prioritized and categorized into three tiers, with Tier 1 considered the highest priority. The District provided input on prioritization based on historical experience, day-to-day operations, and field observations from the recent 2023 storms. The following criteria were used to categorize system improvements into the appropriate tier:

- Tier 1
  - Channel Sediment Excavation. Levee reaches with greater than or equal to 50% estimated reduced flow from the published design flow.
  - Slurry Wall Installation. Levee reaches identified by draft NULSE or the Fall 2022 DWR Inspection Report (DWR 2022c) where serious or critical sites are identified.
  - Other system improvements based on correspondence with the District.
  - Tier 1 system improvements respond to significant public safety threats.

- Tier 2
  - Channel Sediment Excavation. Levee reaches with less than 50% to 20% estimated reduced flow from the published design flow.
  - Other system improvements based on correspondence with the District.
  - Tier 2 system improvements respond to additional public safety threats after Tier 1.
- Tier 3
  - Channel Sediment Excavation. Levee reaches with less than 20% estimated reduced flow from the published design flow.
  - Other system improvements based on correspondence with the District.
  - Tier 3 system improvements respond to minor threats to public safety while providing additional improvements.

## 6.2 Project Cost Estimates

Cost estimates for this system assessment are for planning purposes only. Further feasibility studies will be required before proceeding to design and construction of these system improvements.

To prepare these estimates, existing cost estimates from the 2015 USJR RFMP (SJRFCPA 2015) and 2022 CVFPP Update were (DWR 2022a) escalated to 2026 dollars. Unit and lump sum costs were updated to current prices by multiplying the original costs by an inflation factor based on IHS Markit, legacy S&P Global.

To develop high-level cost estimates for new system improvements, the following items were considered:

- Work Components – System improvements were broken down into the different work components such as surveying, earthwork, structural concrete, and slope protection. Volume or other types of measurement were then used to estimate material quantities. These quantities were then multiplied by the current unit prices to develop the estimate. Unit and lump sum prices were developed based on local bidding prices for similar work in the region.
- Engineering Judgment for Planning and Design – Planning and design costs were generally determined using best engineering judgment as a percentage of the construction costs.
- Engineering Judgment for Contingency Costs – Contingency costs were determined using best engineering judgment from past efforts as a percentage of construction costs.

The list of prioritized system improvements and their estimated costs are presented in Table 6-1. These system improvements are needed to address major system concerns and restore the system to its original published design capacity. The list includes system improvements developed

during the 2015 USJR RFMP (SJRFCPA 2015), 2022 CVFPP Update efforts (DWR 2022a), the Firebaugh Feasibility Study (Gouveia 2022), and this assessment.

As funding becomes available, Tier 1 system improvements should be implemented first. The approximate total cost for the projects presented in Table 6-1 is $1.31 billion, with $529 million assigned to Tier 1 projects. The cost estimates are approximate given the conceptual definitions of the proposed system improvements. Several recommended studies would lead to the identification of additional system improvements and refined cost estimates.

Table 6-1. System Improvements and Cost Estimates

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Channel Sediment Excavation at LU 5/6 LMs 0 to 3.7 | Excavate sedimentation areas to reduce the estimated constricted flow (67% of published design flow). | To be developed | $83,800,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Evaluation of Sediment Removal | Study to be developed. Identify the most efficient locations from which to remove sediment buildup. Preliminary locations and cost estimates are given in this table based on a reduction in capacity; however, a more detailed study (such as operational justification for sediment removal and costs of trucking and disposal) should be implemented before proceeding with these projects. | To be developed | $200,000-$400,000 | High-level cost estimate for studies is based on engineering judgment. | -- |
| 1 | Comprehensive Evaluation of All Control Structures | This evaluation would include the Mariposa, Chowchilla, Eastside, and Owens Creek (including the Owens Creek Bridge) Control Structures. This evaluation would exclude Sand Slough and San Joaquin River Control Structures. The current DWR inspection reports provide ratings on control structures for the District. Three were determined to be minimally acceptable according to the Fall 2022 DWR Inspection Report (DWR 2022c) (Ash Slough Drop Structure 3, the San Joaquin River Structure, and the Sand Slough Structure); the San Joaquin River Structure has been closed for years and is nonoperational. The Sand Slough Drop Structure is being considered for removal. The evaluation would provide a comprehensive technical and engineering analysis to determine actions needed for rehabilitation or replacement. USBR is also considering control structure improvements as part of the SJRRP; however, this does not include the District system along the bypass channels. The Owens Creek Control Structure is planned to be investigated under DWR's FSRP in late 2024, along with the Sand Slough Structure and the San Joaquin River Structure. Owens Creek Control Structure is a part of the SPFC, owned by the State, and listed under District as-builts. For the last 10 years, DWR inspectors have marked it as unacceptable. A feasibility study is needed to assess the options for repair of the Owens Creek Control Structure versus replacement. | To be developed | $200,000-$400,000 | High-level cost estimate for studies is based on engineering judgment. | District-identified (2023–2024) |
| 1 | Rehabilitation of San Joaquin River Control Structure | Settlement has occurred at the San Joaquin River Control Structure, resulting in the wing walls separating from the structure. The wing wall backfill could be excavated and the voids grouted under the spread footings, or spread footings could be added or enlarged to minimize further settlement. This is a high-priority project for the District. Depending on phasing or timing, the design could be coordinated with the SJRRP 2B project to allow incorporation of fish passage or habitat restoration elements within the project footprint. However, it is also possible that improvements to the San Joaquin River Control Structure resulting from implementation of Reach 2B would occur as a separate project. | To be developed | $1,030,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Costs were escalated to 2026 dollars and increased based on engineering judgment. | 2015 USJR RFMP (SJRFCPA 2015) |
| 1 | Rehabilitation of Chowchilla Canal Bypass Control Structure | Similar to the Rehabilitation of San Joaquin River Control Structure, the overall condition of the Chowchilla Canal Bypass Control Structure requires rehabilitation, including repair of wing walls, general concrete structure, and gates. | To be developed | $1,030,000 | Same cost as Rehabilitation of San Joaquin River Control Structure project was assumed. | District-identified (2023–2024) |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Levee Assessment — Upstream of Chowchilla Canal Bypass Control Structure | Many boils and a large amount of erosion and seepage occurred upstream of the bifurcation in the 2023 water year. Potential system improvements could include levee rehabilitation or slurry walls. This area includes approximately 4 miles on both the right and left banks. | To be developed | $150,000-$300,000 | High-level cost estimate for studies is based on engineering judgment. | -- |
| 1 | Slurry Wall on LU 24 from LMs 0 to 8.34 | Install slurry wall because of the following issues. The draft NULSE PI Score is 93 (DWR forthcoming). The District identifies seepage as the most significant issue and cites 20+ years of seepage issues for the entire levee. Draft NULSE reports critical seepage issues for the entire levee length from LMs 0 to 8.3. This segment has experienced extensive under-seepage and boils at multiple locations approximately between LM 0.0 and LM 3.9. Seepage has historically been observed along the landside toe, which indicates that under-seepage issues may be of more significant concern. Previous site reconnaissance indicates seepage berms have been placed in some of the previously identified locations; however, the District reports that the levee experiences chronic boils and seepage during high-water events. The Fall 2022 DWR Inspection Report (DWR 2022c) identifies four critical and one serious seepage sites at LMs 0.8, 1.6, 1.7, 2.8, and 3.6 to 3.8. NULE states that the entire levee does not meet criteria for through-seepage or under-seepage hazard. The 2022 FSSR identifies more than five historical boil sites from LMs 0.3 to 1.2 (DWR 2022b). | To be developed | $24,300,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 6 from LMs 12 to 18 | Improve Eastside Bypass levees in areas of subsidence from El Nido Crossing to Sandy Mush Road (LMs 12 to 18). Subsidence occurs from Avenue 7 in Madera County to Washington Road in Merced County, but the capacity issues are downstream of Washington Road North to Mariposa Bypass. The levees in this area have been increased in size three times since their original design, and the concern now is the integrity of the levees rather than the height. This levee reach has an estimated reduced flow of 34% from the published design flow. | To be developed | $17,500,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | 2015 USJR RFMP (SJRFCPA 2015) |
| 1 | Eastside Bypass (LUs 5 and 6) Drop Structures | Construct four drop structures in the Eastside Bypass to aid in addressing seepage, sedimentation, and capacity issues from LMs 8.8 to 28.6, which includes Sandy Mush Road to Washington Road (LMs 12 to 20). | To be developed | $82,500,000 | Appendix E provides detailed cost estimates. As-built drawings for Ash Slough drop structures were referenced. | District-identified (2023–2024) |
| 1 | Slurry Wall on LU 23 from LMs 0 to 10.23 | Install slurry wall because of the following issues. The draft NULSE PI Score is 83 (DWR forthcoming). The District identifies seepage as the most significant issue and cited 20+ years of seepage issues for the entire levee. Draft NULSE reports critical seepage issues for the entire levee length of LMs 0 to 10.2. This segment experienced boils and seepage at multiple locations in 1997, between approximately LM 0.5 and LM 1.8. A seepage berm was constructed under the PL 84-99 program, between LM 0.6 and LM 1.5. However, the District reports that the segment still experiences chronic boils and seepage during high-water events. Through-seepage is generally not as significant of a problem as under-seepage. The Fall 2022 DWR Inspection Report cites three critical seepage sites located at LMs 0.2 to 0.6, 1.9, and 3.6 (DWR 2022c). NULE states that the entire levee does not meet criteria for through-seepage hazard. The 2022 FSSR identified fewer than five historical boil sites from LMs 0.3 to 1.2 (DWR 2022b). | To be developed | $29,900,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Slurry Wall on LU 6 from LMs 0 to 9.64 | Install slurry wall because of the following issues. The draft NULSE PI Score is 86 (DWR forthcoming). The 2022 FSSR identified more than five historical seepage sites along the levee (DWR 2022b). | To be developed | $28,200,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Evaluation of Ash Slough Drop Structures | The existing drop structures were built in the late 1960s. Ash Slough Drop Structure 3 was determined to be minimally acceptable according to the Fall 2022 DWR Inspection Report (DWR 2022c). The drop structure bays will also need to be evaluated. | To be developed | $200,000-$400,000 | High-level cost estimate for studies is based on engineering judgment. | 2015 USJR RFMP (SJRFCPA 2015) |
| 1 | Third-Party Impacts Caused by the San Joaquin River Restoration Program Study | This study would evaluate the impacts on the District's system from the USBR SJRRP. The bypasses were designed to remain dry until they are needed to convey flood flows. SJRRP operations have introduced fishery flows into the bypasses during non-flood periods that cause excessive vegetation growth, which reduces flood flow capacity and significantly increases vegetation management costs. The District spent $30,000 on large-scale vegetation removal during approximately 2022 to 2024 in an area with excessive vegetation growth caused by high water levels throughout the year from SJRRP flow releases. The District states that some of the erosion issues may have resulted from high flows and rapid changes in water levels caused by changes in SJRRP flow releases. | To be developed | $200,000-$400,000 | High-level cost estimate for studies is based on engineering judgment. | District-identified (2023–2024) |
| 1 | Slurry Wall on LU 5 from LMs 8.8 to 28.6 | Install slurry wall because of the following issues. The draft NULSE PI Score is 56 (DWR forthcoming). The District indicated that the segment experiences chronic boils and seepage during high-water events. The 2022 FSSR identified more than five historical boil sites and more than five historical seepage sites along the levee (DWR 2022b). From Mariposa Bypass to Ash Slough, the levee does not meet criteria for NULE through-seepage hazard. From the Chowchilla Canal Bypass to Mariposa Bypass, the levee does not meet criteria for NULE under-seepage hazard. This includes the levees identified from El Nido Crossing to Sandy Mush Road (LMs 12 to 18), where subsidence has caused capacity issues. The levees in this area have been increased in size three times since their original design, and the concern now is the integrity of the levees rather than the height. This levee reach has an estimated reduced flow of 34% from the published design flow. | To be developed | $58,000,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 18 from LMs 1.5 to 8.4 | Install slurry wall because of the following issues. The draft NULSE PI Score is 54 (DWR forthcoming). This segment experienced boils, piping, and seepage at LM 1.5, LM 4.9, and LM 8.4 in 1997 and 2006. | To be developed | $20,200,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 12 from LMs 0 to 3.4 | Install slurry wall because of the following issues. The draft NULSE PI Score is 53 (DWR forthcoming). The entire levee experiences seepage and boils during high-water events according to the District. Under-seepage has been identified as a greater concern than through-seepage. The Fall 2022 DWR Inspection Report identified two serious seepage sites (DWR 2022c). | To be developed | $9,930,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Slurry Wall on LU 2 from LMs 2.3 to 13.8 | Install slurry wall because of the following issues. The draft NULSE PI Score is 51 (DWR forthcoming). The District indicated that boils, under-seepage, and through-seepage occur during high-water events and that under-seepage is more of a concern. There were fewer than five historical seepage sites identified in the 2022 FSSR (DWR 2022b). The entire levee does not meet criteria for NULE under-seepage hazard. | To be developed | $33,600,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 6 from LMs 18 to 21.4 | Install slurry wall because of the following issues. The Fall 2022 DWR Inspection Report identified nine serious and two critical seepage sites (LMs 18 to 21.4) (DWR 2022c). | To be developed | $9,930,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 1 from LMs 4 to 11.4 | Install slurry wall because of the following issue. The Fall 2022 DWR Inspection Report identified serious seepage sites (DWR 2022c). | To be developed | $21,800,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 3 from LMs 1.2 to 1.6 | Install slurry wall because of the following issues. The Fall 2022 DWR Inspection Report identified three serious seepage sites from LMs 1 to 2 (DWR 2022c). The 2022 FSSR identified fewer than five historical seepage sites (DWR 2022b). | To be developed | $1,170,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Slurry Wall on LU 1 from LMs 14.2 to 14.5, LMs 15.7 to 17.3, LMs 19.3 to 19.8, and LMs 20.5 to 21.1 | Install slurry wall due to the following issue. The Fall 2022 DWR Inspection Report identified serious seepage sites (DWR 2022c). | To be developed | $9,070,000 | Cost estimates for slurry walls are based on a 25-foot depth and $21.45 per square foot of wall (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Firebaugh Project Area 1: Setback Levee and Riparian Restoration at the Wastewater Treatment Plant | Project includes 4,850 LF of replacement levees, 4,850 LF of recreational trails, and 115 acres of riparian/wetland habitat land purchase and implementation. | To be developed | $16,200,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia 2022) |
| 1 | Firebaugh Project Area 2: Stabilization of the Eroding Bank at a Sharp Bend in the San Joaquin River | Project includes 500 LF of sheet pile and 500 LF of recreational trails. | To be developed | $3,520,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia 2022) |
| 1 | Firebaugh Project Area 3: Setback Levee to Protect the Firebaugh Water Treatment Plant near the Rodeo Grounds | Project includes 1,000 LF of replacement levees, 1,000 LF of recreational trails, and 15 acres of riparian/wetland land purchase and habitat implementation. | To be developed | $3,000,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia 2022) |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 1 | Firebaugh Long-Term Projects | Project includes 13,000 LF of replacement levees, 13,000 LF of recreational trails, and the Eastside Acres Improvements. | To be developed | $48,200,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia 2022) |
| 1 | Channel Sediment Excavation at LU 13/14 (Entire Length) | Excavate sedimentation areas to reduce the estimated constricted flow (50% of published design flow). | To be developed | $14,100,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 1 | Levee Breaches Unit 1, LM 9.90 | Levee breaches at Unit 1, LM 9.90 and Unit 5, LM 0.25 are the result of previous flood flow actions. Levee washout occurred during a flooding event in the late 1960s. Past USACE inspection rated the LUs unacceptable for project standards (potential for PL 84-99 eligibility). The addition of structures with a series of flap gates is proposed; the structures would contain floodwater in the river channel and permit landside floodwater to drain into the river by removing the flash boards. | To be developed | $413,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 1 | Levee Breaches Unit 5, LM 0.25 | Levee breaches at Unit 1, LM 9.90 and Unit 5, LM 0.25 are the result of previous flood flow actions. Levee washout occurred during a flooding event in the late 1960s. Past USACE inspection rated the LUs unacceptable for project standards (potential for PL 84-99 eligibility). The addition of structures with a series of flap gates is proposed; the structures would contain floodwater in the river channel and permit landside floodwater to drain into the river by removing the flash boards. Rebuild and reinstall Desktop Study Identification Designations. | To be developed | $413,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 1 | Sand Slough Control Structure Removal | Remove the Sand Slough Control Structure to improve fish passage and increase flow capacity. DWR inspectors have marked this feature as unacceptable for the last 10 years. | To be developed | $446,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 2 | Channel Sediment Excavation at LU 5/6 LMs 18.7 to 29.1 | Excavate sedimentation areas to reduce the estimated constricted flow (45% of published design flow). | To be developed | $236,000,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 2 | Sediment Removal in the Chowchilla Canal Bypass Settling Basin | According to the O&M manual (LSJRFCP 1978), the Chowchilla Canal Bypass Settling Basin is located below the control structure with a sedimentation storage of 200,000 CY. The main geometric shape of the basin measures 1,600 feet along the centerline of the bypass channel, 250 feet in width, and 7.5 feet in depth. The side slopes have a ratio of 3:1, with 500 feet of wedge shape transition at each end conforming to the drainage channel section. Sedimentation disposal areas are on the landside of the bypass levees. On the right bank, the spoil area extends from LM 14.7 to LM 16.09; on the left bank, the spoil area extends from LM 13.99 to LM 15.27. | To be developed | $15,500,000 | Assume sediment removal of 200,000 CY. Other cost assumptions are from the 2015 USJR RFMP "Sediment removal in Eastside Bypass" project. | 2015 USJR RFMP (SJRFCPA 2015) |
| 2 | Channel Sediment Excavation at LU 3/4 (Entire Length) | Excavate sedimentation areas to reduce the estimated constricted flow (42% of published design flow). | To be developed | $6,570,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
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| 2 | Channel Sediment Excavation at LU 5/6 LMs 3.7 to 7.9 | Excavate sedimentation areas to reduce the estimated constricted flow (39% of published design flow). | To be developed | $67,000,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 2 | Bridge Enlargement over Eastside Bypass at Sandy Mush Road | The Sandy Mush Road crossing of the Eastside Bypass includes a bridge deck and piles with elevated road embankments at each end of the bridge. The flow area under the bridge and between the embankments is much less than the upstream flow area of the bypass. This constricts flood flows and causes upstream freeboard encroachment. The elevated road embankments have been cut three times in the past to allow the flood flows to pass. Cutting the road is problematic for Merced County because the road is designated as an arterial evacuation route. The bridge needs to be lengthened to reduce the flow restriction. An alternative option could be to install culverts in the embankments to reduce the flow area. As part of this project, opportunities for riparian and wetland habitat enhancements will be considered. | To be developed | $2,480,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 2 | Channel Sediment Excavation at LU 5/6 LMs 9.8 to 18.7 | Excavate sedimentation areas to reduce the estimated constricted flow (34% of published design flow). | To be developed | $236,000,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 2 | Enlarge Chowchilla Canal Bypass Control Structure | The Chowchilla Canal Bypass Control Structure, at the head waters of the Chowchilla Canal Bypass, should be enlarged with two additional gate bays to minimize upstream seepage and levee failure risk. This will increase the emergency flow capacity and operational flexibility of the structure. The bypass channel may need to be evaluated for increased channel capacity. System improvement will require geotechnical analyses and would include fish passage. Reinforcement and seals were put in at an existing gate in 2012 to change the vibration frequency. Although the gate now vibrates less, the issue is not fully resolved. | To be developed | $5,200,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 2 | Raise Part of Left Bank on LU 6 | Portions of the left bank LU 6—which are opposite right bank LUs 5, 7, 8, 9, and 10—were constructed as much as 2 feet lower than the right bank levees and need to be raised to provide the design freeboard. System improvement would require modeling of the system in the area to set levee elevation. The project levee was never accepted by the District, which presents a governance issue. This project is important to improving flow capacity. | To be developed | $6,540,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 2 | Channel Sediment Excavation at LU 1/2 LMs 0 to 11.5 | Excavate sedimentation areas to reduce the estimated constricted flow (27% of published design flow). | To be developed | $74,700,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 2 | Channel Sediment Excavation at LU 1/2 LMs 19.5 to End | Excavate sedimentation areas to reduce the estimated constricted flow (27% of published design flow). | To be developed | $22,200,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 2 | Channel Sediment Excavation at LU 11/12 (Entire Length) | Excavate sedimentation areas to reduce the estimated constricted flow (25% of published design flow). | To be developed | $15,100,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 2 | Channel Sediment Excavation at LU 5/6 LMs 7.9 to 9.8 | Excavate sedimentation areas to reduce the estimated constricted flow (23% of published design flow). | To be developed | $16,000,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 3 | Sediment Removal at Chowchilla Canal Bypass Control Structure | Remove sediment directly at the Chowchilla Canal Bypass Control Structure. As part of this project, opportunities for riparian and wetland habitat enhancements will be considered. | To be developed | $269,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 3 | Install New Gaging Station - Ash Slough | Install gaging station to anticipate flows into the Eastside Bypass. There is potential funding available from DWR. The locations are on the Fresno River, 5 miles upstream of District, and on Ash Slough, at the start of the flood levees. Both channels enter the District's system. There is no date for when the stations will be installed, but data will be available on California Data Exchange Center once they are installed. | In-progress | $254,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 3 | Channel Sediment Excavation at LU 1/2 LMs 11.5 to 19.5 | Excavate sedimentation areas to reduce the estimated constricted flow (16% of published design flow). | To be developed | $22,200,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 3 | Channel Sediment Excavation at LU 7/8 (Entire Length) | Excavate sedimentation areas to reduce the estimated constricted flow (16% of published design flow). | To be developed | $8,090,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 3 | Install New Gaging Station - Fresno River | Install gaging station to anticipate flows into the Eastside Bypass. There is potential funding available from DWR. The locations are on the Fresno River, 5 miles upstream of District, and on Ash Slough, at the start of the flood levees. Both channels enter the District's system. There is no date for when the stations will be installed, but data will be available on California Data Exchange Center once they are installed. | In-progress | $254,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 3 | Upper San Joaquin Sediment Study | The District has a significant sediment management problem due to the transport of large volumes of sediment into the area from upstream sources. Subsidence along portions of the Eastside Bypass is causing extreme scour and incision in the channel, which results in sediment mobilization and subsequent settlement in downstream reaches. This project would develop a sediment study in USJR region that identifies upstream sources of sediment as well as regional mitigation efforts. With SJRRP and DWR improvements, there is a greater frequency of flows running through the system. This study would identify the new system in terms of sediment. | To be developed | $155,000-$309,000 | Project was developed as part of the 2015 USJR RFMP in 2014 dollars. Escalated costs to 2026 dollars. | 2015 USJR RFMP (SJRFCPA 2015) |
| 3 | Channel Sediment Excavation at LU 15/16 (Entire Length) | Excavate sedimentation areas to reduce the estimated constricted flow (5% of published design flow). | To be developed | $2,780,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |
| 3 | Channel Sediment Excavation at LU 17/18 LMs 13 to End | Excavate sedimentation areas to reduce the estimated constricted flow (2% of published design flow). | To be developed | $2,770,000 | Cost estimate for sediment excavation is $57.40 per CY (2024 dollars), which includes a 30% contingency cost. Appendix E provides further cost details. | -- |

| Tier | System Improvement | Description | Status | 2026 Value | Estimated Cost Assumptions | Source Document |
|---|---|---|---|---|---|---|
| 3 | Install New Gaging Station - Mariposa Bypass | District identified the need to add a new gaging station on Mariposa Bypass. | To be developed | $254,000 | High-level cost estimate for studies is based on escalated 2015 USJR RFMP project "Ash Slough or Fresno River Gaging Stations." | District-identified (2023–2024) |
| 3 | Install New Gaging Station - Berenda Slough | District identified the need to add a new gaging station on Berenda Slough. | To be developed | $254,000 | High-level cost estimate for studies is based on escalated 2015 USJR RFMP project "Ash Slough or Fresno River Gaging Stations." | District-identified (2023–2024) |
| 3 | Feasibility Study to Address LU 22 Freeboard Issues and Livestock Erosion | With no source of water in the area other than the District, the landowners have the right to allow their cattle to graze over LU 22. This feasibility study would investigate options to address erosion issues in the area, such as placing mats. The District has placed new gravel in this area from FSRP funding. | To be developed | $150,000-$300,000 | High-level cost estimate for studies is based on engineering judgment. | District-identified (2023–2024) |
| 3 | Chowchilla Bypass (LUs 17 and 18) Drop Structures | Construct three drop structures in the Chowchilla Bypass to aid in addressing sedimentation and capacity issues. | To be developed | $35,000,000 | Appendix E provides detailed cost estimates. As-built drawings for Ash Slough drop structures were referenced. | District-identified (2023–2024) |
| 3 | Project Area 4A: Ecosystem Restoration Projects | Project includes 8,000 LF of replacement levees, 17,500 LF of recreational trails, the Poso Canal Control Structure, and 196 acres of riparian/wetland habitat land purchase and implementation. | To be developed | $364,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia 2022) |
| 3 | Project Area 4B: Ecosystem Restoration Projects | Project includes 9,000 LF of replacement levees, 9,000 LF of recreational trails, 1,800 LF of new berm, and 294 acres of riparian/wetland habitat land purchase and implementation. | To be developed | $361,000 | Appendix E provides detailed cost estimates from the Firebaugh Feasibility Study (Gouveia 2022). | Firebaugh Feasibility Study (Gouveia 2022) |

LF = linear foot (feet)
PL = public law

# Chapter 7 Funding Sources

The District was created by the California State Legislature in 1955 to operate, maintain, and repair facilities of the Project. District revenue is generated through benefit assessments on land parcels within District boundaries. These assessments support District O&M and are not intended or adequate to fund capital improvements. The District continues to face critical challenges in acquiring funding for flood system improvements to address subsidence, sedimentation, and aging infrastructure that continue to significantly decrease the ability of the Project to safely convey and manage flood flows, as the region is subject to more frequent extreme events and increasing flood risk. The State has started to address some of these challenges, particularly through its grant funding programs and assistance with local cost share requirements, but much greater financial support is needed to restore the Project to original published design capacities and increase system resilience to cope with future extreme hydrologic events. Continued coordination and action are needed at the local, State, and federal levels to overcome the District's increasing financial challenges.

The cost of the system improvements identified and prioritized in the previous chapters adds up to a total estimated cost of $1.30 billion, with $519 million assigned to Tier 1 projects. These improvements provide significant benefits to public safety, environmental stewardship, system resilience, and regional economic stability. Detailed financial plans will need to be prepared for each improvement as more information becomes available and as projects are considered for specific funding opportunities.

The City of Firebaugh faces significant challenges in funding new capital expenditures for proposed system improvements. The City of Firebaugh has four system improvements (Tier 1) that amount to $68.7 million. State and federal assistance is needed to fund these improvements.

## 7.1 Funding Sources

There are potential federal, State, and local funding sources that might be available to support system capital improvements. Federal and State funding sources include two major categories—grant programs with a focus on public safety and grant programs with a focus on environmental stewardship. Many of the federal and State grant programs fund projects that provide both benefits. A potential future funding source, California Proposition 4, which was recently passed during the November 2024 election, allows for a $10 billion bond focused on safe drinking water, wildlife prevention, and protection of communities and natural lands from climate risk. The majority of proposition funds will be delivered via loans and grants to local governments. Of the $10 billion, $3.8 billion is earmarked for drought, flood, and water supply goals, and $300 million is earmarked for farms and agricultural sustainability (LAO 2024).

Revenue sources for special districts include property assessments, ad valorem taxes, rates, and fees. Districts must follow the guidelines of Propositions 13, 218, and 26 when changing fees. Because of the current financial situation of the District, these federal and State revenue sources are critical to funding system improvements.

Federal funding programs for public safety come primarily from the Federal Emergency Management Agency (FEMA) and USACE. Federal funding for environmental stewardship includes National Resource Conservation Service, U.S. Fish and Wildlife Service, National Park Service, and USBR programs. FEMA funding is typically awarded to individual states' offices of emergency services, which then administer grant programs to local and regional agencies. The California Office of Emergency Services administers FEMA grant funding for California. DWR programs dominate the State funding sources for public safety. State environmental stewardship funding sources include the Conservation Stewardship Program, Wildlife Conservation Board, State Water Resources Control Board, and California Natural Resources Agency.

Federal and State sources that provide funds specifically for flood improvements include the following:

- FEMA Flood Mitigation Assistance Program, with a 25% non-federal cost share and a reduction in non-federal cost share for certain communities
- FEMA Pre-Disaster Mitigation Program, with a 25% non-federal cost share and a reduction in non-federal cost share for small, impoverished communities
- FEMA Building Resilient Infrastructure and Communities Grant Program, with a 25% non-federal cost share and a reduction in non-federal cost share for economically disadvantaged rural communities
- USACE planning grants
- DWR Small Communities Flood Risk Reduction Program
- DWR Integrated Regional Water Management Grants Program

Funding sources are also needed to provide money for preparation of planning and environmental documents and feasibility studies to support funding applications for project design and construction. Every system improvement will have to go through this type of process. It is also important to identify any additional O&M costs that will be required to maintain new facilities after construction.

## 7.2 Recommended Actions – State Level

In June 2023, the USJR region released an update to the 2015 USJR RFMP finance chapter, which recommended the following actions at the State level and local level, respectively (SJRFCPA 2023):

- The State should consider modifying grant program eligibility requirements to allow for up to 100% State cost share for qualifying projects.

- The State should address remaining funding gaps for local communities, including funding for non-SPFC facilities (specifically the City of Firebaugh).
- The State should solicit feedback from past FSRP and Flood Maintenance Assistance Program funding recipients to make improvements to existing grant programs. Potential improvements to the programs include improving clarity of program requirements, establishing clear guidelines on valuation of in-kind services toward local cost share requirements, and improving the process of expense approval.
- The State should pursue continued, stable funding to meet critical public safety system improvement needs. Direct funding programs like FSRP and Flood Maintenance Assistance Program have been critical to the region, but continued funding of these programs is not guaranteed.

## 7.3 Recommended Actions – District Level

- DWR and CVFPB need to respond to USACE's letter deauthorizing the Project. Submit a request to USACE to reauthorize federal recognition of the Project to make it eligible for PL 84-99 funding.
- Because the State owns the Project, the State needs to provide assurances of future emergency assistance to the Project if USACE will not reconsider federal authorization.
- Continue engagement in regional and State planning efforts to help identify remaining critical funding gaps and align local projects with statewide priorities for direct funding opportunities.
- Continue to look for opportunities to broaden and deepen collaboration across water sectors by actively engaging in integrated regional water management networks and local groundwater sustainability agency efforts.
- Advocate for lower or no local cost share or in-kind services for grant programs to assist small, rural, and/or disadvantaged communities.
- Advocate for continued funding for DWR's direct funding programs and new direct funding programs that address underfunded critical needs for capital improvements.
- Take advantage of California Office of Emergency Services' Prepare California funding opportunities to support grant application efforts and help meet local cost share requirements.

# Chapter 8 Conclusions and Recommendations

## 8.1 Conclusions

The District encompasses a high-value agricultural area that has historically experienced major losses from flooding events. Agriculture provides the foundation for the regional economy, and implementation of system improvements that support sustainable agriculture is critical to the long-term economic viability of the region. Loss of highly productive agricultural lands would have a significant impact on the long-term economy of the region.

District revenue is generated through benefit assessments on land parcels within District boundaries. These assessments support District O&M and are not intended or adequate to fund capital improvements. The District continues to face critical challenges to acquire funding for flood system improvements to address subsidence, sedimentation, and aging infrastructure that continue to significantly decrease the ability of the Project to safely convey and manage flood flows, as the region is subject to more frequent extreme events and increasing flood risk. Federal and State funding is needed for system improvements to reduce flood risk.

The State has assisted the District on an emergency basis. However, if there were levee breaches similar to those in 1997, where levees breached on both the north and south sides of the system above the Chowchilla Bifurcation Structure, the State would be solely responsible for post recovery, as the District is not currently eligible for USACE PL 84-99 flood response.

Significant investment is needed to return the flood system to its original published design capacity, and substantial funding sources are needed to support these investments. The approximate total cost for these needed system improvements is $1.31 billion, with $529 million assigned to Tier 1 projects. Although the District was able to convey excessive flood flows during the 2023 storms, without any catastrophic failure, significant improvements must be implemented to improve system resiliency to manage future extreme hydrologic events. It is critical that the District significantly improve its flood infrastructure, flood system resilience, emergency management, and environmental enhancement by acquiring funding to implement single-purpose public safety and multi-benefit projects.

## 8.2 Recommendations

This system assessment serves as a foundation for considering future District system improvements and studies. State and federal grant program funding is needed to implement the prioritized system improvements identified in Chapter 6. The District needs to pursue initial funding for feasibility studies for these flood system improvements and potential multi-benefit opportunities. Completion of feasibility studies provides critical information and cost estimates needed to apply for permitting, design, and construction funding.

## 8.2.1 Flood System Improvements

The proposed flood system improvements address major concerns about the flood system, such as conveyance capacity, erosion, sedimentation, subsidence, and levee seepage and stability deficiencies. The following list summarizes the Tier 1 proposed improvements identified in Chapter 6:

- Channel Sediment Excavation – Improvements will address sedimentation that has significantly reduced channel flow capacity District wide. Projects include problematic reaches on the Eastside Bypass (LU 5/6 LMs 0 to 3.7), and Ash Slough (LU 13/14 entire length).
- Rehabilitation of the San Joaquin River Control Structure – Settlement has occurred at the control structure, resulting in the wing walls separating from the structure. The wing wall backfill could be excavated and voids grouted under the spread footings, or spread footings could be added or enlarged to minimize further settlement.
- Rehabilitation of the Chowchilla Canal Bypass Control Structure – Similar to the Rehabilitation of San Joaquin River Control Structure, the overall condition of the Chowchilla Canal Bypass Control Structure requires rehabilitation including repair of wing walls, general concrete structure, and gates.
- Slurry Wall Installation – Improvements will address recurring and significant levee deficiencies such as seepage, boils, sinkholes, erosion, and subsidence throughout the District. The following reaches are of the highest priority:
  - Mariposa Bypass to Merced River (LU 1 LMs 4 to 11.4, LMs 14.2 to 14.5, LMs 15.7 to 17.3, LMs 19.3 to 19.8, and LMs 20.5 to 21.1)
  - Mariposa Bypass to Merced River (LU 2 LMs 2.3 to 13.8)
  - Backwater areas upstream of Mariposa Bypass (LU 3 LMs 1.2 to 1.6)
  - Eastside Bypass (LU 5 LMs 8.8 to 28.6)
  - Eastside Bypass (LU 6 LMs 0 to 9.64, LMs 18 to 21.4)
  - Mariposa Bypass (LU 12 LMs 0 to 3.4)
  - Chowchilla Canal Bypass (LU 18 LMs 1.5 to 8.4)
  - Upstream of Chowchilla Bifurcation (LU 23 LMs 0 to 10.23)
  - Upstream of Chowchilla Bifurcation (LU 24 LMs 0 to 8.34)
- Eastside Bypass Drop Structures – Construct four drop structures in the Eastside Bypass to aid in addressing seepage, sedimentation, and capacity issues.
- Firebaugh Project Areas 1–3 and Firebaugh Long-Term Projects – Improvements include a setback levee and riparian restoration at the wastewater treatment plant, stabilization of the eroding bank on the San Joaquin River, a setback levee to protect the water treatment plant, and several miles of replacement levees.

- Levee Breaches at Unit 1 (LM 9.9) and Unit 5 (LM 0.25) – Past USACE inspection rated the LUs unacceptable for project standards. It is proposed to add structures with a series of flap gates to contain floodwater in the river and permit landside floodwater to drain into the river by removing the flash boards.
- Sand Slough Control Structure Removal – DWR inspectors have marked this feature as unacceptable for the last 10 years.

## 8.2.2 Proposed Studies

Given the conceptual-level scope of this system assessment, several studies are recommended to evaluate complex system-wide issues such as sedimentation, subsidence, erosion control, and aging facility conditions. These studies will help focus rehabilitation efforts and the need for funding to properly address these complex issues. Funding is needed to initiate the Tier 1 priority studies identified in Chapter 6 and described as follows:

- Evaluation of District-wide Sediment Removal – With a completed sediment study and therefore a greater understanding of sediment transport and deposition in the District, efforts can be focused on identifying key locations for sediment removal.
- Comprehensive Evaluation of All Control Structures – Given the age and changing operational needs of the original system control structures, a comprehensive evaluation is needed to identify repairs and improvements to control structures to provide safe, reliable operation and greater operational flexibility.
- Levee Assessment – Upstream of Chowchilla Canal Bypass Control Structure – The District has identified this reach of the San Joaquin River (LUs 23 and 24) as a high priority. Major concerns such as seepage and levee integrity need to be studied, especially given the recent large storm seasons that have tested this reach.
- Evaluation of Ash Slough Drop Structures – Similar to the comprehensive evaluation of all control structures, the existing Ash Slough drop structures need to be evaluated to identify solutions to sedimentation and aging structural conditions.
- Third-party Impacts Caused by the SJRRP - SJRRP operations have introduced fishery flows into the bypasses during non-flood periods that cause excessive vegetation growth, which reduces flood flow capacity and significantly increases vegetation management costs. The District states that some of the erosion issues may have resulted from high flows and rapid changes in water levels caused by changes in SJRRP flow releases.

## 8.2.3 Multi-Benefit Projects

Multi-benefit projects reduce flood risk and can also include other benefits, such as enhancing fish and wildlife habitats, improving water supply reliability, addressing subsidence, and providing recreational opportunities.

Primary multi-benefit opportunities involve diversion of flood flows onto adjacent lands through levee deauthorization or removal, levee breaching, operable gates, pumps, and

improved conveyance between the floodplains and the main river channel or bypass system. This provides flood attenuation, transitory storage of floodwaters, and localized reductions in flood stage and velocities (SJRFCPA 2015).

The ecosystem benefits of these improvements include the following:

- Increase in the extent and frequency of floodplain inundation
- Removal of hard bank protection
- Restoration or enhancement of native wetland, riparian, and floodplain vegetation communities and associated benefits for many species of wildlife
- Restoration of hydrologic connectivity between the channel corridor and adjacent floodplain terraces and removal of barriers to fish migration
- Recharge of groundwater basins

An example of a proposed multi-benefit opportunity is with the City of Firebaugh. The city has a history of flooding, and 100-year flood protection for Firebaugh could combine structural flood protection (levee improvements) with potential levee setbacks and ecosystem restoration.

The District should continue to participate in and provide feedback to the DWR Flood-Managed Aquifer Recharge (Flood-MAR) program. Additionally, the District should continue coordination with DWR's program Multiple Benefit Floodplain Restoration Studies in which DWR is conducting studies in several pilot study areas, including the USJR region. The main purposes of the pilot studies are ecosystem enhancements, flood risk reduction, and groundwater sustainability. The District is participating with the DWR project team and has provided essential on-the-ground knowledge about system operation, challenges, and opportunities.

### 8.2.4 Future Actions

The District should continue to engage with the federal, State, and local entities in the region and coordinate with other interested parties and regional planning agencies so it can best leverage available funding opportunities to support design and construction of system improvements.

- DWR and CVFPB need to respond to USACE's letter deauthorizing the Project. Submit a request to USACE to reauthorize federal recognition of the Project to make it eligible for PL 84-99 funding.
- Because the State owns the Project, the State needs to provide assurances of future emergency assistance to the Project if USACE will not reconsider federal authorization.
- Create direct-assistance rehabilitation funding for projects that will mitigate the loss of conveyance capacity due to extreme subsidence in the region. This program should also include funding for local Sustainable Groundwater Management Act groundwater recharge projects that would stop further loss of channel capacity due to subsidence.

- Establish DWR/CVFPB funding for flood system rehabilitation considering wetted conditions caused by the federal SJRRP and due to significant vegetation growth resulting from SJRRP releases.
- Through the RFMP, participate in the development of a San Joaquin River Basin-wide study including planning assumptions, hydrologic and hydraulic modeling analyses, ecosystem restoration opportunities, benefits, peer review, and financing capabilities.
- Monitor future funding opportunities from potential State and federal sources, such as DWR's Urban Flood Risk Reduction and Small Communities Programs, to identify recommended regional improvements that may be eligible for direct or competitive funding.
- Develop more refined project descriptions, detailed cost estimates, and schedules to support funding applications for high-priority capital improvements.
- Investigate potential funding opportunities for multi-benefit and Integrated Regional Water Management projects.
- Continue coordination with regional flood management planning teams on the San Joaquin River (Upper, Mid, and Lower) to ensure that planning efforts and projects are coordinated.

# Chapter 9 References


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# Appendix A
# Excerpts from *Fall 2022 Levee Maintenance Deficiency Summary Report*

## Table A-1. Fall 2022 California Department of Water Resources Inspection Report Erosion and/or Seepage Sites by Levee Unit

| Levee | Location | POI Number | Category | Failure Mode | Start LM | End LM |
|---|---|---|---|---|---|---|
| Unit 01 | San Joaquin River | 178-101 | Serious | Seepage | 14.27 | 14.37 |
| | | 178-100 | Serious | Seepage | 15.82 | 17.24 |
| | | 178-FOC-5 | Serious | Seepage | 18.8 | 18.8 |
| | | 181-FOC-3 | Serious | Seepage | 19.88 | 19.23 |
| | | 181-FOC-4 | Serious | Seepage | 20.73 | 20.53 |
| | | 181-FOC-5 | Serious | Seepage | 20.91 | 20.91 |
| Unit 03 | San Joaquin River | 183-100 | Serious | Seepage | 1.17 | 1.17 |
| | | 183-1 | Serious | Seepage | 1.34 | 1.34 |
| | | 183-FOC-5 | Serious | Seepage | 1.57 | 1.57 |
| Unit 05 | Eastside Bypass | 182-4 | Serious | Seepage | 13.88 | 13.88 |
| | | 182-100 | Serious | Seepage | 14.89 | 14.46 |
| | | 182-2 | Critical | Seepage | 15.03 | 15.03 |
| | | DWR_NA0010_05_R_2012_01 | Critical | Seepage | 30.56 | 30.56 |
| | | DWR_NA0010_05_R_2012_02 | Serious | Seepage | 31.59 | 31.59 |
| Unit 06 | Eastside Bypass | DWR_NA0010_06_R_2012_01 | Critical | Erosion | 0.05 | 0.05 |
| | | 252-FOC-1 | Serious | Seepage | 13.16 | 13.16 |
| | | 252-FOC-2 | Serious | Seepage | 13.8 | 13.8 |
| | | 252-1 | Serious | Seepage | 14.24 | 14.24 |
| | | 252-111 | Serious | Seepage | 14.47 | 14.57 |
| | | 252-106 | Serious | Seepage | 16.75 | 16.04 |

| Levee | Location | POI Number | Category | Failure Mode | Start LM | End LM |
|---|---|---|---|---|---|---|
| | | 252-FOC-3 | Serious | Seepage | 17.17 | 17.17 |
| | | 252-FOC-4 | Serious | Seepage | 17.76 | 17.76 |
| | | 252-FOC-5 | Serious | Seepage | 18.05 | 18.05 |
| | | 252-FOC-6 | Serious | Seepage | 19.15 | 19.15 |
| | | 253-136 | Critical | Seepage | 21.28 | 21.28 |
| Unit 12 | Mariposa Bypass | 354-FOC-1 | Serious | Seepage | 0.61 | 0.61 |
| | | 354-101 | Serious | Seepage | 1.77 | 1.07 |
| Unit 18 | Chowchilla Canal Bypass | 357-FOC-4 | Serious | Seepage | 10.96 | 11.02 |
| Unit 23 | San Joaquin River | 219-100 | Critical | Seepage | 0.21 | 0.73 |
| | | 219-FOC-6 | Critical | Seepage | 1.93 | 1.93 |
| | | 219-FOC-7 | Critical | Seepage | 3.64 | 3.64 |
| Unit 24 | San Joaquin River | 220-107 | Critical | Seepage | 0.85 | 0.86 |
| | | 220-100 | Serious | Seepage | 1.79 | 1.71 |
| | | 220-1 | Critical | Seepage | 2.85 | 2.85 |
| | | 220-4 | Critical | Seepage | 3.53 | 3.53 |
| | | 220-105 | Critical | Seepage | 3.7 | 3.76 |

LM = levee mile(s)
POI = point of interest

# Appendix B
# Lower San Joaquin Levee District Comprehensive List of Issues by Levee Unit

**Table B-1. District Deficiencies by Levee Unit**

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 1 | All | 2022 FSSR | Historical Boil Site | <5 sites identified. |
| 1 | All | 2022 FSSR | Historical Seepage Site | <5 sites identified. |
| 1 | All | 2022 FSSR | Historical Erosion Site | <5 sites identified. |
| 1 | All | 2022 FSSR | Levee Penetrations | 15+ sites. |
| 1 | All | 2022 FSSR | Encroachment Site | 3 unacceptable, 3 minimally acceptable sites identified. |
| 1 | All | 2022 FSSR | Historical Slope Instability Site | 5+ sites identified. |
| 1 | LM 14-21 (multiple segments) | 2022 DWR Inspection Report | New Seepage Sites | 6 serious sites identified. |
| 1 | LM 11.5-19.5 | 2022 FSSR | San Joaquin River Design Capacity Issues | Diminished current freeboard capacity (8,400 cfs current / 10,000 cfs design). |
| 1 | Eastside Bypass to upstream SJR end of project levee | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. |
| 1 | LM 0-11.5 | 2022 FSSR | San Joaquin River Design Capacity Issues | Not specified in FSSR report, but GIS shows a freeboard capacity of 19,000 cfs compared to 26,000 cfs design. |
| 1 | LM 19.5-end | 2022 FSSR | San Joaquin River Design Capacity Issues | Labeled as backwater zone from FSSR report. GIS shows a freeboard capacity of 1,100 cfs compared to 1,500 cfs design. |
| 1 | LM 9.90 | 2015 USJR RFMP | Levee Break | Levee break identified in 2015 USJR RFMP. USACE inspections rated the levee unit as unacceptable and installing new structures to allow the project to operate as intended. |
| 2 | End of Levee 2 | 2022 FSSR | Historical Boil Site | <5 sites identified. |
| 2 | All | 2022 FSSR | Historical Seepage Site | <5 sites identified. |
| 2 | All | 2022 FSSR | Historical Erosion Site | <5 sites identified. |
| 2 | Beginning of Levee 2 | 2022 FSSR | Encroachment Site | 1 minimally acceptable sites identified. |
| 2 | All | 2022 FSSR | Levee Penetrations | 10+ sites. |
| 2 | End of Levee 2 | 2022 FSSR | Historical Slope Instability Site | 5+ sites identified. |
| 2 | Mariposa Bypass to Bear Creek | 2022 FSSR | San Joaquin River Design Capacity Issues | Diminished current freeboard capacity (8,400 cfs current / 10,000 cfs design) from Mariposa Bypass to Bear Creek. |
| 2 | All | 2022 FSSR | NULE Levee Geometry Hazard | Does not meet criteria. |
| 2 | All | 2022 FSSR | NULE Overall Hazard Classification | Does not meet criteria. |
| 2 | All | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. |
| 2 | LM 0.68-0.74 | 2022 DWR Inspection Report | Existing Erosion Site | Existing erosion site identified at LM 0.68-0.74. |
| 2 | Mariposa Bypass to End of Levee | 2022 FSSR | San Joaquin River Design Capacity Issues | Labeled as backwater zone from FSSR report. GIS shows a freeboard capacity of 1,100 cfs compared to 1,500 cfs design. |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 2 | All | NULSE | Levee Seepage Issues | This segment has no documented seepage incidents. However, a district representative indicated that boils and both underseepage and through seepage occur during high water events and that underseepage is more of a concern. As such, the preliminary repair length is assumed to be approximately 13.79 miles, the entire length of the segment. The preliminary feasible remedial alternatives include construction of a drained seepage berm or a cutoff wall. Existing penetrations through the levee, consisting of pipe diameters ranging from 24 to 36-inches and located approximately 6 to 15 feet below the levee crown, as well as numerous channels, ponds, and canals adjacent to the landside levee toe may impact the potential remediation alternatives. |
| 3 | All | 2022 FSSR | Historical Seepage Site | <5 sites identified. |
| 3 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 3 | All | 2022 FSSR | Slope Stability Rating | 1 minimally acceptable site identified. |
| 3 | LM 2-end of levee 3 | 2022 FSSR | Encroachment Site | 2 minimally acceptable sites identified. |
| 3 | LM 0-1.5 | 2022 FSSR | Historical Boil Site | 2 sites identified. |
| 3 | LM 1-2 | 2022 DWR Inspection Report | New Seepage Sites | 3 serious sites identified. |
| 3 | Washington Rd. Bridge over SJ River | District-identified 2023 issues | Washington Rd. Bridge Closure | Site 7. Closed due to high flows in 2023 storms. Washington Bridge was blocked on January 11 on the San Joaquin River. Hyacinth was causing a backup/damming. |
| 3 | All | 2022 FSSR | San Joaquin River Design Capacity Issues | Increased current freeboard capacity (2,600 cfs current / 1,500 cfs design) from Sand Slough to Fresno Slough. |
| 3 | LM 0.6 | District-identified 2023 issues | Boil Site | Site 8. 3/23/23: Boil reported. Landowner and LD are responding. |
| 4 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 4 | LM 0-1 | 2022 FSSR | Encroachment Site | 1 minimally acceptable sites identified. |
| 4 | All | 2022 FSSR | San Joaquin River Design Capacity Issues | Increased current freeboard capacity (2,600 cfs current / 1,500 cfs design) from Sand Slough to Fresno Slough. |
| 4 | SJR Control Structure | District-identified 2023 issues | Inoperable Gates | San Joaquin River Control Structure gates are inoperable, and they are a part of the SPFC. DWR inspectors have marked this feature as unacceptable for the past 10 years. |
| 4 | SJR Control Structure | 2022 DWR Inspection Report | Structure Inspection Rating | Minimally acceptable. |
| 4 | Sand Slough Structure | 2022 DWR Inspection Report | Structure Inspection Rating | Minimally acceptable. |
| 5 | LM 14-17 | 2022 FSSR | Historical Subsidence Site | <5 sites identified. |
| 5 | Upstream of Mariposa Bypass | 2022 FSSR | Historical Levee Overtopping | >5 sites. |
| 5 | All | 2022 FSSR | Encroachment Site | 2 unacceptable sites identified. |
| 5 | All | 2022 DWR Inspection Report | New Seepage Sites | 3 serious sites and 2 critical sites identified. |
| 5 | All | 2022 FSSR | Levee Penetrations | 30+ sites. |
| 5 | All | 2022 FSSR | Historical Slope Instability Site | 5+ sites identified. |
| 5 | All | 2022 FSSR | Historical Boil Site | 5+ sites identified. |
| 5 | All | 2022 FSSR | Historical Seepage Site | 5+ sites identified. |
| 5 | All | 2022 FSSR | Historical Erosion Site | 5+ sites identified. |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 5 | Washington Rd. Bridge over Eastside Bypass | District-identified 2023 issues | Washington Rd. Bridge Closure | Site 11. 3/30/23: County of Merced closed Washington bridge due to high flows in 2023 storms. The bridge was closed over the Eastside Bypass on March 30. |
| 5 | LM 3.7-7.9 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (11,000 cfs) from Owens Creek to Bear Creek. |
| 5 | LM 0-3.7 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (11,500 cfs) from Bear Creek to SJR. |
| 5 | LM 32.2-35.2 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (12,900 cfs) from Berenda Slough to Fresno River. |
| 5 | LM 9.8- 18.7 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (16800 cfs) from Sand Slough to Mariposa Bypass. |
| 5 | LM 29.1-32.2 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (17,100 cfs) from Ash Slough to Berenda Slough. |
| 5 | LM 23.7-29.1 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (26,400 cfs) from Ash Slough to end of backwater (Flanagan Rd / Hwy 152). |
| 5 | LM 7.9-9.8 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (7,400 cfs) from Mariposa Bypass to Deep Slough and Owens Creek. |
| 5 | LM 18.7-23.7 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (8,900 cfs) from end of backwater (Flanagan Rd / Hwy 152) to Sand Slough. |
| 5 | All | 2022 FSSR | NULE Levee Geometry Hazard | Does not meet criteria. |
| 5 | Downstream end of project levee to Ash | 2022 FSSR | NULE Overall Hazard Classification | Does not meet criteria. |
| 5 | Mariposa Bypass to Ash Slough | 2022 FSSR | NULE Through-Seepage Hazard | Does not meet criteria. |
| 5 | Mariposa Bypass to upstream end of project levee | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. |
| 5 | LM 2.61-2.68, LM 14.93-14.97 | 2022 DWR Inspection Report | Existing Erosion Sites | Existing erosion sites identified at LM 2.61-2.68 and LM 14.93-14.97. |
| 5 | LM 19-end of levee | District-identified 2023 issues | Severe Channel Subsidence and Scouring | District reports that scouring and subsidence is so severe that large flood flows will not reach the toe of the levee. |
| 5 | Ave 18 1/2 bridge | District-identified 2023 issues | Bridge Foundation Erosion | Site 6, Bridge Foundation Erosion due to high flows in 2023 storms.<br>1/14/2023 0800; LD notified Madera Co regarding erosion to 18 1/2 bridge, right bank down stream location.<br>1/20/2023; LD contacted Madera Co EOS and Madera Supervisors for support to declare emergency for failing foundation of bridge due to flood flows.<br>1/21/23; LD spoke to Madera Supervisor Chief of Staff of failing bridge and recommend declaring emergency. Waiting on Madera Co for repairs. Madera Co EOS and Public Works are monitoring Ave 18 ½ bridge foundation erosion, where the bridge goes over the Flood Bypass, and they have also closed both directional lanes. No new updates from Madera Co EOS since 1/24/23.<br>3/19/23: Bridge is still closed. No new updates from County. |
| 5 | RM 0.25 | 2015 USJR RFMP | Levee Break | Levee break identified in 2015 USJR RFMP. USACE inspections rated the levee unit as unacceptable and installing new structures to allow the project to operate as intended. |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 5 | LM 32.2-35.2 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 10,000 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 11,200 cfs |
| 5 | LM 29.1-32.2 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 12,000 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 15,200 cfs |
| 5 | LM 7.9-9.8 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 12,000 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 9,200 cfs |
| 5 | LM 3.7-7.9 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 13,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 8,200 cfs |
| 5 | LM 9.8- 18.7 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 16,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 10,900 cfs |
| 5 | LM 18.7-29.1 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 17,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 9,600 cfs |
| 5 | LM 0-3.7 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 18,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 6,100 cfs |
| 5 | Berenda Slough to Mariposa Bypass | 2015 USJR RFMP | Sedimentation | Significant sedimentation issues reported. Largest sedimentation at West Washington Rd. |
| 5 | Chowchilla Bypass to Mariposa Bypass | Reclamation Subsidence Monitoring | Subsidence Issues | Significant subsidence issues reported. |
| 5 | LM 16.5 | District-identified 2023 issues | Wave Wash Site | Site 10. 3/28/23: Reported to FOC of wave wash damage to levees.<br>3/30/23: CCC crews responded and wave wash protection started.<br>10/2024: Emergency plastic is still on levee, waiting for DWR SDDER program to repair 4 miles. |
| 5 | LM 8.75-28.63 (estimate) | NULSE | Levee Seepage Issues | This segment has experienced seepage and boils between LM 21.1 and LM 26.5. The boils were observed on the landside slope and near the landside toe, indicating both through seepage and underseepage may be a concern. A district representative indicated that the segment experiences chronic boils and seepage during high water events. As such, the preliminary repair length is assumed to be approximately 5.4 miles from LM 21.1 to LM 26.5. The preliminary feasible remedial alternatives include construction of a drained seepage berm or a cutoff wall. Existing penetrations through the levee, consisting primarily of pipe diameters from 24 to 48-inches and located approximately 2 to 16 feet below the levee crown, as well as potential sloughs near the landside toe may impact the potential remediation alternatives. There appear to be no other real estate restrictions or constraints along and adjacent to the preliminary repair location. |
| 6 | LM 0-9.64 (estimate) | NULSE | Levee Seepage Issues | This segment has experienced seepage and breaches. None of the seepage incidents have been documented, however district representatives indicate that both underseepage and through seepage occur during high water events. As such, the preliminary repair length is assumed to be approximately 9.64 miles, the entire length of the segment. The preliminary feasible remedial alternatives include construction of a drained seepage berm or a cutoff wall. Existing penetrations through the levee, consisting of pipe diameters from 16 to 36-inches and located approximately 7 to 17 feet below the levee crown, marshy wetlands, and ditches both perpendicular and parallel to the landside levee toe may impact the potential remediation alternatives. |
| 6 | LM 14-17 | 2022 FSSR | Historical Subsidence Site | <5 sites identified. |
| 6 | RM 0.05 | 2022 DWR Inspection Report | New Erosion Site | 1 new critical erosion site identified. |
| 6 | LM 8 | 2022 FSSR | Historical Levee Breach | 1 site . |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 6 | Upstream of Mariposa Bypass | 2022 FSSR | Historical Levee Overtopping | 1 site. |
| 6 | All | 2022 FSSR | Encroachment Site | 1 unacceptable, 6 minimally acceptable sites identified. |
| 6 | All | 2022 FSSR | Levee Penetrations | 15+ sites. |
| 6 | RM 0.10-14.97 | 2022 DWR Inspection Report | New Erosion Sites | 3 new erosion site identified. (1) RM 0.10-0.14; (2) RM 2.61-2.68; (3) RM 14.93-14.97. |
| 6 | All | 2022 FSSR | Historical Slope Instability Site | 5+ sites identified. |
| 6 | All | 2022 FSSR | Historical Boil Site | 5+ sites identified. |
| 6 | All | 2022 FSSR | Historical Seepage Site | 5+ sites identified. |
| 6 | All | 2022 FSSR | Historical Erosion Site | 5+ sites identified. |
| 6 | LM 18-21.4 | 2022 DWR Inspection Report | New Seepage Sites | 9 serious sites and 2 critical sites identified. |
| 6 | LM 19-end of levee | District-identified 2023 issues | Severe Channel Subsidence and Scouring | District reports that scouring and subsidence is so severe that large flood flows will not reach the toe of the levee. |
| 6 | Washington Rd. Bridge | District-identified 2023 issues | Washington Rd. Bridge Closure | Closed due to high flows in 2023 storms. Washington Bridge was blocked on January 11 on the San Joaquin River; the bridge was closed over the Eastside Bypass on March 30. |
| 6 | DSID 19876 and 19877 | District-identified 2023 issues | Drainpipe Failures | Sites 3 and 5.Collapsed pipe (DSID 19876) and failure (DSID 19877). |
| 6 | LM 3.7-7.8 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (11000cfs) from Eastside Bypass (Deep Slough) to Bear Creek. |
| 6 | LM 0-3.7 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (11500cfs) from Bear Creek to SJR. |
| 6 | LM 33.1-35.8 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (12900cfs) from Berenda Slough to Fresno River. |
| 6 | LM 9.7-19.3 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (16800cfs) from Sand Slough to Mariposa Bypass. |
| 6 | LM 30.0-33.1 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (17100cfs) from Ash Slough to Berenda Slough. |
| 6 | LM 24.5-30.0 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (26400cfs) from Ash Slough to end of backwater (Flanagan Rd). |
| 6 | LM 7.8-9.7 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (7400cfs) from Mariposa Bypass to Deep Slough and Owens Creek. |
| 6 | LM 19.4-24.5 | 2022 FSSR | Eastside Bypass Design Capacity Issues | Diminished current freeboard capacity (8900cfs) from end of backwater (Flanagan Rd) to Sand Slough. |
| 6 | All | 2022 FSSR | NULE Overall Hazard Classification | Does not meet criteria. |
| 6 | San Joaquin River to Chowchilla River | 2022 FSSR | NULE Through-Seepage Hazard | Does not meet criteria. |
| 6 | Mariposa Bypass to upstream end of project levee | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 6 | All | 2022 FSSR | NULE Levee Geometry Hazard | Does not meet criteria. |
| 6 | Ave 18 1/2 bridge | District-identified 2023 issues | Bridge Foundation Erosion | Site 6, Bridge Foundation Erosion due to high flows in 2023 storms.<br>1/14/2023 0800; LD notified Madera Co regarding erosion to 18 1/2 bridge, right bank down stream location.<br>1/20/2023; LD contacted Madera Co EOS and Madera Supervisors for support to declare emergency for failing foundation of bridge due to flood flows.<br>1/21/23; LD spoke to Madera Supervisor Chief of Staff of failing bridge and recommend declaring emergency.<br>Waiting on Madera Co for repairs. Madera Co EOS and Public Works are monitoring Ave 18 ½ bridge foundation erosion, where the bridge goes over the Flood Bypass, and they have also closed both directional lanes. No new updates from Madera Co EOS since 1/24/23.<br>3/19/23: Bridge is still closed. No new updates from County. |
| 6 | LM 33.1-35.8 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 10,000 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 11,200 cfs |
| 6 | LM 30.0-33.1 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 12,000 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 15,200 cfs |
| 6 | LM 7.8-9.7 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 12,000 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 9,200 cfs |
| 6 | LM 3.7-7.8 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 13,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 8,200 cfs |
| 6 | LM 9.7-19.3 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 16,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 10,900 cfs |
| 6 | LM 19.4-30.0 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 17,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 5,900 cfs |
| 6 | LM 0-3.7 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 18,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 6,100 cfs |
| 6 | Berenda Slough to Mariposa Bypass | 2015 USJR RFMP | Sedimentation | Significant sedimentation issues reported. Largest sedimentation at West Washington Rd. |
| 6 | Chowchilla Bypass to Mariposa Bypass | Reclamation Subsidence Monitoring | Subsidence Issues | Significant subsidence issues reported. |
| 6 | LM 13 | District-identified 2023 issues | Erosion Site | Site 3.<br>1/10/23 1300; reported to DWR FOC of failing levee.<br>1/11/23 0800; CA DWR inspectors en route.<br>11/12/23 0830: CA DWR responded and stated to monitor. No action response needed at the moment.<br>4/1/23: DWR FFS went to inspect and deemed it was a critical area that needed to be repaired.<br>4/4/23: CALOES mission tasked, working on getting a rock contract. |
| 7 | All | 2022 FSSR | Historical Slope Instability Site | <5 sites identified. |
| 7 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 7 | All | 2022 FSSR | Bear Creek Design Capacity Issues | Diminished current freeboard capacity (5,900 cfs current / 7,000 cfs design) from Deep Slough to East Side Canal. |
| 7 | All | 2022 FSSR | NULE Levee Geometry Hazard | Does not meet criteria. |
| 8 | All | 2022 FSSR | Levee Penetrations | >5 sites. |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 8 | All | 2022 FSSR | Bear Creek Design Capacity Issues | Diminished current freeboard capacity (5,900 cfs current / 7,000 cfs design) from Deep Slough to East Side Canal. |
| 9 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 9 | All | 2022 FSSR | Owens Creek Design Capacity Issues | Not specified in FSSR report, but GIS shows a freeboard capacity of 3,100 cfs compared to 2,000 cfs design. |
| 10 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 10 | All | 2022 FSSR | Owens Creek Design Capacity Issues | Not specified in FSSR report, but GIS shows a freeboard capacity of 3,100 cfs compared to 2,000 cfs design. |
| 11 | All | 2022 FSSR | Historical Slope Instability Site | <5 sites identified. |
| 11 | All | 2022 FSSR | Historical Boil Site | <5 sites identified. |
| 11 | All | 2022 FSSR | Historical Erosion Site | <5 sites identified. |
| 11 | All | 2022 FSSR | Levee Penetrations | >5 sites identified. |
| 11 | All | 2022 FSSR | Mariposa Bypass Design Capacity Issues | Not specified in FSSR report, but GIS shows a freeboard capacity of 3,400 cfs compared to 8,500 cfs design. |
| 11 | All | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 8,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 6,400 cfs |
| 12 | All | 2022 FSSR | Historical Slope Instability Site | <5 sites identified. |
| 12 | All | 2022 FSSR | Historical Boil Site | <5 sites identified. |
| 12 | All | 2022 FSSR | Historical Erosion Site | <5 sites identified. |
| 12 | All | 2022 FSSR | Levee Penetrations | >5 sites. |
| 12 | All | 2022 DWR Inspection Report | New Seepage Sites | 2 serious sites identified. |
| 12 | All | 2022 FSSR | Mariposa Bypass Design Capacity Issues | Not specified in FSSR report, but GIS shows a freeboard capacity of 3,400 cfs compared to 8,500 cfs design. |
| 12 | All | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 8,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 6,400 cfs |
| 12 | All | NULSE | Levee Seepage Issues | This segment experiences seepage and boils during high water events according to a district representative. None of the locations or type of seepage have been documented. It has also been indicated that underseepage is more of a concern than through seepage. As such, the preliminary repair length is assumed to be approximately 3.36 miles, the entire length of the segment. The preliminary feasible remedial alternatives include construction of a drained seepage berm or a cutoff wall. Existing penetrations through the levee, consisting of pipe diameters from 24 to 48-inches and located approximately 2 to 18 feet below the levee crown, existing control structures, and landside ditches both perpendicular and adjacent to the landside levee toe may impact the potential remediation<br>alternatives. There appear to be no other real estate restrictions or constraints along and adjacent to the preliminary repair location. |
| 13 | All | 2022 FSSR | Historical Seepage Site | <5 sites identified. |
| 13 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 13 | All | 2022 FSSR | Historical Erosion Site | 1 site identified. |
| 13 | All | 2022 FSSR | Slope Stability Rating | 1 unacceptable site identified. |
| 13 | All | 2022 FSSR | Encroachment Site | 5+ (unacceptable, minimally acceptable) sites identified. |
| 13 | All | 2022 FSSR | Historical Slope Instability Site | 5+ sites identified. |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 13 | All | 2022 FSSR | Ash Slough Design Capacity Issues | Diminished current freeboard capacity (2,500 cfs current / 5,000 cfs design). |
| 13 | Ash Slough Drop Structures 3 and 4 | District-identified 2023 issues | Sedimentation Issues | District reports sedimentation issues at Ash Slough Drop Structures 3 and 4. |
| 13 | Ash Slough Drop Structure 3 | 2022 DWR Inspection Report | New Structure Inspection Rating | Minimally acceptable. |
| 14 | All | 2022 FSSR | Encroachment Site | <5 (unacceptable, minimally acceptable) sites identified. |
| 14 | All | 2022 FSSR | Historical Slope Instability Site | <5 sites identified. |
| 14 | All | 2022 FSSR | Historical Seepage Site | <5 sites identified. |
| 14 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 14 | All | 2022 FSSR | Slope Stability Rating | 1 minimally acceptable site identified. |
| 14 | All | 2022 FSSR | Ash Slough Design Capacity Issues | Diminished current freeboard capacity (2,500 cfs current / 5,000 cfs design). |
| 14 | All | 2022 FSSR | NULE Landside Slope Stability Hazard | Does not meet criteria. |
| 14 | Near Eastside Bypass confluence | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. <5mi length. |
| 15 | All | 2022 FSSR | Historical Slope Instability Site | <5 sites identified. |
| 15 | All | 2022 FSSR | Historical Seepage Site | <5 sites identified. |
| 15 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 15 | All | 2022 FSSR | Berenda Slough Design Capacity Issues | Diminished current freeboard capacity (1,900 cfs current / 2,000 cfs design) from end of backwater zone (Hemlock Rd.) to Eastside Bypass (entire length of levee). |
| 15 | LM0-1.2 | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. |
| 16 | All | 2022 FSSR | Historical Slope Instability Site | <5 sites identified. |
| 16 | All | 2022 FSSR | Historical Seepage Site | <5 sites identified. |
| 16 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 16 | All | 2022 FSSR | Historical Erosion Site | 1 sites identified. |
| 16 | All | 2022 FSSR | Slope Stability Rating | 1 unacceptable sites identified. Was this mapped? Not mapped. |
| 16 | All | 2022 FSSR | Berenda Slough Design Capacity Issues | Diminished current freeboard capacity (1,900 cfs current / 2,000 cfs design) from end of backwater zone (Hemlock Rd.) to Eastside Bypass (entire length of levee). |
| 16 | All | 2015 USJR RFMP | Berenda Slough Design Capacity Issues | Diminished current freeboard capacity (1900cfs) from end of backwater zone (Hemlock Rd.) to Eastside Bypass. Diminished current freeboard capacity (1400cfs) from end of backwater zone (Hemlock Rd.) to end of project |
| 16 | LM 0-0.5 | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. |
| 17 | All | 2022 FSSR | Historical Sinkhole Site | <5 sites identified. |
| 17 | All | 2022 FSSR | Historical Boil Site | <5 sites identified. |
| 17 | All | 2022 FSSR | Historical Erosion Site | <5 sites identified. |
| 17 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 17 | All | 2022 FSSR | Historical Slope Instability Site | 5+ sites identified. |
| 17 | LM 1.2-3 | 2022 FSSR | NULE Landside Slope Stability Hazard | Does not meet criteria. |
| 17 | All | 2022 FSSR | NULE Through-Seepage Hazard | Does not meet criteria. |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 17 | LM 1.2-3, LM 9.6-16 | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. |
| 17 | All | 2022 FSSR | NULE Levee Geometry Hazard | Does not meet criteria. Section of Unit 17 does meet criteria. |
| 17 | LM 13-end of levee | District-identified 2023 issues | Sedimentation Issues | The District identified sedimentation from approximately LM 13-end of levee which affects channel capacity. |
| 17 | LM 0-16.1 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 5,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 5,400 cfs |
| 17 | All | 2015 USJR RFMP | Sedimentation | Significant sedimentation issues reported. The District is starting to observe moving sediment, and sandbars are appearing downstream where they are not historically observed, the District has also observed sediment appearing on the sides of the pilot channel, further constricting flow to the middle sections and sediment buildup upstream of county bridges. In addition, many flap gates are filled with sediment. |
| 17 | RM 1.5-8.5 | Reclamation Subsidence Monitoring | Subsidence Issues | Significant subsidence issues reported. |
| 18 | All | 2022 FSSR | Historical Sinkhole Site | <5 sites identified. |
| 18 | All | 2022 FSSR | Historical Boil Site | <5 sites identified. |
| 18 | All | 2022 FSSR | Historical Erosion Site | <5 sites identified. |
| 18 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 18 | RM 10.9-11.0 | 2022 DWR Inspection Report | New Seepage Sites | 1 serious sites identified. |
| 18 | All | 2022 FSSR | Encroachment Site | 1 unacceptable, 3 minimally acceptable sites identified. |
| 18 | All | 2022 FSSR | Historical Slope Instability Site | 5+ sites identified. |
| 18 | All | 2022 FSSR | NULE Levee Geometry Hazard | Does not meet criteria. |
| 18 | All | 2022 FSSR | NULE Overall Hazard Classification | Does not meet criteria. |
| 18 | All | 2022 FSSR | NULE Through-Seepage Hazard | Does not meet criteria. |
| 18 | All | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. |
| 18 | LM 13-end of levee | District-identified 2023 issues | Sedimentation Issues | The District identified sedimentation from approximately LM 13-end of levee which affects channel capacity. |
| 18 | LM 0-16.0 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 5,500 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 4.0 feet at 5,400 cfs |
| 18 | All | 2015 USJR RFMP | Sedimentation | Significant sedimentation issues reported. The District is starting to observe moving sediment, and sandbars are appearing downstream where they are not historically observed, the District has also observed sediment appearing on the sides of the pilot channel, further constricting flow to the middle sections and sediment buildup upstream of county bridges. In addition, many flap gates are filled with sediment. |
| 18 | LM 1.2-8.2 | Reclamation Subsidence Monitoring | Subsidence Issues | Significant subsidence issues reported. |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 18 | LM 1.5-8.4 | NULSE | Levee Seepage Issues | This segment has experienced boils, piping and seepage at LM 1.5, LM 4.9, and LM 8.4 in 1997 and 2006. Subsequently, seepage berms have been constructed at three locations between approximately LM 12.5 and LM 15.3, under the PL 84-99 program. These repairs do not cover the previously documented past performance locations and according to a district representative, the segment still experiences seepage issues. As such, the preliminary repair length is assumed to be approximately 6.9 miles, between LM 1.5 and LM 8.4. Preliminary feasible remedial alternatives include construction of a drained seepage berm or a cutoff wall. Existing penetrations through the levee, with pipe diameters generally between 15 and 36-inches and located about 4 to 17 feet below the crown, landside ditches/ponds, as well as residential/commercial structures near the landside toe may impact the potential remediation alternatives. |
| 22 | Owens Creek Control Structure | District-identified 2023 issues | Degraded Structure | Owens Creek Control Structure (including the Owens Creek Bridge which spans the control structure) is severly aged and in need of repairs and funding from DWR. |
| 22 | All | 2022 FSSR | Encroachment Site | <5 sites identified. |
| 22 | All | 2022 FSSR | Levee Penetrations | <5 sites. |
| 22 | All | 2022 FSSR | Historical Slope Instability Site | 5+ sites identified. |
| 22 | All | 2022 FSSR | Historical Erosion Site | 5+ sites identified. |
| 23 | All | NULSE | Levee Seepage Issues | This segment has experienced documented boils and seepage at multiple locations in 1997, between approximately LM 0.5 and LM 1.8. A seepage berm was constructed under the PL84-99 program, between LM 0.6 and LM 1.5. However according to a district representative, the segment still experiences chronic boils and seepage during high-water events, but specific locations and years are unknown at this time. It was also indicated that through seepage is generally not as significant of a problem as underseepage. As such, the preliminary repair length is assumed to be the remaining segment length from LM 1.5 to LM 10.23, approximately 8.7 miles. The preliminary feasible remedial alternatives include construction of a drained seepage berm or a cutoff wall. Existing penetrations through the levee, with diameters of generally 30 to 36-inches and about 5 to 13 feet below the levee crown, as well as landside ditches near the landside toe may impact the potential remediation alternatives. There do not appear to be any real estate restrictions or other constraints along and adjacent to the levee segment. |
| 23 | All | 2022 FSSR | Historical Slope Instability Site | <5 sites identified. |
| 23 | All | 2022 FSSR | Historical Boil Site | <5 sites identified. |
| 23 | All | 2022 FSSR | Historical Erosion Site | <5 sites identified. |
| 23 | All | 2022 FSSR | Historical Levee Overtopping | 1 site |
| 23 | All | 2022 FSSR | Encroachment Site | 1 unacceptable sites identified. |
| 23 | All | 2022 FSSR | Slope Stability Rating | 2 minimally acceptable sites identified. |
| 23 | All | District-identified 2023 issues | Seepage | 20+ years of seepage issues. 2023 storm events with 10000cfs flows exacerbated seepage issues. |
| 23 | LM 0.5-3 | District-identified 2023 issues | Boil Sites | The District reports dozens of boils on levee slope and up to 10ft off of the levee toe. CalOES responded to 2 locations during 2023 storms. |
| 23 | All | 2022 DWR Inspection Report | New Seepage Sites | 3 critical sites identified. |
| 23 | All | 2022 FSSR | Levee Penetrations | 5+ sites. |
| 23 | All | 2022 FSSR | Historical Levee Breach | 6 sites. |

| Levee Unit | Location (Levee Mile) | Source Document | Deficiency Type | Description |
|---|---|---|---|---|
| 23 | All | 2022 FSSR | NULE Landside Slope Stability Hazard | Does not meet criteria. |
| 23 | All | 2022 FSSR | NULE Through-Seepage Hazard | Does not meet criteria. |
| 23 | LM 0-9.6 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 8,000 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 3.0 feet at 9,000 cfs |
| 24 | All | NULSE | Levee Seepage Issues | This segment has experienced extensive underseepage and boils at multiple locations approximately between LM 0.0 and LM 3.9. The seepage has historically been observed along the landside toe which indicates underseepage issues may be more significant of a concern. Previous site reconnaissance indicates seepage berms have been placed in some of the past performance locations, however according to a district representative, the levee experiences chronic boils and seepage during highwater events. As such, the preliminary repair extent is assumed to be approximately 3.9 miles. Preliminary feasible remedial alternatives include construction of a drained seepage berm or a cutoff wall. Existing penetrations through the levee, with diameters generally 24-inches and greater and located about 2 to 13 feet below the crown elevation, may impact the potential remediation alternatives. There do not appear to be any real estate restrictions or other constraints along and adjacent to the levee segment. |
| 24 | All | 2022 FSSR | Historical Slope Instability Site | <5 sites identified. |
| 24 | All | 2022 DWR Inspection Report | New Seepage Sites | 1 serious and 4 critical sites identified. |
| 24 | All | 2022 FSSR | Historical Levee Overtopping | 1 site |
| 24 | All | 2022 FSSR | Encroachment Site | 1 unacceptable, 3 minimally acceptable sites identified. |
| 24 | All | 2022 FSSR | Historical Levee Breach | 2 sites. |
| 24 | All | District-identified 2023 issues | Seepage | 20+ years of seepage issues. 2023 storm events with 10000cfs flows exacerbated seepage issues. |
| 24 | All | 2022 FSSR | Historical Boil Site | 5+ sites identified. |
| 24 | All | 2022 FSSR | Historical Erosion Site | 5+ sites identified. |
| 24 | All | 2022 FSSR | Levee Penetrations | 5+ sites. |
| 24 | All | 2022 FSSR | NULE Levee Geometry Hazard | Does not meet criteria. |
| 24 | All | 2022 FSSR | NULE Overall Hazard Classification | Does not meet criteria. |
| 24 | All | 2022 FSSR | NULE Through-Seepage Hazard | Does not meet criteria. |
| 24 | All | 2022 FSSR | NULE Underseepage Hazard | Does not meet criteria. |
| 24 | LM 0-8.4 | 2024 HEC-RAS Results | Difference between Original and Current Capacities | Original Published Capacity - 8,000 cfs<br>2024 HEC-RAS Maximum Flow to meet Freeboard Requirement - 3.0 feet at 9,000 cfs |
| District-wide | | 2015 USJR RFMP | Levee Patrol Road Resurfacing | The District needs additional financial resources to regularly resurface levee patrol roads. |

# Appendix C
# Excerpts from 2022 Flood System Status Report Update: Levee Evaluation Results

**Table C-1. 2022 Flood System Status Report Update Levee Evaluation Results**

| Stream | NULE Segment | NULE Subreach | Length (miles) | Overall Rating | Geometry | Freeboard | Through-Seepage | NULE Slope Stability | Under-Seepage | Inspection Slope Stability |
|---|---|---|---|---|---|---|---|---|---|---|
| Ash Slough | 358 | Ash Slough_A | 0.21 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Does Not Meet Criteria | Meets Criteria |
| Ash Slough | 358 | Ash Slough_B | 0.57 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Meets Criteria | Does Not Meet Criteria |
| Ash Slough | 358 | Ash Slough_C | 1.22 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Does Not Meet Criteria | Meets Criteria |
| Ash Slough | 356 | District, Unit 13 | 1.34 | Meets Criteria | Meets Criteria | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria | Meets Criteria |
| Bear Creek Bypass | 345 | District, Unit 7 | 3.46 | Meets Criteria | Meets Criteria | Not Assessed | Does Not Meet Criteria | Meets Criteria | Meets Criteria | Meets Criteria |
| Berenda Slough | 359 | Berenda Slough_A | 0.55 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Berenda Slough | 359 | Berenda Slough_B | 0.92 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Berenda Slough | 359 | Berenda Slough_C | 0.40 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Meets Criteria | Meets Criteria |
| Berenda Slough | 254 | Berenda Slough_F | 1.04 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Does Not Meet Criteria | Meets Criteria |
| Berenda Slough | 254 | Berenda Slough_G | 0.38 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Does Not Meet Criteria | Meets Criteria |
| Berenda Slough | 254 | Berenda Slough_H | 0.55 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Chowchilla Canal Bypass | 261 | Eastside Bypass_H | 1.28 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Chowchilla Canal Bypass | 261 | Eastside Bypass_I | 1.44 | Does Not Meet Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Does Not Meet Criteria |
| Chowchilla Canal Bypass | 261 | Eastside Bypass_J | 0.66 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Chowchilla Canal Bypass | 261 | Eastside Bypass_K | 4.40 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Chowchilla Canal Bypass | 261 | Eastside Bypass_L | 1.88 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Chowchilla Canal Bypass | 261 | Eastside Bypass_M | 1.91 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Meets Criteria |
| Chowchilla Canal Bypass | 261 | Eastside Bypass_N | 2.54 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Meets Criteria |
| Chowchilla Canal Bypass | 261 | Eastside Bypass_O | 1.99 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Meets Criteria |
| Chowchilla Canal Bypass | 357 | District, Unit 18 | 15.98 | Does Not Meet Criteria | Meets Criteria | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Does Not Meet Criteria | Meets Criteria |
| Eastside Bypass | 182 | District, Unit 5 | 19.76 | Does Not Meet Criteria | Meets Criteria | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Does Not Meet Criteria | Meets Criteria |
| Eastside Bypass | 252 | District, Unit 6 | 9.58 | Does Not Meet Criteria | Meets Criteria | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Does Not Meet Criteria | Meets Criteria |
| Eastside Bypass | 253 | District, Unit 6 | 16.42 | Does Not Meet Criteria | Meets Criteria | Not Assessed | Does Not Meet Criteria | Meets Criteria | Does Not Meet Criteria | Meets Criteria |
| Eastside Bypass | 351 | District, Unit 6 | 9.47 | Does Not Meet Criteria | Meets Criteria | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Meets Criteria | Meets Criteria |
| Eastside Bypass | 184 | Eastside Bypass_A | 0.69 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Does Not Meet Criteria | Does Not Meet Criteria |
| Eastside Bypass | 184 | Eastside Bypass_B | 0.78 | Does Not Meet Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Does Not Meet Criteria |
| Eastside Bypass | 184 | Eastside Bypass_C | 0.93 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Eastside Bypass | 184 | Eastside Bypass_D | 0.60 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Eastside Bypass | 218 | Eastside Bypass_E | 0.64 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| Eastside Bypass | 218 | Eastside Bypass_F | 1.02 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Does Not Meet Criteria | Meets Criteria |
| Eastside Bypass | 218 | Eastside Bypass_G | 1.18 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Meets Criteria | Meets Criteria |
| San Joaquin River | 219 | Gravelly Ford_A | 3.03 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Meets Criteria |

| Stream | NULE Segment | NULE Subreach | Length (miles) | Overall Rating | Geometry | Freeboard | Through-Seepage | NULE Slope Stability | Under-Seepage | Inspection Slope Stability |
|---|---|---|---|---|---|---|---|---|---|---|
| San Joaquin River | 219 | Gravelly Ford_B | 2.62 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Meets Criteria | Meets Criteria |
| San Joaquin River | 219 | Gravelly Ford_C | 0.48 | Does Not Meet Criteria | Not Assessed | Not Assessed | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Does Not Meet Criteria |
| San Joaquin River | 219 | Gravelly Ford_D | 1.33 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| San Joaquin River | 219 | Gravelly Ford_E | 2.77 | Meets Criteria | Not Assessed | Not Assessed | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria |
| San Joaquin River | 176 | District, Unit 1 | 11.33 | Meets Criteria | Meets Criteria | Not Assessed | Meets Criteria | Meets Criteria | Meets Criteria | Meets Criteria |
| San Joaquin River | 178 | District, Unit 1 | 7.88 | Does Not Meet Criteria | Meets Criteria | Not Assessed | Meets Criteria | Meets Criteria | Does Not Meet Criteria | Meets Criteria |
| San Joaquin River | 177 | District, Unit 2 | 13.75 | Does Not Meet Criteria | Meets Criteria | Not Assessed | Does Not Meet Criteria | Meets Criteria | Does Not Meet Criteria | Meets Criteria |
| San Joaquin River | 220 | District, Unit 24 | 8.38 | Does Not Meet Criteria | Meets Criteria | Not Assessed | Does Not Meet Criteria | Does Not Meet Criteria | Does Not Meet Criteria | Meets Criteria |

Note: It is unclear why the table gives different ratings than the figure for slope stability. It can be assumed that “Unacceptable” correlates to “Does Not Meet Criteria” and both “Minimally Acceptable” and “Acceptable” correlate to “Meets Criteria.”
NULE = Non-Urban Levee Evaluation

# Appendix D
# Additional Flood Management Issues and System Deficiencies

This appendix provides additional information that supplements Chapter 5. Levee deficiencies documented in Section D.1 do not warrant capital system improvements but are considered routine maintenance.

# D.1. Levee Deficiencies

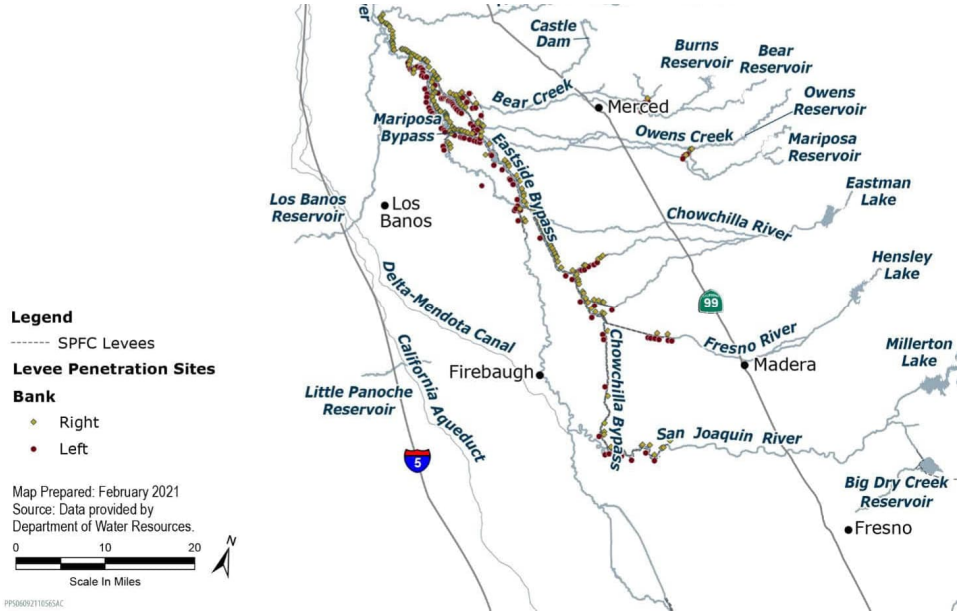
This section documents different types of additional levee deficiencies: penetrations, vegetation, seepage, animal burrows, and encroachments.

## D.1.1 Penetrations

Penetrations through levees are necessary for utility connections such as irrigation water conveyance, electricity, gas, communications, and drainage facilities. Penetrations can provide potential pathways for seepage and may contribute to levee failure. In some instances, if backfill surrounding penetrations is more permeable than levee soils, a seepage pathway can develop. Older penetrations are more susceptible to seepage, which can be prone to corrosion or collapse. As metal pipes age, they can corrode, creating holes and leaks. These penetrations can cause a levee embankment to erode, creating areas of weakness or internal voids. This internal erosion often remains hidden until a surface expression develops, such as a sinkhole.

The Lower San Joaquin Levee District (District) website states there are 328 drainpipes with flap gates through the levees. Figure D-1 shows documented levee penetrations from the *2022 Flood System Status Report Update* (FSSR; DWR 2022). The District has been working with the California Department of Water Resources (DWR) to replace these drainpipes and will continue coordination during future capital system improvement implementation. Because of ongoing maintenance activities and new permit applications, there is a need for continual updates and quality control of the utility crossing inventory database. As new information becomes available, revisiting previous records is necessary so that latest information can be used (DWR 2022).

## Figure D-1. Levee Penetrations




*Source: DWR 2022.*

### D.1.2 Levee Vegetation

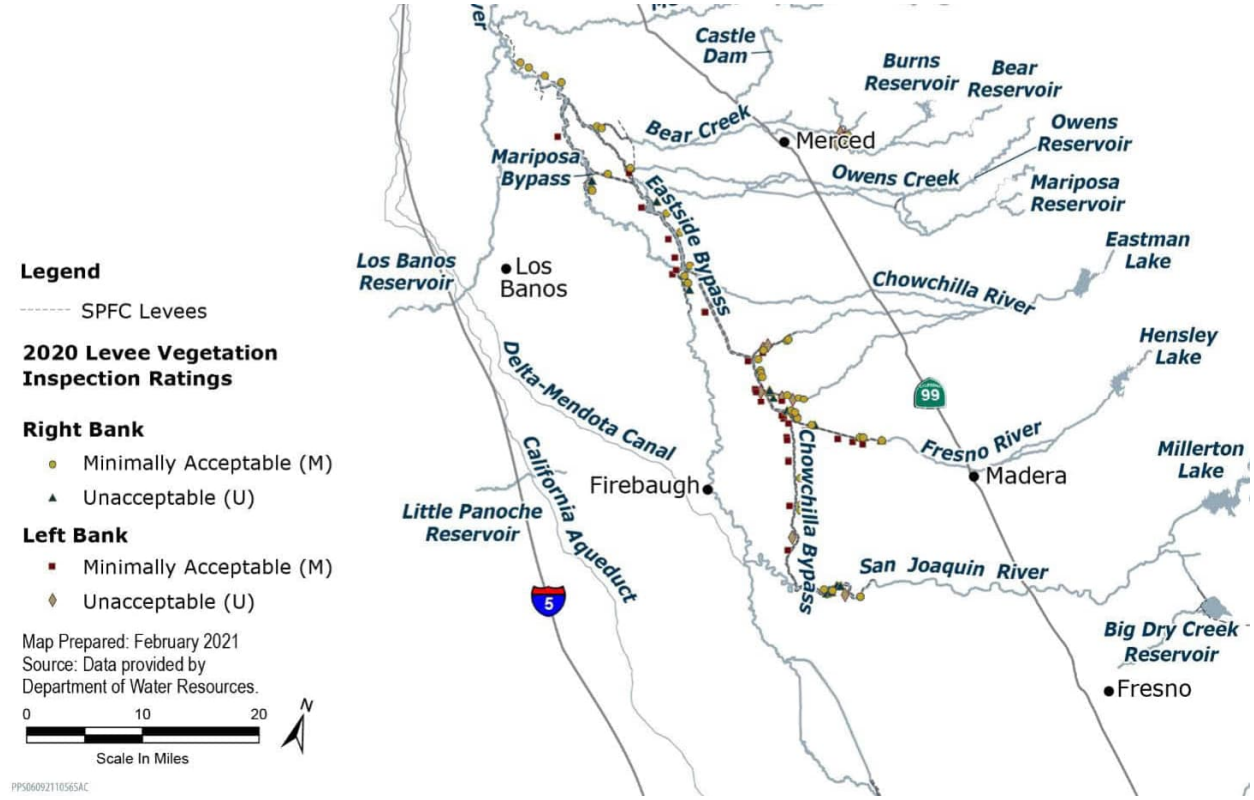
DWR visually inspects State Plan of Flood Control (SPFC) levees for vegetation as part of their semiannual levee maintenance inspections. Table D-1 shows the DWR inspection rating descriptions for vegetation on earthen levees. Figure D-2 shows inspection rating results.

**Table D-1. Levee Inspection Ratings for Vegetation on Earthen Levees**

| Inspection Rating | Rating Description |
|---|---|
| Acceptable | The levee has no unwanted vegetation (brush, bushes, and undesirable weeds) blocking visibility or access; vegetation is maintained per DWR's Vegetation Criteria. |
| Minimally Acceptable | Tall grass, weeds, brush, or other vegetation partially block visibility of or access to the levee, or 15 feet, or the limit of the easement at the landside toe and 20 feet from shoulder down the waterside of the levee, or some combination of these. Tall grass, weeds, or brush partially block visibility of or access to the levee, or are within 10 feet of the landside toe, or both. |
| Unacceptable | Tall grass, weeds, brush, or other vegetation completely block visibility of or access to the levee or extend to 15 feet or the limit of the easement at the landside toe and 20 feet from shoulder down the waterside of the levee, or both. Tall grass, weeds, or brush completely block visibility of or access to the levee, or are within 10 feet of the landside toe, or both. |

*Source: DWR 2022.*

## Figure D-2. Levee Vegetation Inspection Rating Results




*Source: DWR 2022.*

### D.1.3 Seepage

In addition to seepage issues warranting capital system improvements (Section 5.2) there are other causes that are addressed by routine maintenance. Other factors that may increase the potential for seepage, include the presence of erodible fill, animal burrows, or other penetrations that exit from the landside levee slope or foundation, potentially causing the levee to erode or degrade.

The District reported farmers installing interceptor drains and pumping water when it seeps on their land, lowering the head pressure, resulting in seepage acceleration, piping, and boil issues. This resulted after the SJRRP purchased seepage easements for land adjacent to the flood bypasses and the inability of the levees to accommodate year-round restoration flow releases through the bypass system.

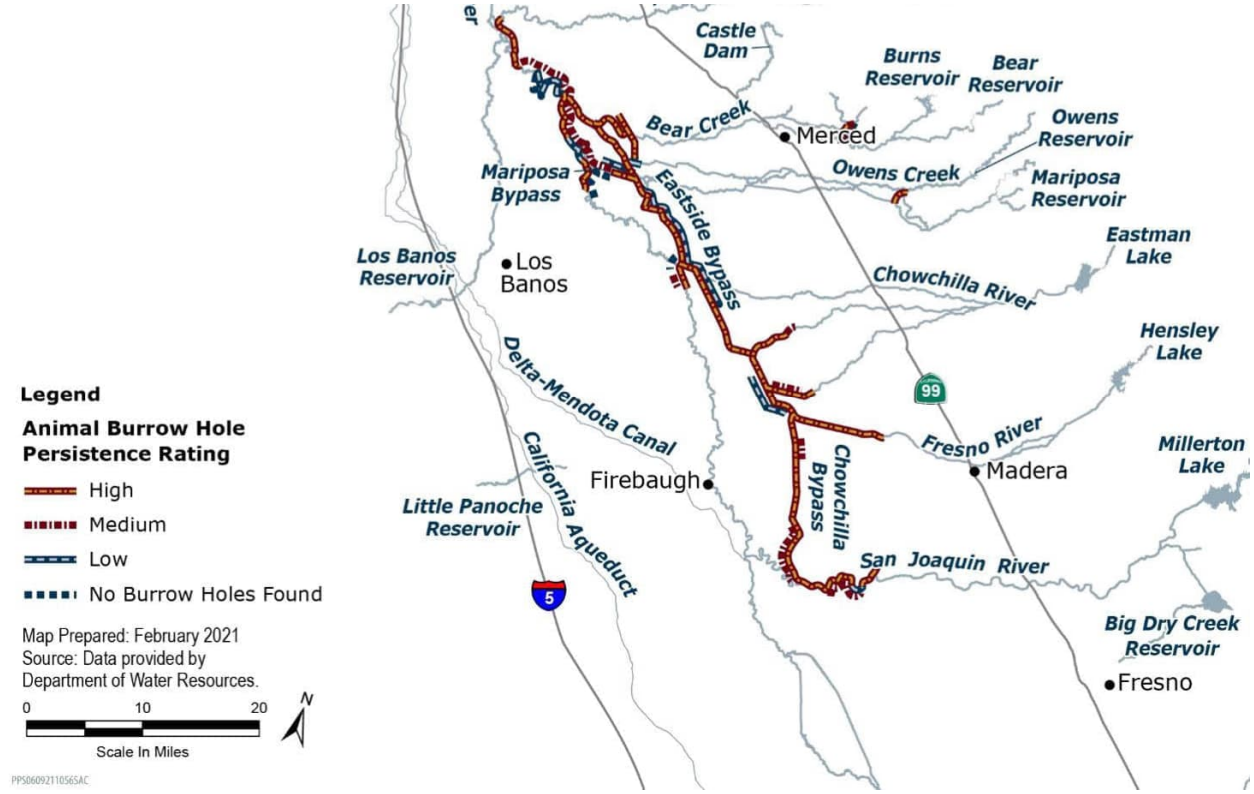
### D.1.4 Animal Burrowing

Levees may be damaged by animals creating burrows to form tunnels and galleries. The void spaces created by animal burrows can cause a preferential seepage path through a levee, promote surface and internal erosion, and reduce the strength of levee embankment and foundation materials by increasing pore water pressure. Large burrows and dens can also eventually collapse, inducing internal zones of low strength within a levee, reducing its stability

and internal erosion resistance. The collapse of large void spaces creates sinkholes at the surface, which could lead to levee breaches if the collapse occurs during high water. The Upper San Joaquin River (USJR) Regional Flood Management Plan (RFMP) (SJRFCPA 2015) identified that the District needs additional financial resources to implement a grout rig program for filing animal burrows in levees.

The 2022 FSSR analyzed DWR inspection data on animal burrow hole persistence from 2009 to 2020. Results are shown on Figure D-3, with categorized levels of animal burrow hole persistence (that is, low, medium, and high persistence).

## Figure D-3. Animal Burrow Hole Persistence Rating Results




*Source: DWR 2022.*

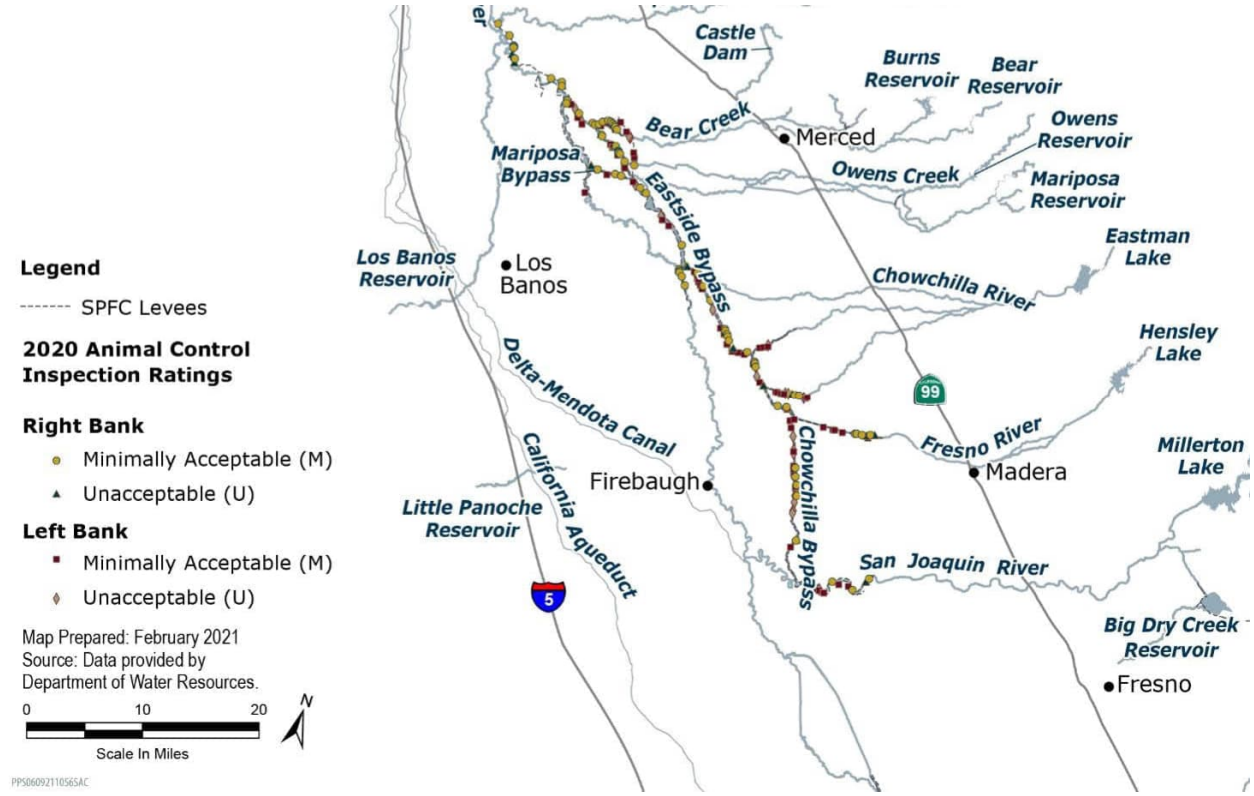
DWR visually inspects SPFC levees for burrowing animal damage at least twice a year, and reports results annually. Table D-2 shows DWR inspection rating descriptions for animal control of burrowing animals. Figure D-4 shows inspection ratings.

## Table D-2. Levee Inspection Ratings for Burrowing Animal Control on Earthen Levees

| Inspection Rating | Rating Description |
|---|---|
| Acceptable | Burrowing animal holes have been backfilled in a manner that adequately addresses the void created in the levee. A continuous animal burrow control program is in place that includes elimination of active burrowing and the filling of existing burrows. Less than five holes (i.e., a hole that penetrates the levee prism more than 6 inches) in any 25-foot length of levee, and that has less than 2 cubic feet of material observed beside any hole. All holes are less than 6 inches in diameter. |
| Minimally Acceptable | Either more than five holes were observed in a 25-foot length of levee or at least one hole greater than 6 inches in diameter was observed. No burrowing animal activity was observed on the opposing slope, and holes penetrate the levee prism more than 6 inches. |
| Unacceptable | More than 2 cubic feet of material was observed beside at least one burrow. Either five or more burrows were observed in a 25-foot length of levee or a burrow 6 inches in diameter or more was observed with burrowing animal activity on the opposing slope. Burrows penetrate the levee prism more than 6 inches. |

*Source: DWR 2022.*

## Figure D-4. Animal Control Inspection Rating Results




*Source: DWR 2022.*

### D.1.5 Encroachments

Encroachments are any obstruction or physical intrusion by construction of works or vegetation adjustment into a flood control project. Examples of encroachments include boat docks and ramps, placement of fill, pump stations, structures, and landscaping. DWR visually inspects SPFC levees for encroachments at least two times per year. Table D-3 shows DWR inspection rating descriptions for encroachments on earthen levees used for annual inspections in 2020.

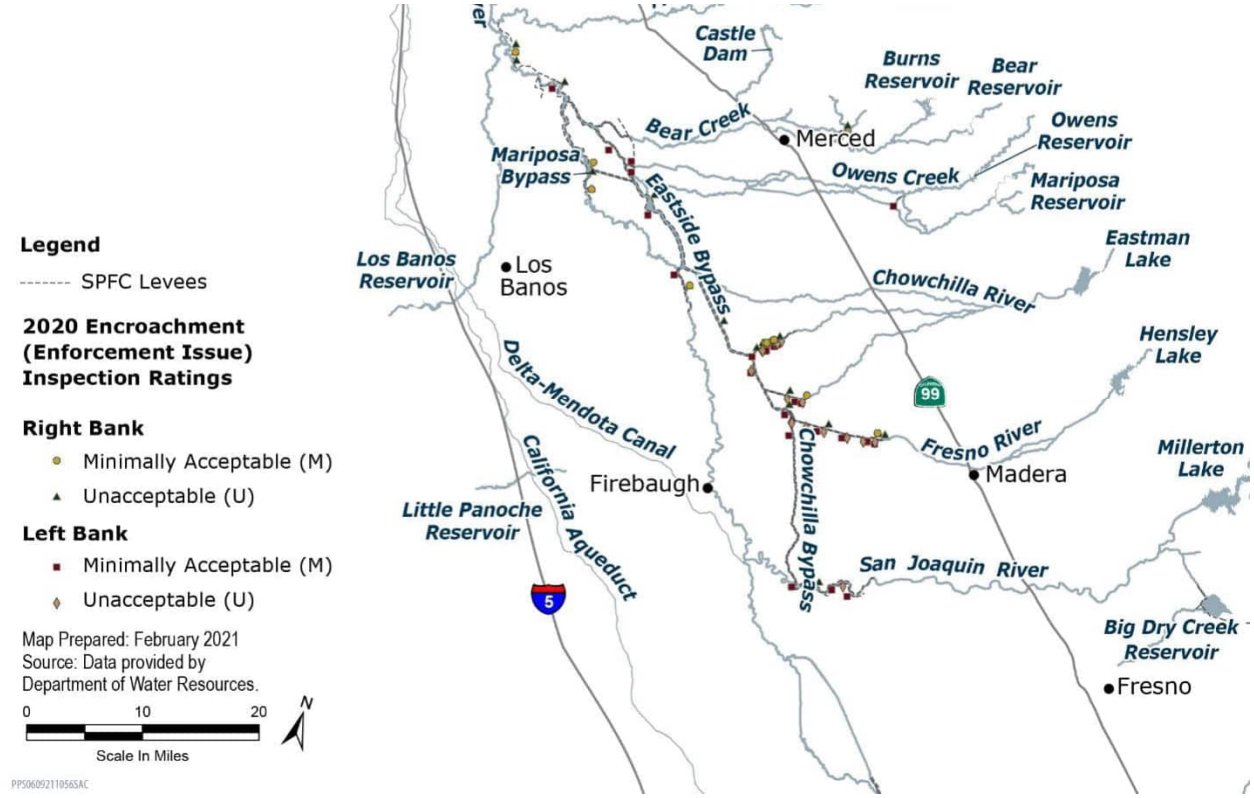
Figure D-5 shows inspection results for privately owned, unpermitted encroachments that threaten levee integrity and need enforcement (citations for unpermitted encroachment). The San Joaquin River upstream of the Chowchilla Canal Bypass Control Structure, the Chowchilla Bypass at the Fresno River, Berenda Slough, and Ash Slough contain the most encroachments in the District.

**Table D-3. Levee Inspection Ratings for Encroachments on Earthen Levees**

| Inspection Rating | Rating Description |
|---|---|
| Acceptable | No trash or debris present. No excavation, structures, or other encroachments threaten levee integrity. No encroachments obstruct visibility or access to the levee or landside toe easement. |
| Minimally Acceptable | Minimal trash or debris present. Minor excavation, structure, or other encroachments pose minor threat to levee integrity. |
| Unacceptable | Significant trash or debris present. Major excavation, structure, or other encroachments pose major threat to levee integrity. |

*Source: DWR 2022.*

## Figure D-5. 2020 Encroachment Inspection Rating Results




*Source: DWR 2022.*

## D.1.6 References


California Department of Water Resources (DWR). 2022b. *2022 Flood System Status Report Update*. November. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Flood-Management/Flood-Planning-and-Studies/Central-Valley-Flood-Protection-Plan/Files/CVFPP-Updates/2022/2022-FSSR-MainDocument_Final_.pdf.

San Joaquin River Flood Control Project Agency (SJRFCPA). 2015. *Upper San Joaquin River Regional Flood Management Plan.* Funded by the California Department of Water Resources. February.

# Appendix E
# Detailed Cost Estimates

## Table E-1. Excavation Costs by Levee Unit

| Levee Unit | Location (levee miles) | Levee Miles of Excavation | District Estimated Length of Excavation (feet) | Excavated Material (CY) | Cost[a] |
|---|---|---|---|---|---|
| 1 / 2 | LM 0–11.5 | 11.5 | 13,100 | 970,000 | $72,400,000 |
| | LM 11.5–19.5 | 8 | 9,090 | 288,000 | $21,500,000 |
| | LM 19.5–end | 3.5 | 3,980 | 31,500 | $2,350,000 |
| | Total Levee Unit 1 / 2 | | | 1,290,000 | $96,200,000 |
| 3 / 4 | All | 2 | 2,270 | 85,400 | $6,370,000 |
| 5 / 6 | LM 0–3.7 | 3.7 | 7,360 | 1,090,000 | $81,300,000 |
| | LM 3.7–7.9 | 4.2 | 8,350 | 871,000 | $65,000,000 |
| | LM 7.9–9.8 | 1.9 | 3,780 | 208,000 | $15,500,000 |
| | LM 9.8– 18.7 | 8.9 | 17,700 | 1,950,000 | $146,000,000 |
| | LM 18.7–29.1 | 10.4 | 20,700 | 3,070,000 | $229,000,000 |
| | Total Levee Unit 5 / 6 | | | 7,190,000 | $536,000,000 |
| 7 / 8 | All | 3.4 | 4,830 | 105,000 | $7,840,000 |
| 11 / 12 | All | 3.3 | 4,690 | 195,000 | $14,600,000 |
| 13 / 14 | All | 1.3 | 3,690 | 183,000 | $13,700,000 |
| 15 / 16 | All | 16.1 | 18,300 | 36,200 | $2,700,000 |
| 17 / 18 | LM 13–end | 3.2 | 18,200 | 36,000 | $2,690,000 |
| Total All Levees | | 81.4 | 136,040 | 9,120,000 | $680,000,000 |

[a] Cost estimates for sediment excavation are in 2024 dollars at $57.40 per CY, including a 30% contingency cost.
CY = cubic yard(s)
LM = levee mile(s)

## Table E-2. Slurry Wall Costs by Levee Unit

| Levee Unit | Location Beginning (levee miles) | Location End (levee miles) | Section Length (miles) | Section Length (feet) | Cost[a] |
|---|---|---|---|---|---|
| 1 | 4 | 11.4 | 7.4 | 39,072 | $21,000,000 |
| | 14.2 | 14.5 | 0.3 | 1,584 | $849,000 |
| | 15.7 | 17.3 | 1.6 | 8,448 | $4,530,000 |
| | 18.8 | 18.9 | 0.1 | 528 | $283,000 |
| | 19.3 | 19.8 | 0.5 | 2,640 | $1,420,000 |
| | 20.5 | 21.1 | 0.6 | 3,168 | $1,700,000 |
| | Total Levee Unit 1 | | 10.5 | 55,440 | $29,700,000 |
| 2 | 2.3 | 13.8 | 11.5 | 60,720 | $32,600,000 |
| 3 | 1.2 | 1.6 | 0.4 | 2,112 | $1,130,000 |
| 5[b] | 8.8 | 28.6 | 19.8 | 104,544 | $56,100,000 |
| 6 | 0 | 9.64 | 9.64 | 50,899 | $27,300,000 |
| | 12 | 18 | 6 | 31,680 | $17,000,000 |
| | 18 | 21.4 | 3.4 | 17,952 | $9,630,000 |
| | Total Levee Unit 6 | | 13.04 | 68,851 | $53,900,000 |
| 12 | 0 | 3.4 | 3.4 | 17,952 | $9,630,000 |
| 18 | 1.5 | 8.4 | 6.9 | 36,432 | $19,500,000 |
| 23 | 0 | 10.23 | 10.23 | 54,014 | $29,000,000 |
| 24 | 0 | 8.34 | 8.34 | 44,035 | $23,600,000 |
| | | Total All Levees | 90 | 480,000 | $255,000,000 |

[a] Cost estimates for slurry walls are based on 2024 dollars with a 25-foot depth and $21.45 per square foot of wall, including a 30% contingency cost.
[b] The 19.8 miles for LU 5 addresses seepage issue sites identified in draft NULSE (DWR forthcoming), the 2022 FSSR (DWR 2022a), and the Fall 2022 DWR Inspection Report (DWR 2022b). This includes rehabilitation of USBR's Restoration Program slurry wall (1.5 miles) near Sandy Mush Rd. around LM 12, which is

planned to be funded by DWR. It also addresses the rehabilitation of the wave wash area at LM 16.5 (approximately 4 miles). The District is working with DWR to obtain funding for the project, but it is not finalized.
DWR = California Department of Water Resources
FSSR = Flood System Status Report
LM = levee mile(s)
LU = levee unit
NULSE = Non-Urban Levee Seepage Evaluation
USBR = U.S. Bureau of Reclamation

References:

California Department of Water Resources (DWR). 2022c. *Fall 2022 Levee Maintenance Deficiency Summary Report.* November. https://cdec.water.ca.gov/cgi-progs/products/NA0010_Full_FA_2022.pdf.

California Department of Water Resources (DWR). 2022d. *Inspection and Local Maintaining Agency Report of the Central Valley State-Federal Flood Protection System.* December.

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## Table E-3. Projects from the Firebaugh Multi-Benefit Flood Management Project Flood Risk Reduction Feasibility Study

| Item | Description | Quantity | Unit | Cost/Unit ($) | Amount ($) |
|---|---|---|---|---|---|
| Project Area 1: Setback Levee and Riparian Restoration at the Wastewater Treatment Plant | | | | | |
| 1 | Replacement Levees[a] | 4,850 | LF | $1,547 | $7,500,000 |
| 2 | Recreational Trails[b] | 4,850 | LF | $250 | $1,210,000 |
| 3 | Riparian/Wetland Habitat Land Purchase | 115 | AC | $27,175 | $3,130,000 |
| 4 | Riparian/Wetland Habitat Implementation | 115 | AC | $2,000 | $230,000 |
| 5 | Other Costs (30%)[d] | | | | $3,620,000 |
| | | | | Subtotal Items 1 through 5 | $15,700,000 |
| Project Area 2: Stabilization of the Eroding Bank at a Sharp Bend in the San Joaquin River | | | | | |
| 1 | Sheet Pile | 500 | LF | $5,000 | $2,500,000 |
| 2 | Recreational Trails[b] | 500 | LF | $250 | $125,000 |
| 3 | Other Costs (30%)[d] | | | | $788,000 |
| | | | | Subtotal Items 1 through 3 | $3,410,000 |
| Project Area 3: Setback Levee to Protect the Firebaugh Water Treatment Plant near the Rodeo Grounds | | | | | |
| 1 | Replacement Levees[a] | 1,000 | LF | $1,547 | $1,550,000 |
| 2 | Recreational Trails[b] | 1,000 | LF | $250 | $250,000 |
| 3 | Riparian/Wetland Habitat Land Purchase | 15 | AC | $27,175 | $408,000 |
| 4 | Riparian/Wetland Habitat Implementation | 15 | AC | $2,000 | $30,000 |
| 5 | Other Costs (30%)[d] | | | | $671,000 |
| | | | | Subtotal Items 1 through 5 | $2,910,000 |
| Project Area 4A: Ecosystem Restoration Projects | | | | | |
| 1 | Replacement Levees[a] | 8,000 | LF | $1,547 | $12,400,000 |
| 2 | Recreational Trails[b] | 17,500 | LF | $250 | $4,380,000 |
| 3 | Poso Canal Control Structure | 1 | LS | $2,015,500 | $2,020,000 |

| Item | Description | Quantity | Unit | Cost/Unit ($) | Amount ($) |
|---|---|---|---|---|---|
| 4 | Riparian/Wetland Habitat Land Purchase | 196 | AC | $40,763 | $7,990,000 |
| 5 | Riparian/Wetland Habitat Implementation[c] | 196 | AC | $2,000 | $392,000 |
| 6 | Other Costs (30%)[d] | | | | $8,150,000 |
| | | | | Subtotal Items 1 through 6 | $35,300,000 |
| Project Area 4B: Ecosystem Restoration Projects | | | | | |
| 1 | Replacement Levees[a] | 9,000 | LF | $1,547 | $13,900,000 |
| 2 | Recreational Trails[b] | 9,000 | LF | $250 | $2,250,000 |
| 3 | New Berm | 1,800 | LF | $1,200 | $2,160,000 |
| 4 | Riparian/Wetland Habitat Land Purchase | 294 | AC | $27,175 | $7,990,000 |
| 5 | Riparian/Wetland Habitat Implementation[c] | 294 | AC | $2,000 | $588,000 |
| 6 | Other Costs (30%)[d] | | | | $8,070,000 |
| | | | | Subtotal Items 1 through 6 | $35,000,000 |
| Long-Term Projects | | | | | |
| 1 | Replacement Levees[a] | 13,000 | LF | $1,547 | $20,100,000 |
| 2 | Recreational Trails[b] | 13,000 | LF | $250 | $3,250,000 |
| 3 | Eastside Acres Improvements (Ring Levee) | 1 | LS | $12,505,670 | $12,500,000 |
| 4 | Other Costs (30%)[d] | | | | $10,800,000 |
| | | | | Subtotal Items 1 through 4 | $46,700,000 |
| | | | | Total (Rounded) | $139,000,000 |

Note: All cost estimates are from the Firebaugh Feasibility Study (Gouveia 2022) in 2022 dollars.

[a] A unit cost of $1,547 per linear foot was used for the replacement levees. The replacement levees will have a crest width of 12 feet, a side slope of 2:1 on the land side, and slope of 3:1 on the river side for the ratio of horizontal distance to every foot of vertical height. Each levee will include an inspection trench of side slope 1:1 with a base width of 12 feet and height of 6 feet. The required levee heights at each location of the reach were determined to include a freeboard of 3 feet.

[b] The unit costs for the recreational trails include pavement for the levee tops as well as signs, benches, and other amenities. The placement of the signs and benches will be determined during the detailed design stage of the project.

[c] The unit costs for the riparian/wetland habitat implementation is based on approximately 600 to 800 trees per acre to be planted along with specific environmental permits, and costs for a biologist to be present during construction.

[d] An additional cost equivalent of 30% of the estimated capital costs for the recommended projects has been included to cover "other" project-related costs such as:

- Design – 7.5%
- Permitting, regulatory compliance, and *California Environmental Quality Act* – 2.5%
- Construction management – 10%
- Program implementation – 5%
- Project construction contingency - 5%

AC = acre(s)
LF = linear foot (feet)
LS = lump sum

References:

Gouveia Engineering, Inc. (Gouveia). 2022. *Firebaugh Multi-Benefit Flood Management Project Flood Risk Reduction Feasibility Study – Final Report.* June.

## Table E-4. Eastside Bypass Drop Structures (Four Total)

| Item | Description | Quantity | Units | Cost/Unit | Amount[a] |
|---|---|---|---|---|---|
| 1 | Earthwork | 33,749 | CY | $90 | $3,037,453 |
| 2 | CIP Concrete Wall, high = 6 feet, incl. concrete footer | 16,920 | SF | $127 | $2,144,244 |
| 3 | CIP Concrete End Walls, both sides, high = 21.5 feet, incl. concrete footer | 4,000 | SF | $183 | $730,000 |
| 4 | 18" square x 36" depth CIP Concrete Piers, reduce flow speed | 1,412 | EA | $1,750 | $2,471,000 |
| 5 | 18" x 24" CIP Concrete Curb | 2,820 | FT | $90 | $253,800 |
| 6 | 12" CIP Concrete Slab | 76,140 | SF | $65 | $4,949,100 |
| 7 | Stone Protection, incl. 6" Filter Blanket | 2,820 | FT | $613 | $1,729,600 |
| 8 | Other Costs (30%) | 1 | LS | $4,594,559 | $4,594,559 |
| | | | | Subtotal Items 1 through 8 | $19,909,757 |

[a] Cost estimates are in 2022 dollars for each drop structure. Assumptions: Length = 705 feet, height longitudinal wall = 6 feet, height end wall = 20 feet

CIP = cast-in-place
CY = cubic yard(s)
EA = each
FT = foot (feet)
LS = lump sum
SF = square foot (feet)

## Table E-5. Chowchilla Canal Bypass Drop Structures (Three Total)

| Item | Description | Quantity | Units | Cost/Unit | Amount[a] |
|---|---|---|---|---|---|
| 1 | Earthwork | 19,023 | CY | $90 | $1,712,607 |
| 2 | CIP Concrete Wall, high = 6-ft, incl. concrete footer | 9,540 | SF | $127 | $1,208,989 |
| 3 | CIP Concrete End Walls, both sides, high = 21.5-ft, incl. concrete footer | 3,000 | SF | $153 | $460,000 |
| 4 | 18" square x 36" depth CIP Concrete Piers, reduce flow speed | 795 | EA | $1,750 | $1,391,250 |
| 5 | 18" x 24" CIP Concrete Curb | 1,590 | FT | $90 | $143,100 |
| 6 | 12" CIP Concrete Slab | 42,930 | SF | $65 | $2,790,450 |
| 7 | Stone Protection, incl. 6" Filter Blanket | 1,590 | FT | $613 | $975,200 |
| 8 | Other Costs (30%) | 1 | LS | $2,604,479 | $2,604,479 |
| | | | | Subtotal Items 1 through 8 | $11,286,074 |

[a] Cost estimates are in 2022 dollars for each drop structure. Assumptions: Length = 530 feet, height longitudinal wall = 6 feet, height end wall = 20 feet

CIP = cast-in-place
CY = cubic yard(s)
EA = each
FT = foot (feet)
LS = lump sum
SF = square foot (feet)