Flood Risk Reduction Feasibility Study for Delta Legacy Community of Locke, CA

Funded by California Department of Water Resources Small Communities Flood Risk Reduction Program

Submitted to:
Sacramento County Department of Water Resources

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Visit the Hood Story Map for more details of the community, its history, and flood risk concerns: Locke Story Map - Sacramento County Small Communities Flood Risk Reduction Program.[1]

[1] https://sacramentocounty.maps.arcgis.com/apps/MapJournal/index.html?appid=277f1bd2979b4cc2adb068ec234daa33

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Acronyms and Abbreviations

AFOTF	Agricultural Floodplain Ordinance Task Force
APE	area of potential effect
BFE	Base Flood Elevation
BWFS	Basin-Wide Feasibility Study
BW-12	Biggert-Waters Flood Insurance Reform Act of 2012
CDP	Census Designated Place
CCR	California Code of Regulations
CDFW	California Department of Fish and Wildlife
CEQA	California Environmental Quality Act
CFR	California Code of Federal Regulations
cfs	cubic feet per second
Conservancy	Delta Conservancy
CPT	cone penetration test
CRHR	California Register of Historical Resources
CRS	Community Rating System
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CVP	Central Valley Project
CVRMP	Central Valley Riparian Mapping Project
DCA	Delta Conveyance Authority
DCC	Delta Cross Canal
DLIS	Delta Levees Investment Strategy
DPC	Delta Protection Commission
DSC	Delta Stewardship Council
DWR	California Department of Water Resources
EAD	Expected Annual Damages
EIR	Environmental Impact Report
ESP	Emergency Safety Plan

FEMA	Federal Emergency Management Agency
FIMA	Federal Insurance and Mitigation Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FODSS	Flood Operation Decision Support System
fps	feet per second
FSRP	Flood System Repair Project
GAR	Geotechnical Assessment Report
GHAD	Geologic Hazard Abatement District
HFIAA	Homeowner Flood Insurance Affordability Act
HMP	Hazard Mitigation Plan
HOA	Homeowners Association
IWM	Integrated Water Management
LHMP	Local Hazard Mitigation Plan
LMA	Local Maintaining Agency
LOI	Letter of Intent
LURMP	Land Use and Resource Management Plan
NAVD 88	North American Vertical Datum 1988
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NRHP	National Register of Historic Places
NULE	Non-Urban Levee Evaluation
OA	Operational Area
OES	Office of Emergency Services
O&M	operation and maintenance
OMRR&R	operation, maintenance, repair, replacement, and rehabilitation
PL	Public Law
RD	Reclamation District
RFMP	Regional Flood Management Plan
RM	river mile

RMA	routine maintenance agreement
RSP	rock slope protection
SB	Senate Bill
SCFRRP	Small Communities Flood Risk Reduction Program
SEMS	Standardized Emergency Management System
SFHA	Special Flood Hazard Area
SPA	Special Planning Area
SPFC	State Plan of Flood Control
SR	State Route
SREL	Sacramento River East Levee
SRFCP	Sacramento River Flood Control Project
SSJDNHA	Sacramento-San Joaquin Delta National Heritage Area
SWIF	System-wide Improvement Framework
SWP	State Water Project
USACE	U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
WGBL	Walnut Grove Branch Line (former SPRR rail alignment in North-Central Delta)
WSEL	water surface elevation

Executive Summary

In 2017, Sacramento County received grants from the California Department of Water Resources (DWR) Small Communities Flood Risk Reduction Program (project) to complete feasibility studies to reduce flood risk to six Delta Legacy Communities in the north Delta, including: Hood, Courtland, Locke, West Walnut Grove, Ryde, and East Walnut Grove. The scope of this study includes the following:

- Identifying a potential suite of structural and non-structural flood risk reduction elements
- Developing management actions (MAs) based on the combination of one or more potential flood risk reduction elements
- Developing and preparing implementation costs for each of the management actions
- Identifying a preferred suite of management actions and other non-structural measures based on stakeholder and community input and,
- Developing an implementation plan which includes an implementation schedule and finance plan

The study considers potential solutions to reduce flood risks to lives and property while sustaining agriculture and the regional economy, improving riverine habitat viability, addressing regional levee maintenance governance, and improving the resiliency and reliability of conveying fresh water through the Delta with an improved leveed system in the Sacramento River Corridor upstream of the Delta Cross Channel.

Locke is located north of the Delta Cross Channel along the left bank of the Sacramento River, approximately 0.7 miles northeast of the community of Walnut Grove. Levees, which protect the tract of land known as Libby McNeil where the Delta Legacy Community of Locke is located, are primarily maintained by Reclamation District (RD) 369. The levees downstream of Locke are located on the tract of land known as Walnut Grove and are maintained by RD 554. In total, the collective Locke study area is protected by nearly 5.25 miles of levees which provide protection from flows in the Sacramento River on the west, Delta Meadows Slough to the north (maintained by RD 551 – Pearson District), and Snodgrass Slough to the east.

The majority of the levees surrounding the Locke study area were initially constructed prior to 1906 by local interests and were generally built using materials dredged from the adjacent Sacramento River and the nearby adjoining Snodgrass Slough to the east, and Delta Meadows Slough to the north. Over time, various improvements have been made to the levees in the study area located along the left bank of the Sacramento River and they are now considered part of the State and federally-authorized Sacramento River Flood Control Project (SRFCP) and are now part of State Plan of Flood Control (SPFC) levees. The levees on the east and north sides of RD 369 adjoining Snodgrass Slough, Delta Meadows, and the Delta Cross Channel have also

been improved over time but are not considered part of the federally and state authorized SRFCP nor a portion of the SPFC levee system. This study closely reviews the condition of the subject levee systems and expands upon DWR's Non-Urban Levee Evaluations (NULE) program. Sacramento County and its consultants developed this feasibility study in coordination with a planning committee comprised of residents and business owners within the community of Locke, including representatives from RD 369. Other representative participating stakeholders with interest and knowledge in providing enhanced flood protection for the Delta Legacy Community of Locke, including residents and landowners within Locke and agricultural landowners within the RD 369 basin, were also consulted. Several stakeholder meetings were held to identify existing concerns and solicit feedback on the project process.

Structural-based Management Actions

A suite of seven potential structural-based MAs were formulated based on stakeholder discussions and available geotechnical data, including new geotechnical data collected in the late summer/early fall of 2019 as part of this feasibility study. These structural-based MAs include repairing and strengthening-in-place various portions of and/or the entirety of the RD 369 perimeter levee system, improving a portion of the RD 551 Delta Meadows Slough levee, constructing a potential cross levee north of Locke within RD 369, and securing 100-year Federal Emergency Management Agency (FEMA) accreditation for the community of Locke.

These seven structural-based MAs can be paired with a suite of non-structural MAs, including the potential implementation of a community-based private flood insurance program developed specifically for the noted community and/or additional Delta Legacy Communities *via* either a homeowners association, Sacramento County, or other means such as a Geologic Hazard Abatement District (GHAD). The key flood risk-reduction, structural-based MAs for consideration ad associated costs are summarized below within this Executive Summary and in Table 7-1 of Section 7.3 of this Feasibility Study Report (FSR).

The MAs were evaluated qualitatively and quantitatively utilizing Expected Annual Damage (EAD) assessments against the study's planning objectives of reducing risk to life; reducing risk to property damage; reducing probability of levee failure; reducing high, escalating National Flood Insurance Program (NFIP) flood insurance premiums; improved flood preparedness and response; enhancing resiliency and reliability of through-Delta water conveyance, and identifying multi objective opportunities. Each of the MAs were also evaluated qualitatively relative to agricultural sustainability, local support, and cost.

- With this trade-off analysis and a final stakeholder meeting held on December 3, 2020, and follow-up presentations to the Delta Legacy Communities Board of Directors and regional Rotary Club meetings held November 2020 through June 2021, a recommended suite of structural-based MAs was further identified as follows: **Management Action 1**: Repair and Strengthen-in-Place through Geotechnical Remediation, Delta Meadows Cross Slough Levee directly East of Locke (portion of NULE Segment 1054 in RD 369) *– estimated cost of $6.9 to $10.4 million (M) in 2020 dollars*

- **Management Action 2**: Repair and Strengthen-in-Place through Geotechnical Remediation, Snodgrass Slough Levee (a former railroad embankment) southeast of Locke (portion of NULE Segment 1054 in RD 369) – *estimated cost of $12.1 to $13.7M in 2020 dollars*
- **Management Action 3**: Repair and Strengthen-in-Place through Geotechnical Remediation, Sacramento River SPFC Levee just west of and adjacent to Locke (NULE Segment 121 in RD 369 and a portion of NULE Segment 127 in RD 554). Repairs include installation of a seepage cutoff wall, and potential freeboard enhancements to address 100-year conveyance constraints identified in DWR's Channel Capacity Atlas of December 2016 – *estimated cost of $14.4 to $31.6M in 2020 dollars*
- **Management Action 4**: Repair and Strengthen-in-Place through Geotechnical Remediation, Delta Meadows Slough Levee north of Locke (portion of NULE Segment 1040 in RD 551) – *estimated cost of $14.5 to $16.8M in 2020 dollars*
- **Management Action 5**: Construct Cross Levee Immediately North of Locke Paired With: (1) collectively improving RD 369 perimeter levee system south of proposed cross levee and a small segment of a RD 554 levee along the Sacramento River between Locke and the Delta Cross Channel; and (2) Secure 100-Year FEMA Certification of improved levee system(s) for community of Locke inclusive of proposed cross levee and areas south of proposed cross levee and north of the Delta Cross Channel – *estimated cost of $15.7 to $22.5M in 2020 dollars*
- **Management Action 6**: Secure 100-Year FEMA Certification for entire RD 369 Perimeter Levee System inclusive of portions of the RD 551 cross levee system along Delta Meadows Slough and a small segment of the RD 554 levee along the Sacramento River between Locke and the Delta Cross Channel – *estimated cost of $50.3 to $76.2M in 2020 dollars*
- **Management Action 7**: Sacramento River Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke was also recommended as an alternative to MA 6, which combines MAs 3 and 5 – *estimated cost of $25.8 to $44.3M in 2020 dollars*

From the recommended suite of structural-based management actions, a suite of community preferred structural-based management actions was developed based on stakeholder and public input, which includes MAs 1, 5, 6, and 7. MA 6 associated with improving the entire existing levee system(s) around the community of Locke represents the most-costly structural-based management action to reduce flood risks to the entirety of the Locke study area. The estimated cost, net reduction in EAD values to the Locke study area under existing conditions (and future conditions with climate change adjustments) and the range of flood risk reduction payback period in years (excluding interest) associated with MAs 5, 6, and 7 are summarized below in Table ES-1. Net incremental EAD reduction values for MAs 1 through 4 were not incrementally calculated in Appendix E as standalone measures, but MA 6 is representative of collectively

implementing MAs 1 through 4. MAs 5, 6, and 7 range in cost between nearly $16M and $76M in 2020 dollars. Of the three MAs, implementing MA 5 consisting of a potential cross levee system provides the largest incremental value to the community of Locke and the larger study area. With the implementation of MA 5 the total net reduction in EAD for the Locke study area is estimated at $335,000 under existing conditions and $1,428,000 under future conditions with climate change adjustments. MAs 5 and 7 are estimated to result in similar net reductions in EAD , but with estimated costs ranging from $22M to $76M, the flood risk reduction payback period ranges from 16 years to over 200 years.

Table ES-1: Estimated Costs, Net Reductions in EAD Values, Flood Risk Reduction Payback Periods, and Benefit-Cost Ratios for Community of Locke Structural-Based Management Actions

Management Action (MA)	(1) Estimated Cost (millions)[1]	(2) Total Net Reduction in EAD to the Locke Study Area under Existing* and Future** Conditions	(3) = (1)/(2) Range of Flood Risk Reduction Payback Period in Years (excluding interest) under Existing* and Future** Conditions	Benefit-Cost Ratio[2]
Secure 100-Year FEMA certification, with a potential cross levee north of Locke paired with perimeter levee improvements only south of the potential cross levee **(MA 5)**	$15,735,000 - $22,490,000	$335,000* to $1,428,000**	16** to 67* years	0.4* to 1.7**
Secure 100-Year FEMA certification for the entire RD 369 perimeter levee system **(MA 6)**	$50,276,000 - $76,185,000	$353,000* to $1,493,000**	51** to 216* years	0.1* to 0.5**
Sacramento River levee improvements paired with securing 100-Year FEMA certification for the community of Locke with a cross levee **(MA 7)**	$25,794,000 - $44,304,000	$335,000* to $1,428,000**	31** to 132* years	0.2* to 0.9**

Notes:
[1] A range of estimated costs (low-high) are generally provided for each management action concurrent with the costs summarized in Table 6-56-5
[2] Assuming a capital recovery factor of 0.037 (n=50 years, i=2.75%)
* Existing Conditions EAD Net Reduction Value Consistent with 2022 CVFPP Update
** Future Conditions EAD Net Reduction Value with Climate Change Adjustments Consistent with 2017 CVFPP Update

Three key long-term MAs (3, 6, and 7) contain state-wide multi-benefits by repairing, raising, and strengthening-in-place a 1-mile stretch of the Sacramento River left bank SPFC levee within the bounds of the study area just upstream of the Delta Cross Channel. The same geotechnical remedial actions could concurrently improve the efficiency, resiliency, and reliability along the left bank of the Delta freshwater conveyance corridor just upstream of the Delta Cross Channel. The current river channel and levee system collectively serve as a critical link of the through Delta water conveyance system that conveys water *via* the State Water Project (SWP) and the Central Valley Project (CVP) to over 27M Californians and over 3M acres of agricultural crops south of the Delta. The noted 1-mile stretch of the freshwater conveyance corridor is essential to continued and sustainable freshwater conveyance and flood flow through the Delta with or without the introduction of a possible dual or isolated conveyance facility (tunnels or canal) under consideration by the Delta Conveyance Authority (DCA). The 1-mile stretch of the SPFC levee along the left bank of the Sacramento River between RD 551 and the Delta Cross Channel represents approximately 3 percent of the non-urban SPFC levee system along the freshwater conveyance corridor between Freeport and the Delta Cross Channel; and 2 percent of the entire 62 miles of the non-urban SPFC levee system along the freshwater conveyance corridor in the North Delta. The multi-benefit of improving both the water conveyance system and the flood control system could gain wide acceptance and cost-sharing opportunities at the regional, State, and federal levels within and south of the Delta. The cost of these two multi-benefit elements is currently estimated at approximately $14 to $32M (MA 3) and $26 to $44M (MA 7), which could gain the sizeable interest and cost-sharing contributions of the noted interests and beneficiaries statewide and south of the Delta.

Implementation recommendations for these multi-benefit projects include Locke and its neighboring Delta Legacy Communities meeting and working with RFMP representatives, including the Sacramento Area Flood Control Agency (SAFCA), West Sacramento Area Flood Control Agency (WSAFCA), the Central Valley Flood Protection Board (CVFPB), and DWR Maintenance Area 9 (MA 9). There are common interests that suggest implementing levee improvements on a limited number of SPFC levee miles in the North Delta along the Sacramento River in the North Delta will also improve the reliability and resiliency of conveying SWP and CVP water through the entire Delta. The multi-benefit attributes of improving and modernizing the SPFC levee system in tandem with improving conveyance of SWP and CVP water through the Delta should also be presented and shared with the DCA, DWR, the Delta Protection Commission, Delta Stewardship Council, and the Delta Conservancy.

Non-Structural Flood Risk Reduction Measures

In addition to the key structural-based MAs highlighted above, **s**everal non-structural measures were evaluated for their potential to reduce residual flood risk. These non-structural measures can be implemented independent of, or in combination with, the structural-based improvements. This study recommends the following key non-structural measures for implementation, some of which are already in the early stages of implementation:

- Voluntary structural elevation of residential and commercial structures

- Wet or dry floodproofing residential, commercial, and agricultural structures
- Improved emergency response for the Locke study area and adjoining RDs in the Lower-Sacramento – Delta North RFMP region
- Implementation of a community-based flood-risk insurance program specific to the community of Locke in lieu of or in tandem with the current FEMA NFIP. The nearby City of Isleton has taken the initial steps in implementing a similar insurance program and there may be some local economies of scale for Locke and other nearby Delta Legacy Communities in the North Delta to pool their resources together and possibly be a pilot test case for establishing a regionally-based insurance program for rural communities in the Delta and greater Central Valley. In addition to reducing flood insurance rates the program can also be tailored to buy-down risks by establishing and setting aside local cost-share funds to improve and implement flood risk reduction MAs outlined above and non-structural measures outlined herein.
- Updating the Sacramento County Local Hazard Mitigation Plan and formalizing potential relief cut locations within RD 369
- Continued and improved public education and awareness
- Support continued actions to improve and maintain high NFIP Community Rating System (CRS) score for Sacramento County/Courtland
- Continued State support for refinements and Amendments to the NFIP *via* Agricultural Floodplain Ordinance Task Force and H.R. 3167 - National Flood Insurance Program Reauthorization Act of 2019
- Improved governance between RDs 369 and 554, other regional RDs in the north Delta, and a potential Homeowners Association or GHAD for reducing flood risks within the community of Locke
- Long-term flow conveyance improvements and flood easement opportunities along North and South Forks of Mokelumne River and Staten Island

1. Introduction

The California Department of Water Resources (DWR) Small Communities Flood Risk Reduction Program (SCFRRP) and the Regional Flood Management Plans (RFMPs) were created following adoption of the 2012 Central Valley Flood Protection Plan (CVFPP) by the Central Valley Flood Protection Board (CVFPB). Both the RFMPs and SCFRRP were created by DWR and are intended to be locally developed flood risk reduction programs authored by regional flood control agencies, Local Maintaining Agencies (LMAs), local Reclamation Districts (RDs), local land-use planning entities such as counties and cities, and the residents of the communities protected by State Plan of Flood Control (SPFC) levees and other facilities. The RFMP program consists of six regional plans within the extent of the CVFPP, three within the Sacramento River Basin and three within the San Joaquin River Basin. The Lower Sacramento River/North Delta RFMP completed in July of 2014 (herein referred to as the 2014 RFMP) encompasses the greater Sacramento River corridor, the Yolo and Sacramento Bypass systems, and the North Delta Legacy Communities along the Lower Sacramento River system between Sacramento and Rio Vista. Small communities, as defined in the CVFPP, are communities protected by SPFC levees with populations between 200 and 10,000, but exceptions were made to include Delta Legacy Communities with populations of less than 200, such as Locke and Ryde.

The SCFRRP is similar to the DWR five-year plans developed for and by the levee districts throughout the Delta where the LMAs or RDs are tasked with identifying where their greatest risks are to flooding and each of the LMAs or RDs prioritize repairs and improvements to their levee systems to minimize flood risks. The key difference between the two programs is the SCFRRP for the Delta communities in Sacramento County focuses more on the densely populated portions of land tracts protected by SPFC and non-SPFC levees; whereas the Delta five-year plans focus more on the perimeter levee systems protecting the entire tracts/islands within the Delta independent of whether the levees are SPFC or non-SPFC levee systems.

1.1 Intent of Senate Bill 5 for Small Communities

The Central Valley periodically experiences devastating floods. One of the most recent large events in 1997, as well as increased nationwide awareness of flood risk following Hurricane Katrina in 2005, led to passage of the Central Valley Flood Protection Act of 2008, also known as Senate Bill (SB) 5. SB 5 requires DWR to prepare a strategic systemwide flood protection plan for SPFC[1] facilities in the Sacramento-San Joaquin Valley. The 2012 CVFPP was the first iteration of this plan, and SB 5 mandates that it be updated on 5-year intervals.

[1] In summary, the SPFC includes the State and Federal flood control works, lands, programs, plans, conditions, and mode of maintenance and operations of the Sacramento River Flood Control Project described in Section 8350 of the California

Reducing flood risk in currently nonurbanized areas is one objective specified in SB 5. Furthermore, for disadvantaged communities which includes the community of Locke, SB 5 requires cities, counties and State and local flood management agencies to collaborate to provide cost-effective strategies for reducing flood risk, and to develop funding mechanisms to finance flood protection responsibilities at the local level. To this end, the 2012 CVFPP included many broad goals for improved flood management for areas protected by SPFC facilities, including small communities and portions of the Sacramento-San Joaquin Delta (Delta).

The SCFRRP focuses specifically on reducing flood risks for small communities protected by SPFC facilities, including areas designated as Delta "Legacy" Communities. Small communities are defined as communities protected by SPFC facilities with a population of less than 10,000 residents. Delta Legacy Communities are a subset of small communities, located within the legally defined (Legal) Delta, which have cultural, historic, and ambiance value that give the Delta a distinctive sense of place (Delta Protection Commission [DPC], 2012) (Figure 1-1).

Under the SCFRRP, Sacramento County, as the local land-use planning entity, was awarded a DWR grant in 2017 on behalf of the community of Locke, to prepare a feasibility study to identify and prioritize flood risk reduction Management Actions. For the purposes of this report, the community of Locke refers to the densely populated town of Locke. In addition to Locke there are seven additional Delta Legacy Communities that received grant funds to prioritize flood risk reduction measures in the Sacramento River corridor of the North Delta. Those Delta Legacy Communities include, Courtland, Hood, East Walnut Grove, West Walnut Grove/Ryde, Clarksburg, Rio Vista, and the City of Isleton.

Water Code, and of flood control projects in the Sacramento River and San Joaquin River watersheds for which the State (DWR or Central Valley Flood Protection Board) has provided assurances of nonfederal cooperation to the United States.

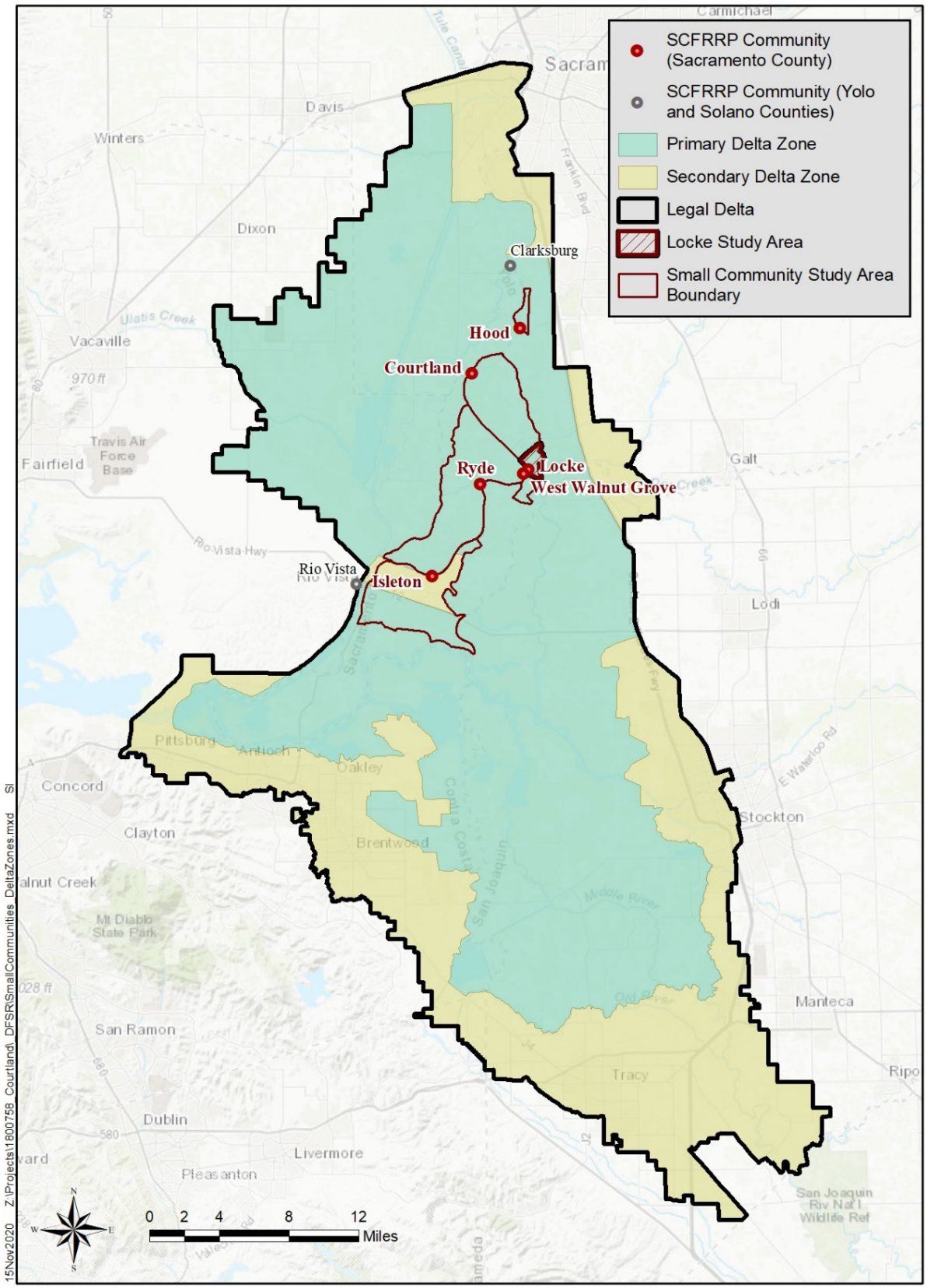


Figure 1-1. Delta Legacy Communities Participating in the Small Communities Flood Risk Reduction Program

1.2 Goals and Scope of the Study

As described in the 2012 and subsequent 2017 CVFPP Update, the goal of the State as well as the Delta Legacy Communities is to improve SPFC levees and applicable adjoining non-SPFC levees protecting small communities to achieve 100-year (1% annual chance) flood protection, as defined by the Federal Emergency Management Agency (FEMA). Consistent with this goal, the goal of this feasibility study is to develop, evaluate, and prioritize structural and non-structural flood risk reduction measures for the Locke study area, which would also strengthen and modernize SPFC levees within the study area upstream of the existing Delta Cross Channel, and to ultimately achieve 100-year flood protection and meet FEMA 100-year certification criteria.

Structural Flood Risk Reduction Measures

- Repair/strengthen in-place existing levee system(s)
- Strengthen existing levee(s)/embankments with cut-off walls, seepage berms, stability berms, etc.
- Repair existing erosion sites on levee systems
- Address and correct known encroachments/deficiencies in levee systems that pose threat to levee integrity
- New setback levee in place of existing levee system segments

The flood risk reduction measures to be developed include multi-benefit objectives for Locke and its agricultural, recreation, and socioeconomic attributes, where possible, as well as statewide water conveyance benefits along the Sacramento River. Improvements of the SPFC levee system protecting the Locke study area can collectively enhance the resiliency and reliability of through-Delta water conveyance upstream of the Delta Cross Channel.

While 100-year flood protection is the goal of the State and the Delta Legacy Communities, there are concerns that improvement of the flood control system could encourage development, thereby potentially increasing flood risk. However, within the Primary Zone of the Delta (as shown in Figure 1-1) there are significant restrictions within the Delta Plan adopted by the Delta Stewardship Council (DSC) that do not permit development to occur by displacing agricultural land uses. As a result, improvements identified in this study are not expected to induce development and/or result in increased flood risk within the Locke study area.

Non-Structural Flood Risk Reduction Measures

- New ring levee system(s) and/or new cross levee to isolate smaller areas (communities) from a larger perimeter levee system that may be more susceptible to levee failures
- New all-weather access roads or flood fight berms to address and potentially fend-off rising flood water that may occur in other portions of a large RD compared to a small fractional area (community) protected by a larger perimeter levee system
- Voluntary elevation of structures, ideally for potential flood depths greater than 3 to 5 ft.
- Wet or dry floodproofing of structures, ideally for flood depths less than 5 ft., and some agricultural structures for flood depths greater than 5 ft.
- Securing FEMA accreditation by executing a number of combined structural and non-structural measures pursuant to 44 CFR §65.10
- Improved Emergency Response; Local Hazard Mitigation Plans, Flood Emergency Safety Plans, and potential relief cuts
- Alternatives to FEMA's National Flood Insurance Program – community- and flood-risk based insurance programs with or without formation of a Geologic Hazard Abatement District
- Public awareness and education of local and regional flood risks
- Improved governance between neighboring LMAs/RDs and communities
- Regional/local flood easements and flood flow/channel conveyance enhancements
- Acquisitions and relocations of structures and residents

1.3 State's Interest in the Delta

The State of California has broad interests in integrated water management within the Delta which must be considered within the context of this feasibility study, including:

- *Water Supply Reliability* – The State supports the availability and conveyance of surface water (when available based on hydrologic conditions), timely delivery, and adequate water quality for urban and agricultural water users. Water, from north of Delta sources, is delivered through the Delta by DWR, *via* the State Water Project (SWP), the State Water Contractors and the U.S. Bureau of Reclamation, *via* the Central Valley Project (CVP).
- SWP and CVP supplies conveyed south of Delta serve approximately 3 million (M) acres of agricultural lands and a population of 27M.
- The entire volume of water conveyed by the SWP and CVP currently passes directly by Locke *via* the SPFC-leveed channel of the Sacramento River.
- The 1 mile of SPFC levees protecting the Locke study area along the left/east bank of the Sacramento River managed by Reclamation District (RD) 369 and 554 also serves as a vital element of the primary through-Delta water conveyance channel in the North Delta, with or without an isolated conveyance system, as presently proposed by the Delta Conveyance Authority (DCA).

Sustainable Delta – the State supports investments that contribute to Delta sustainability and resiliency in the face of sea level rise and climate change, which will likely result in higher and longer duration flood stages.

- *Delta Ecosystem Protection, Enhancement, and Restoration* – The State supports integrating flood and water management with ecosystem restoration actions that may include riparian, tidal marsh, freshwater marsh, and floodplain habitats.
- *Preserving the Unique Characteristics of the Delta* – Delta Legacy Communities have a distinct natural, agricultural, and cultural heritage with the State recognizing the importance of preserving and enhancing the unique characteristics of these Delta Legacy communities. Through numerous initiatives, the State has prioritized support for the preservation and revitalization of these communities as well as the Delta agricultural economy and culture, fishing, boating, waterfowl and upland game bird hunting, wildlife viewing, and recreation. In addition to the State's recognition of significant cultural values, the entire Legal Delta has received the distinction as California's one and only National Heritage Area, designated by Congress in March 2019.
- *Providing Appropriate Levels of Flood Protection* – The State, through DWR, has a long history of cost-sharing with federal and local agencies on projects that provide benefits to the local, State, and national economic interests. Although operation and maintenance (O&M) is coordinated through LMAs in the Delta, for most areas, the State ultimately

has O&M responsibility for SPFC facilities, including SPFC channel maintenance, and also an interest in providing technical and financial assistance for levee maintenance and rehabilitation of non-SPFC facilities within the Delta.

The State's investment in integrated water management must contribute to a sustainable Delta. Therefore, this feasibility study defines which actions could potentially contribute the most to Delta sustainability and how levee investment metrics are defined, tracked, and measured.

1.4 Locke's Need for Improved Flood Protection

Locke is one of eight Delta Legacy Communities located along the Lower Sacramento River Corridor in the North Delta participating in the SCFRRP (Figure 1-2). Most of the levees surrounding the community of Locke were initially constructed prior to 1906 by local interests and were generally built using materials dredged from the adjacent Sacramento River and nearby, adjoining sloughs. The RD 369 levee along Snodgrass Slough was constructed prior to 1937 as part of a railroad embankment. Various improvements have been made to the SPFC levees along the Sacramento River over the years, including levee reconstruction and bank protection work at multiple locations. In 2006, FEMA reached out to Sacramento County and the levee maintenance districts including RD 369 and RD 554 to learn if adequate documentation supported certification of the levees. In 2012, FEMA updated the flood insurance rate maps (FIRMs) and the Libby McNeil tract, inclusive of the community of Locke, was mapped as a Special Flood Hazard Area (SFHA) Zone AE.

As discussed further in Section 3.1.2, flood insurance is required for buildings with a federally backed mortgage located in a SFHA. To remove the Libby McNeil tract including the community of Locke out of SFHA Zone AE, the entire combined perimeter levee system would need to meet current, modern levee design standards to provide a 100-year level of flood protection (pursuant to FEMA accreditation standards in the Code of Federal Regulations, Chapter 1, Subchapter B, Part 65, Section 65.10 [44 CFR §65.10]); however, though the levees protecting the community of Locke have stood the test of time, they currently fall well short of meeting these current levee design standards.

Also in 2012, the Biggert-Waters Flood Insurance Reform Act (BW-12) and the Homeowner Flood Insurance Affordability Act (HFIAA) were passed putting into motion substantial annual increases to flood insurance costs until premiums are rated based on the elevation certificate (see Section 3.1.2 for additional information on HFIAA). The unfortunate oversite in this is that the premiums don't recognize that the homes in Locke are protected by a levee system. Consequently, whether one believes the flood hazard to be of concern, the cost of flood insurance administered by FEMA under the current National Flood Insurance Program (NFIP) has certainly become a large and continuously growing concern.

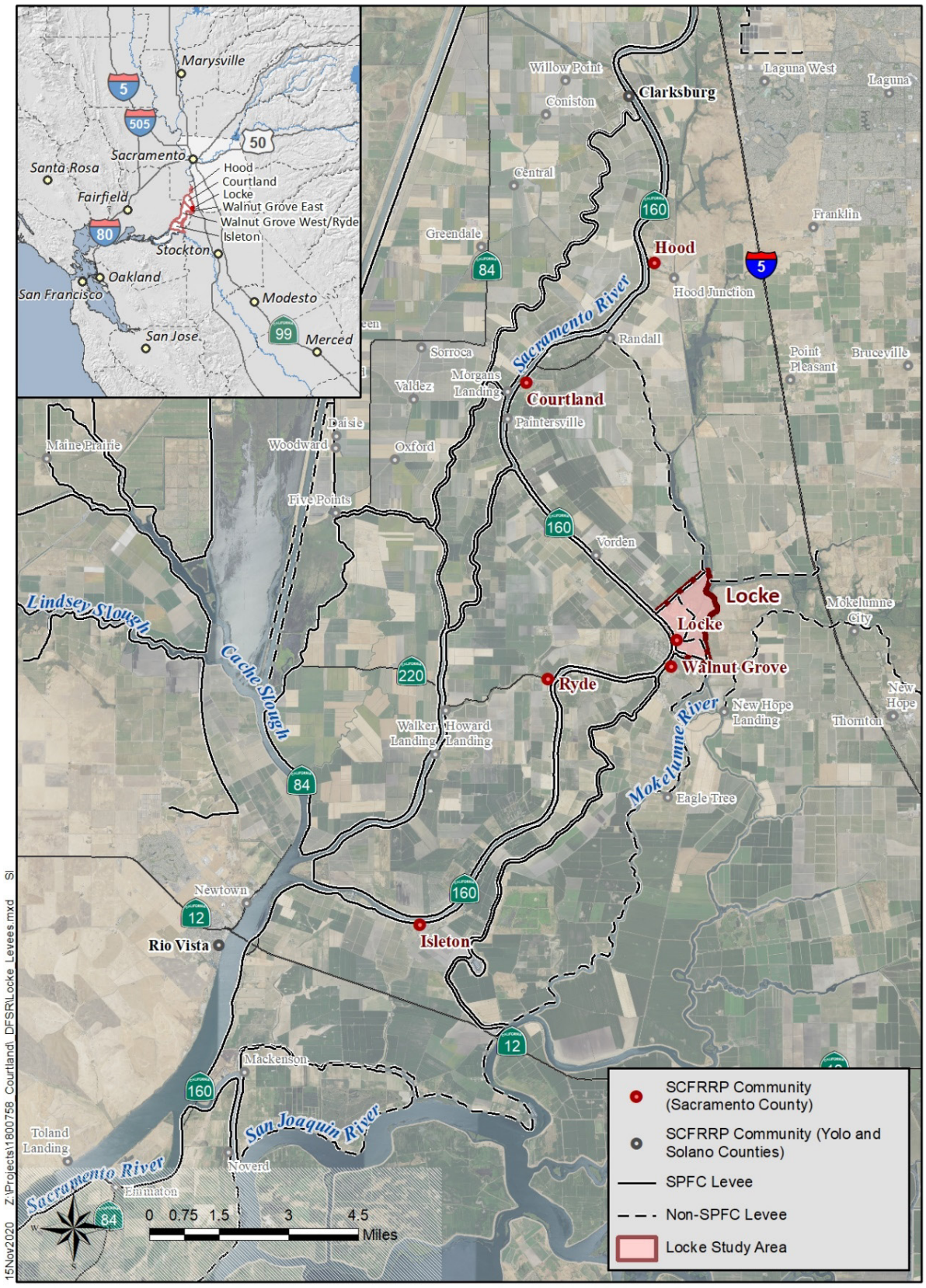


Figure 1-2. Delta Legacy Communities Participating in the SCFRRP.

1.5 Study Area and Location

The 760-acre study area for this SCFRRP effort includes the community of Locke and the larger agricultural area within RD 369, that is also partially protected by RD 551's south levee adjoining Delta Meadows Slough and RD 554's levee just north of the Delta Cross Channel along the east/left bank of the Sacramento River (Figure 1-3). RD 369 encompasses the tract of land known as Libby McNeil, all of Locke, and the Delta Meadows State Recreation Area.

The densely populated portion of Locke encompasses approximately 10-acres and sits at an elevation of 9 to 10 feet (North American Vertical Datum 1988 [NAVD 88]) along the east (left) bank of the Sacramento River, north of the Delta Cross Channel and the town of Walnut Grove. Elevations and flood depths provided herein are referenced to NAVD 88. The study area is largely protected by a 4.5-mile perimeter levee system collectively surrounding the community of Locke and RD 369 – Libby McNeil. Within this system are a total of 1 mile of SPFC levees collectively maintained by RD 369 and RD 554 (0.8 miles – RD 369, 0.2 miles – RD 554), and 3.5 miles of non-SPFC levee maintained by RD 369, RD 554, and RD 551 (1.2 miles – RD 369, 0.9 miles – RD 554, 1.4 miles – RD 551)[2]. The RD 369 levee system (and a 0.60-mile segment of the RD 551 cross levee north of Locke) protects approximately 625-acres within the Locke study area which largely consists of agricultural lands planted in pear orchards, with the levees in RD 554 protecting the remaining 135-acres located between the community of Locke and the Delta Cross Channel. The town of Locke is located within the boundaries of RD 369, and a levee breach of the SPFC levees on the left bank of the Sacramento River within RD 369 or the northerly portion of RD 554 would very likely result in the inundation of RD 369 and the town of Locke.

[2] In addition to other flood management facilities, the SPFC includes "Project levees," which were constructed by the USACE as part of Federal-State flood control projects and were turned over to the State for operations and maintenance ("assurances"). The State has generally passed on the responsibility for routine maintenance of Project levees to LMAs. The SPFC relies on many other non-SPFC features, such as non-State or federal reservoirs to regulate flows and reduce loading on the system, and private levees in the Central Valley or non-project (local) levees in the Delta, for which the State has not provided assurances.

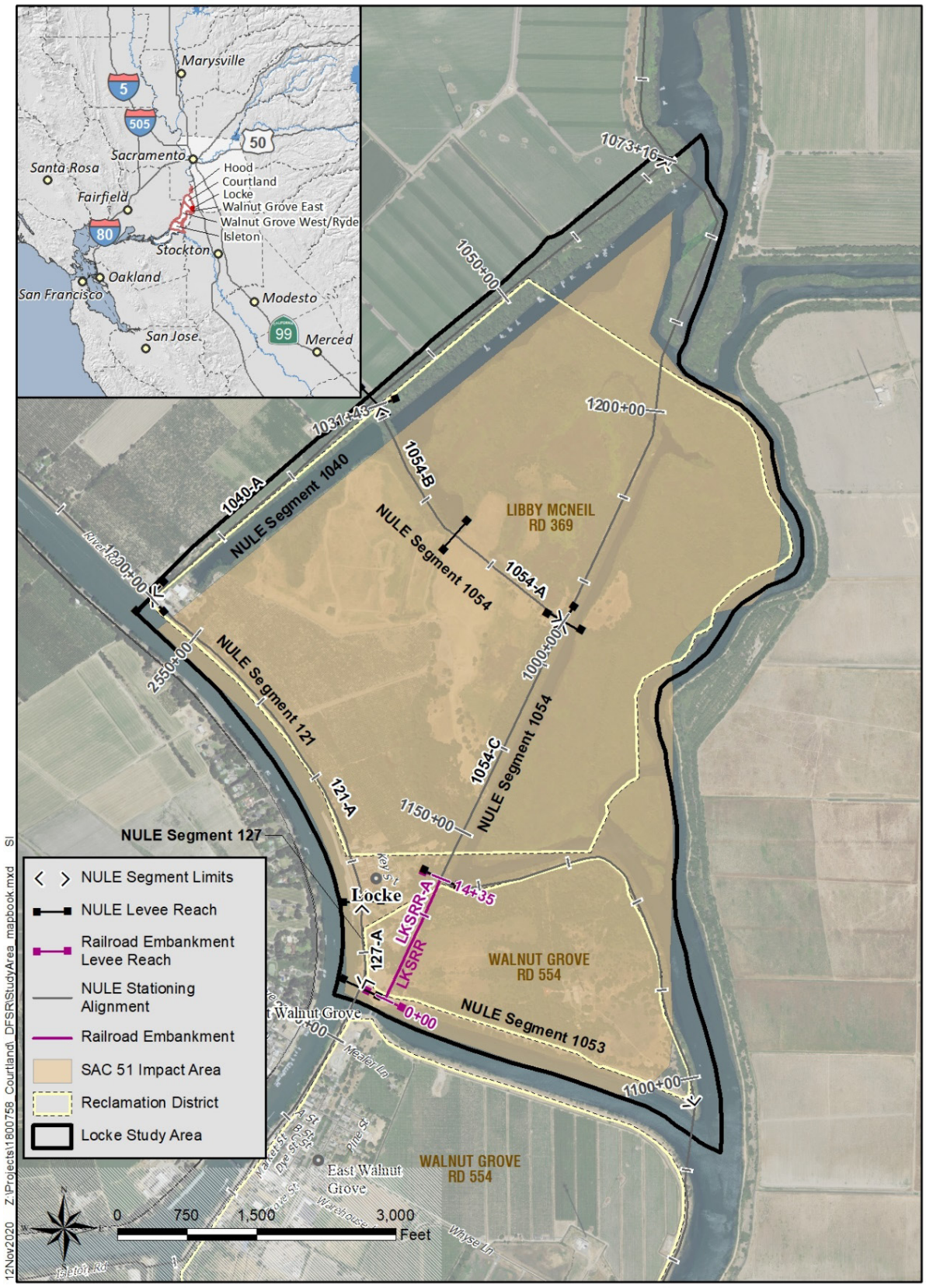


Figure 1-3. Locke Study Area

1.6 Public Outreach and Engagement

This feasibility study has been prepared in close coordination with the community of Locke and agencies with a shared interest in a safe, sustainable, and vibrant Delta. Sacramento County has been engaged with local planning groups for each Delta Legacy Community in Sacramento County to share the story of each community, help the public understand flood risks, and share possible flood risk reduction planning documents and solutions for the future.

Visit the Locke Story Map for more details: Locke Story Map - Sacramento County Small Communities Flood Risk Reduction Program.[3]

1.6.1 Stakeholder Identification and Outreach

The residents and business owners of Locke have been invited and encouraged to participate in the planning effort. This feasibility study has been prepared in coordination with representative participating stakeholders with interest and knowledge in providing enhanced flood protection for Locke. Stakeholders include representatives of RD 369, landowners and NFIP policy holders within RD 369, Sacramento County, DWR, including Sacramento County's floodplain administrator, State, and federal agencies (including FEMA), and non-governmental agencies with interests at the nexus of ecosystem restoration and flood risk solutions within and beyond the Delta. Community residents and landowners within Locke are encouraged to stay engaged in this process.

1.6.2 Communications and Engagement

The goal of this feasibility study is to have the flood risk reduction solutions be developed, promoted, and prioritized by the community of Locke, including areas beyond the community of Locke and within RDs 369 and 554. The feasibility study began by developing a planning committee initially comprised of people that live within the community. The committee is comprised of the following members: Clarence Chu, James Motlow, Russell Ooms, and Douglas Hsia.

Meeting fatigue has occurred in the Delta due to the multitude of planning processes that have been performed particularly in the last decade. Thus, the planning committee acted as representatives that could help guide the study through development prior to being released to the entire community and residents/business owners within RD 369. The study process began with the development of an interactive Story Map on Sacramento County's Storm Ready[4]

[3] Locke Story Map - Sacramento County Small Communities Flood Risk Reduction Program: https://sacramentocounty.maps.arcgis.com/apps/MapJournal/index.html?appid=277f1bd2979b4cc2adb068ec234daa33
[4] http://sacdelta.stormready.org/

website (published in September 2018) that could describe the community, its importance to the region, its current flood risk, and recommended solutions to reduce that risk.

An initial meeting with the planning committee as well as trustees from RD 369 was held in June 2018. The purpose of this meeting was to identify existing concerns, brainstorm opportunities, and develop an array of potential solutions. This meeting acted as a guide to direct the study. The concerns identified included securing protection from flooding from the east levee that backs up to the Delta Meadows State Park, determining costs to repair levees, limited flood planning, unknown governance of the study area's north levee and former railroad embankments, and no geotechnical data on the study area's east levee.

The opportunities include preservation of the Locke Historic District as a benefit of improved flood protection. The Locke Historic District is listed on the National Historic Landmarks, of which only 147 exist in the State. The study area also encompasses a culturally significant Native American area of significance.

Structural MAs and non-structural measures were discussed. The group's highest priority structural MAs were to fix the weakest links on the non-SPFC levees. The non-SPFC levees along the eastern boundary of the study area are the most likely to fail given their small size and risk of flooding from Snodgrass Slough within the Cosumnes River watershed that has no major dam. The former railroad embankment located along the full extent of the eastern boundary of RD 369 was discussed as the group's second highest priority. The group expressed less concern over the SPFC levee along the left bank of the Sacramento River due to its overbuilt dimensions relative the non-SPFC levee segments size.

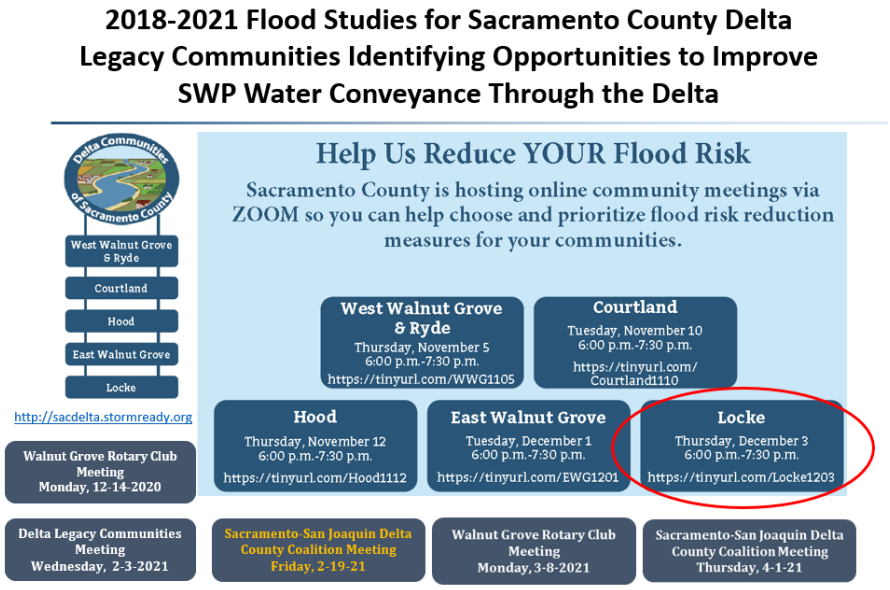
The top non-structural measure was to develop a flood fight plan in the event of a breach on the levees located on the east side of the study area. There also needs to be improved governance as the area immediately south of Locke is an unmanaged area within RD 554's jurisdiction. A common non-structural measure is to raise houses so that the lowest inhabitable floor space is safely above the flood hazard elevation on a firm, flood resistant foundation. However, home elevations are not feasible in this community due to very deep potential flood depths coupled with the historic protections on the buildings and their antiquated structural integrity.

RD 369 felt that additional data regarding the existing levee system would help in this planning effort. In spring of 2019, the study team reached out to individual landowners to perform geotechnical explorations. This included identification of Cone Penetration Tests (CPTs) locations in select areas around Locke to fill in data gaps and obtain an improved picture of levee hazard classifications and performance. Assurances were made to RD 369 and landowners that such investigations would not cause any detriment to property or the levee system. The geotechnical investigations were completed in late summer/early fall of 2019.

As the geotechnical data was analyzed and the suite of structural and non-structural MAs were developed, the study team again met with the community members to discuss initial findings from geotechnical evaluations as well as evaluate MAs in February of 2020. Raising and

rehabilitation of the east non-SPFC levee was discussed, as it almost overtopped in the most recent highwater event in 2017. A cross levee just north of Locke was also considered as it could reduce the number of levee miles that need to be repaired or strengthened-in-place. This solution could also potentially allow for 100-year FEMA certification, pursuant to 44 CFR §65.10, which is the ultimate goal for the community. Click here to learn more about achieving a 100-year level of flood protection pursuant to the current FEMA accreditation standards.[5]

A close review of the FEMA regulations, in particular 44 CFR §65.10 (b) *Design criteria* (4) *Embankment and foundation stability,* indicates certain through seepage and underseepage criteria and factors of safety must be adhered to meet full certification criteria. In the North Delta, where there are significant sandy soil materials underlying the levee systems initially built over 150 years ago and periodically upgraded decades ago, the levees still fall well short of meeting current, modern engineering and FEMA accreditation standards. To meet such standards, most of the levees in the North Delta, including the SPFC and non-SPFC levees protecting the community of Locke, need to be retrofitted with either seepage cutoff walls and/or a combination of seepage/stability berms which are very costly and can cost in excess of $15M per mile.



The study team also discussed the limitation of non-structural options available to the community to reduce flood risk and NFIP insurance premiums. The planning committee as well as the public was provided a draft feasibility study report (FSR) in November 2020 for their review which was followed by a virtual meeting in December 2020 to discuss the draft FSR and receive additional input. During the December 2020 meeting, stakeholders expressed support for a cross levee north of Locke to reduce flood risk to the community. There was also support

[5] FEMA Guidance for Flood Risk Analysis and Mapping - Levees: https://www.fema.gov/sites/default/files/documents/fema_levee-guidance.pdf

expressed for repairing and strengthening the Delta Meadows Cross Slough levee northeast of Locke to reduce flood risk to the community and the larger study area.

This input was incorporated into the final report to be submitted to the County Board of Supervisors for consideration of adoption December of 2021. Additional stakeholder input regarding the preference, prioritization, and implementation of MAs and accompanying non-structural measures summarized in Sections 7 and 8 was also sought between the development of the draft and final FSR.

A summary of outreach meetings held for the Locke study area is provided in Table 1-1.

Table 1-1. Outreach Community Meetings for the Locke Study Area.

Date	Event/Location	Address	Host Organization	Attendance
6/7/2018	Locke Chinese School	13920 Main Street, Locke	SCFRRP Study Team	6
2/19/2019	Locke Chinese School	13920 Main Street, Locke	SCRRRP Study Team	6
2/26/2020	Kiononia Hall	14120 Grand Ave, Walnut Grove	SCFRRP Study Team	12
12/03/2020	Virtual Zoom Meeting	--	SCFRRP Study Team	11

1.6.3 Coordination with Key Agencies within the Delta

This FSR has been prepared in coordination with the Delta stakeholders. They include representatives of RD 369, landowners and FEMA NFIP policy holders within RD 369, the Delta Legacy Communities Task Force, Sacramento County, State and federal agencies, and non-governmental agencies with environmental interests that are knowledgeable about the flood risks and potential solutions within the Delta.

DSC Delta Plan Coequal Goals

1) Providing a more reliable water supply for California and
2) Protecting, restoring, and enhancing the Delta ecosystem.

The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place." (CA Water Code §85054)

Although many agencies are involved in the Delta, three regional agencies are heavily involved in land use policy and sustainability in this region, and thus have a special interest in SPFC improvements, as detailed below.

1.6.3.1 Delta Protection Commission

The DPC is focused on conservation of agricultural land and supporting economically sustainable agricultural operations in the Delta. The DPC maintains and implements the Land Use and Resource Management Plan (LURMP) for the Primary Zone of the Delta. City/County

General Plans and future projects that affect land use in the five Delta counties must be consistent with the LURMP and are subject to review by the DPC.

1.6.3.2 Delta Stewardship Council

The DSC was created to achieve the State mandated coequal goals for the Delta. The DSC also drafts, updates, and administers the Delta Plan, a long-term management plan with recommendations to further the coequal goals, in a manner that protects and enhances the unique cultural, recreational, natural resources, and agricultural values of the Delta as an evolving place. All proposed projects within the Delta must be consistent with the Delta Plan, which precludes displacement of agricultural land uses with non-agricultural land uses, and subsequent structural solutions, such as improving and modifying the existing levee systems identified in this study for the community of Locke, which may be subject to a consistency determination by the DSC.

1.6.3.3 Delta Conservancy

The Delta Conservancy (Conservancy) is the primary State agency focused on the implementation of ecosystem restoration in the Delta and supports efforts that advance environmental protection and the economic well-being of Delta residents. The Conservancy collaborates and cooperates with local communities and other parties to preserve, protect, and restore the natural resources, economy, and agriculture of the Delta and Suisun Marsh. The Conservancy also collaborates on Delta branding and marketing, the Delta Carbon Program, invasive species control, and the California Department of Fish and Wildlife (CDFW) Delta Conservation Framework. The Conservancy's Delta Public Lands Strategy includes integrated conservation for publicly funded lands in the Delta.

1.7 Related Plans, Programs and Studies

Many plans influence flood management in the Delta, as summarized below. This study aggregates and uses evaluations from the CVFPP and DWR's Non-Urban Levee Evaluations (NULE) Program and Flood System Repair Project (FSRP) to inform the development and prioritization of flood risk reduction measures for the Locke study area.

1.7.1 Central Valley Flood Protection Plan

The CVFPP, mentioned previously, proposed improvements to SPFC levees, and where applicable, Delta (non-SPFC) levees, ecosystem enhancements, and flood risk reduction measures for small communities. The CVFPP identifies structural and non-structural options to protect small communities from the 100-year flood, and is the basis for selecting flood risk reduction elements and MAs considered in this feasibility study, including (DWR, 2012a):

1. Reconstructing or repairing perimeter levees in-place or making improvements to existing SPFC perimeter levees, and non-SPFC levees that could impact and/or enhance the performance of SPFC levees.

2. Protecting small communities “in-place” using ring levees, training levees, or floodwalls when improvements do not exceed a certain predetermined cost threshold.
3. Implementing non-structural improvements, such as developing flood fight berms raising and elevating structures, floodproofing, willing seller purchases, and/or relocating structures, when the in-place improvements described above are not feasible.

1.7.2 Sacramento River Basin-Wide Feasibility Study

The Sacramento River Basin-Wide Feasibility Study (BWFS) was prepared subsequent to the 2012 CVFPP and focused on a multi-benefit approach to expansion of the flood bypasses. Solutions proposed in the BWFS germane to the Locke study area include addressing system capacity constraints to allow for improved conveyance through widening the Yolo and Sacramento Bypasses and Fremont and Sacramento Weirs. These expansions and modifications are underway and are expected to provide a reduction in flood stage of 1 to 2 feet along segments of the Sacrament River, adjacent to Delta Legacy Communities, as depicted in Figure 1-4. The noted expansions and modifications to the upstream bypasses and associated weirs will help neutralize some of the basin-wide impacts of climate change in the Lower Sacramento River as most all excess flows will be diverted into the bypass systems with metered or controlled flows being routed downstream of the American River into the Lower Sacramento River in the North Delta. However, it should be noted that the Sacramento River BWFS could not fully address climate change impacts occurring in the neighboring watersheds southeast of the American River. The neighboring watersheds to the southeast are largely uncontrolled watersheds without any significant upstream flood storage regulation within the Morrison Creek, Cosumnes and Mokelumne River watersheds. The watersheds can collectively or individually impact downstream flood stages in the Mokelumne River and Snodgrass Slough that may increase the risk of flooding to the community of Locke.

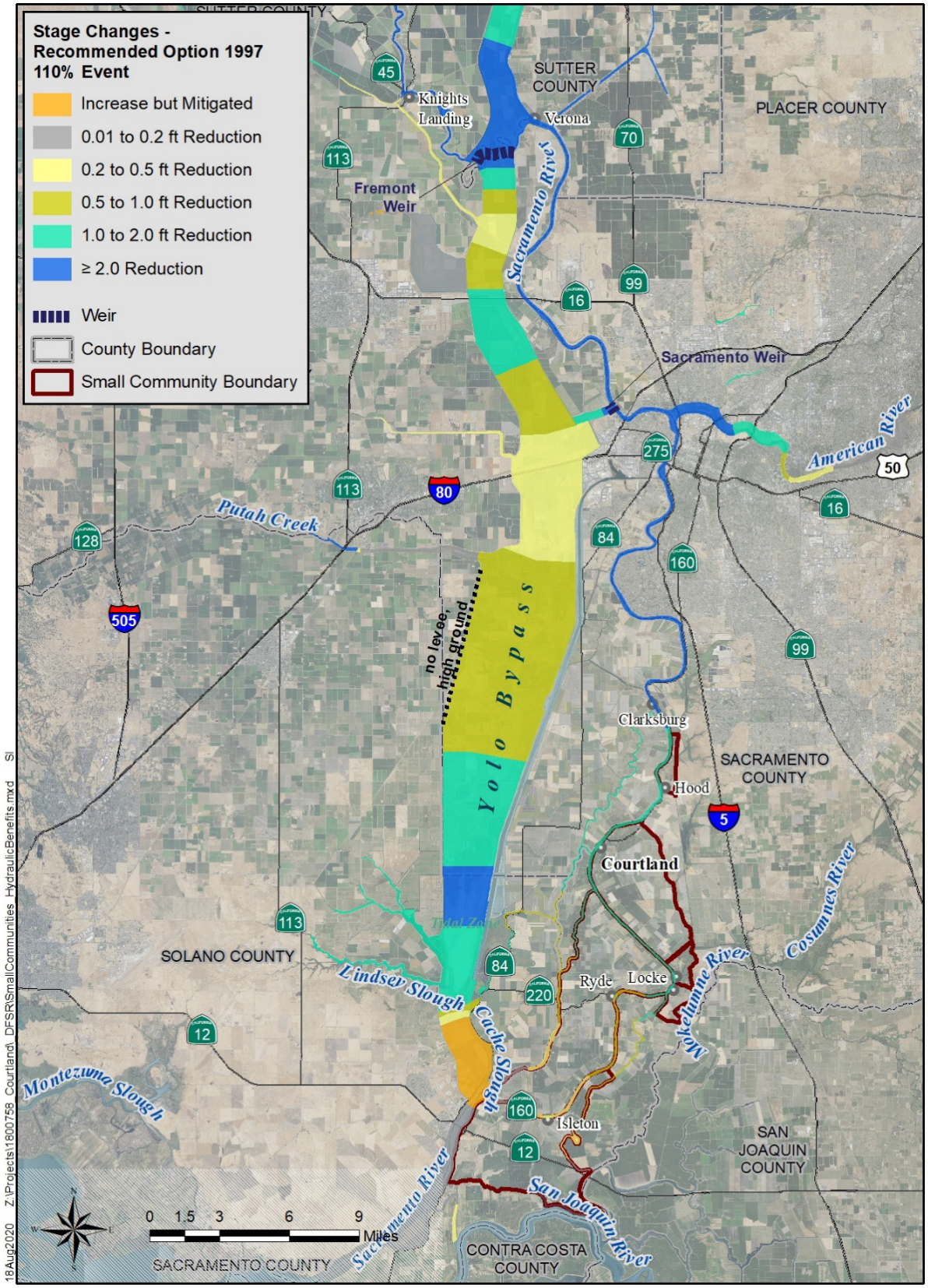


Figure 1-4. Flood Stage Reductions as a Result of the BWFS Expansions and Modifications.

1.7.3 Lower Sacramento River/Delta North Regional Flood Management Plan

The 2014 Lower Sacramento River/Delta North Regional Flood Management Plan (2014 RFMP) was developed by FloodProtect, a regional working group, as the regional follow-on to DWR's 2012 CVFPP. The 2014 RFMP was funded by DWR but drafted by local agencies and identified pre-feasibility level regional flood management solutions (FloodProtect, 2014). The 2014 RFMP also recommended further flood risk reduction feasibility studies for many small communities and Delta Legacy Communities, including Locke.

1.7.4 Delta Levees Investment Strategy

The Delta Levees Investment Strategy (DLIS) was prepared by the DSC as a follow-up to the Delta Plan to identify funding priorities for State investments in Delta levees. Funding priorities were developed using a risk-based analysis, which quantified risks to people, property and infrastructure, water supply reliability, ecosystems, and the Delta as a place, by developing estimates of flooding probability due to seismic and hydrologic events.

The DSC's goal was to develop a list of very-high priority and high priority islands and tracts by quantifying risks using several metrics such as expected annual fatalities and expected annual damages (EAD). Seventeen islands were identified as very-high priority and 36 islands and tracts were identified as high priority (DSC, 2017). However, the Locke study area was placed in the "Other Priority" category, and as such, was not highly prioritized for State investments under the initial DLIS prioritization (Figure 1-5).

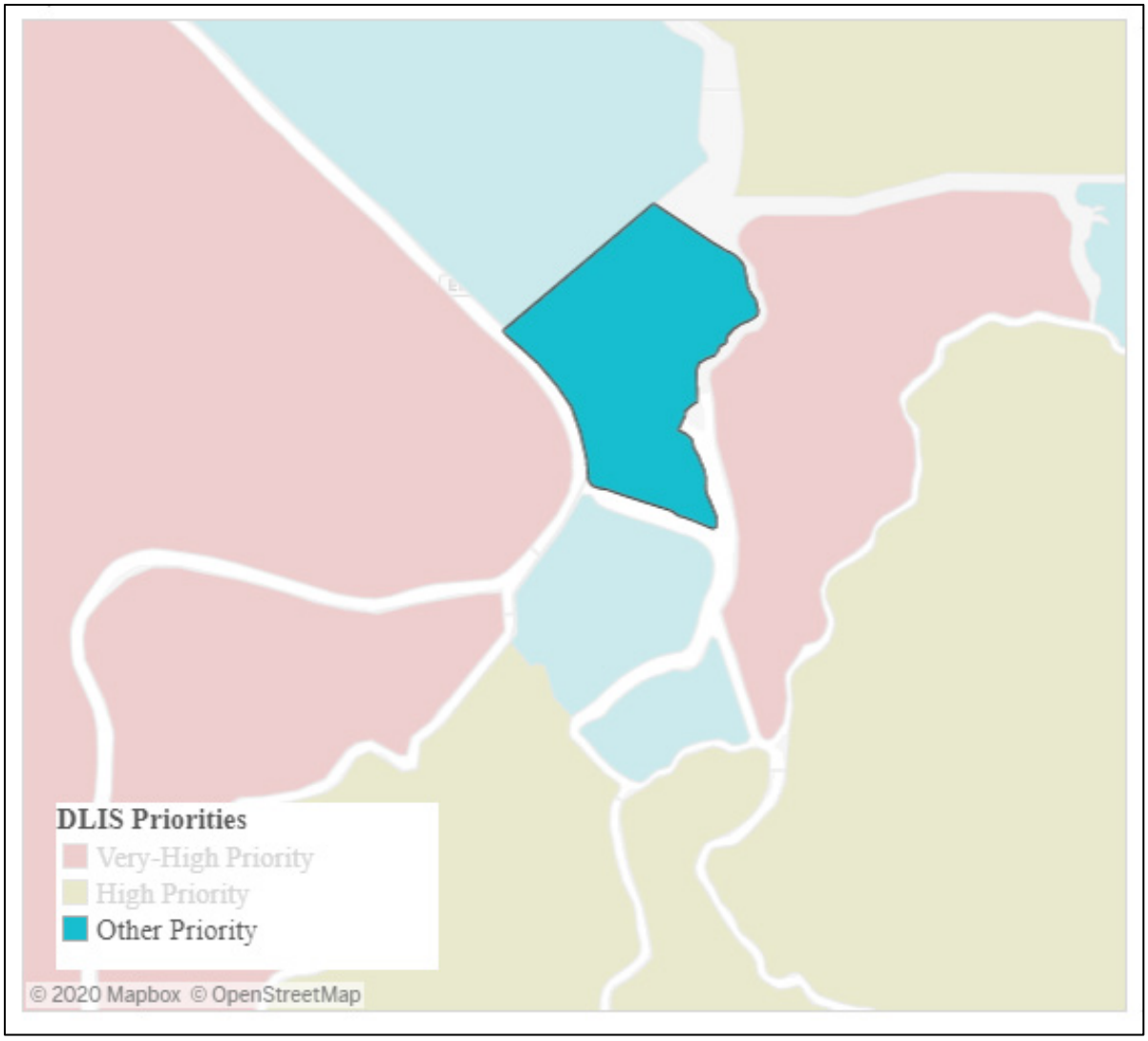


Figure 1-5. DLIS Analysis – Overall Prioritization (Rand Corporation, 2020)

It should be noted that the DSC is in the current process of updating their DLIS, based upon more current data and updated methodologies. A representation of the initial DLIS analysis (annual probability of flooding due to a hydrologic event) is shown in Figure 1-6. The Locke study area was initially estimated to have an annual probability of 0.9 percent of flooding as a result of a hydrologic event according to DLIS. This annual probability of flooding is largely based upon overtopping, combined with information provided in the Delta Risk Management Strategy (DRMS), and not the current geotechnical characteristics of the RD 369 and 554 levee systems.

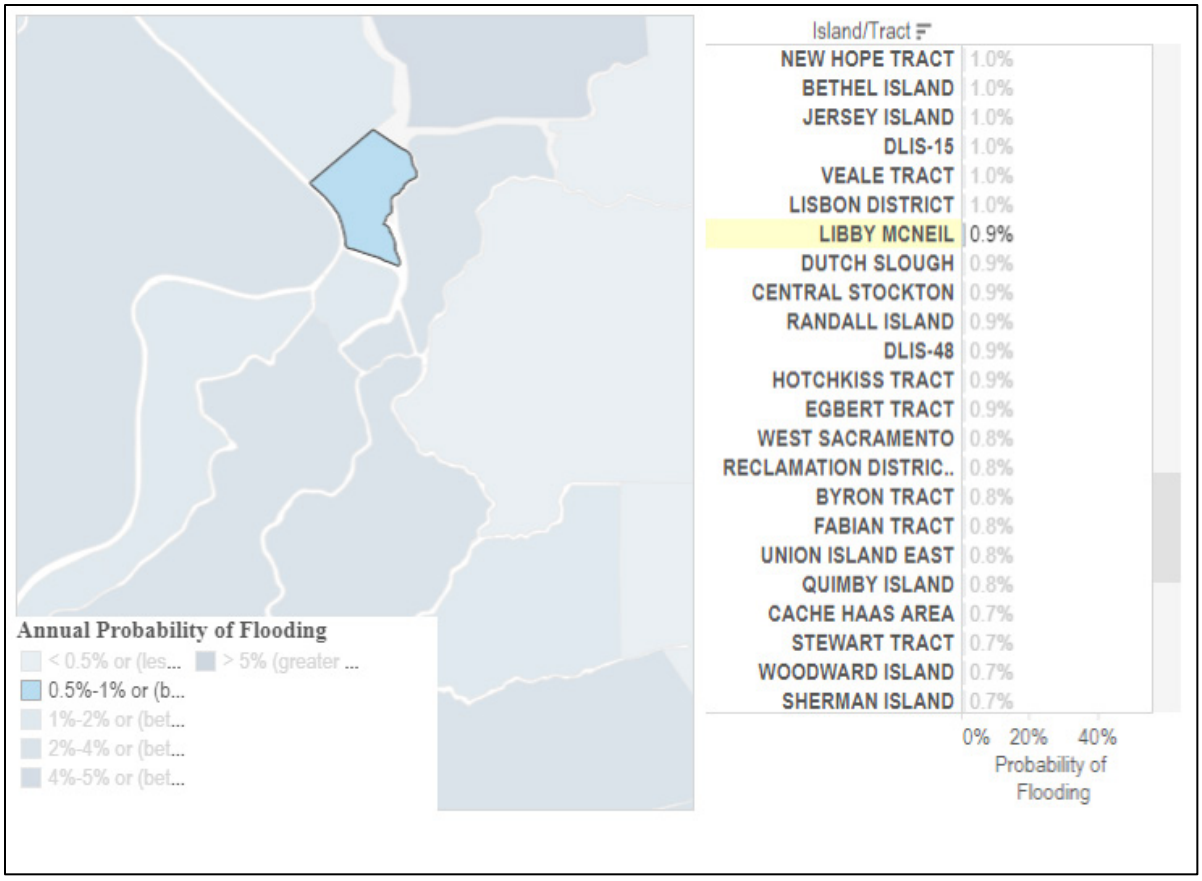


Figure 1-6. DLIS Analysis - Hydrologic Event (Rand Corporation, 2020)

The rulemaking process to adopt regulations implementing the DLIS is ongoing. However, the interactive DLIS Decision Support Tool representing the current prioritization and analysis framework is publicly accessible online here.[6]

1.7.5 Flood System Repair Project

The FSRP is funded by $150M of Proposition 1E funding and aims to assist LMAs in reducing flood risk on a cost-sharing basis. Through the FSRP, LMAs are provided technical and financial support to repair documented critical or serious problems with flood protection. The master database from the FSRP identifies levees with past performance problems for seepage, slope instability, erosion, and other problems (FloodProtect, 2014).

1.7.6 Non-Urban Levee Evaluations

DWR's NULE program evaluated non-urban levees against geotechnical criteria likely to impact levee performance, including stability, through seepage, underseepage, and erosion. In general, the program was administered using a phased approach in communities with less than

[6] Decision Support Tool for the San Francisco Bay-Delta Levee Investment Strategy: https://www.rand.org/pubs/tools/TL266/tool.html

10,000 residents and included Phase 1 preliminary geotechnical evaluations using historical data for all NULE levees, and Phase 2 geotechnical field investigations to further evaluate those levees protecting more than 1,000 persons. NULE levee segments were assigned ratings based on potential failure mode and placed in an overall hazard category for which recommendations and cost estimates were prepared. Data from the NULE program are currently used in conjunction with LMA inspection reports and data from the FSRP to characterize SPFC and non-SPFC levees and to inform future state, regional and local flood planning and financing efforts.

The results of Phase 1 NULE studies for the study area are detailed in Appendix A and in Section 2.1.1. However, the Locke study area did not meet the population threshold for NULE Phase 2 studies and therefore geotechnical investigations were not conducted as part of that study. Therefore, site-specific geotechnical conditions were warranted and developed *via* CPT soundings and accompanying soil sample lab tests were conducted as part of this study in 2019 to further inform this feasibility study (*see* Appendix A for additional information).

1.7.7 Levee System-Wide Improvement Framework

As of August 2020, RD 551 and adjoining RDs developed a draft Letter of Intent (LOI) to move forward with preparation of a System-Wide Improvement Framework (SWIF) plan. The SWIF would address levee systems outside of the immediate RD 551/755 basin, including levees within the Locke study area as part of RD 369. The SWIF will be developed with the support and assistance of the CVFPB and in collaboration with the U.S. Army Corps of Engineers (USACE) and environmental, cultural, and historical resource agencies, as well as other interested parties. Simultaneously, the LMAs (including RD 369) will be attempting to make improvements that address system-wide issues and correct unacceptable inspection items in a prioritized manner to optimize flood risk reduction. The USACE's approval of the LOI will allow the noted LMAs to remain active in the Public Law (PL) 84-99 rehabilitation program for a period of two years while the SWIF is being prepared. It is important to recognize that PL 84-99 does not equate to the more rigorous certification process to obtain a 100-year level of flood protection pursuant to 44 CFR §65.10 FEMA accreditation standards.

2. Existing Conditions

2.1 Existing Conditions

2.1.1 Topography and Levees

Ground elevation for the community of Locke is highest immediately adjacent to the SPFC levee system along the east/left bank of the Sacramento River (8 to 12 ft., NAVD 88). Ground elevations generally slope towards the east of RD 369, with elevations ranging from 2 to 4 feet NAVD 88 (Figure 2-1). Top of levee elevations vary from approximately 15 to 30 feet within the study area, with highest levee elevations located on the northeasterly upstream portion of the basin.

The study area consists of nearly 5.25 miles of levees, including DWR NULE Segments 121, 127, 1040, 1053, and 1054 (Figure 2-1). NULE Segments 121 and 127 comprise the SPFC levees in the study area, extending approximately 1 mile along the left bank of the Sacramento River from the western extension of Delta Meadows Slough at the upstream end to the confluence of the Sacramento River and the Delta Cross Channel at the southern downstream end. The northern, upstream 0.8 miles (NULE Segment 121) are part of the RD 369 levee system, and the remaining 0.2 miles (NULE Segment 127) are part of the RD 554 levee system. The remaining 4.25 miles are non-SPFC levees (NULE Segments 1040, 1053, and 1054) and are primarily operated and maintained by RD 369, RD 554, and RD 551. The Delta Meadows Slough levee (NULE Segment 1040) is part of the RD 551 levee system. It is approximately 1.4 miles long, extending from the confluence of Snodgrass Slough and Meadows Slough westward towards the Sacramento River. The westerly 0.6 miles of this NULE segment are common to the RD 369 basin perimeter. The Delta Meadows Cross Slough right bank levee (portion of NULE Segment 1054) is part of the RD 369 levee system. It is approximately 0.6 miles long, extending from the Delta Meadows Slough levee southeast to the Snodgrass Slough levee portion of NULE Segment 1054. The Snodgrass Slough right bank levee is also part of the RD 369 levee system. This portion of NULE Segment 1054 is about 0.6 miles long and extends along a former railroad embankment from the Delta Meadows Cross Slough levee southwesterly to the boundary with RD 554. The NULE Segment 1054 levee continues approximately 0.9 miles along the right bank of Snodgrass Slough through RD 554. However, this portion of NULE Segment 1054, along with the railroad embankment located along the left bank of the Delta Cross Channel (NULE Segment 1053, 0.74 miles) are not analyzed as part of this feasibility study (URS, 2011a).

As part of the 2017 CVFPP Update, flood risk was assessed by defining impact areas with associated index points within the San Joaquin and Sacramento River Basins. Within this context, defined flood risks were quantified at discrete index points with impact area-specific levee performance curves. The levee performance curves were developed to be representative of

a levee reach protecting the impact area, typically the worst case. Those areas that were vulnerable to a flood hazard from the reach associated with the index point were defined as impact areas. The Locke study area was aggregated into one impact area (SAC 51 [Locke]) as previously depicted in Figure 1-3. Levee performance curves were collectively updated by DWR and Sacramento County for each of the project levee segments in the study area during the course of this study as a result of geotechnical explorations performed in 2016. The new levee performance curves are included in Appendix E.

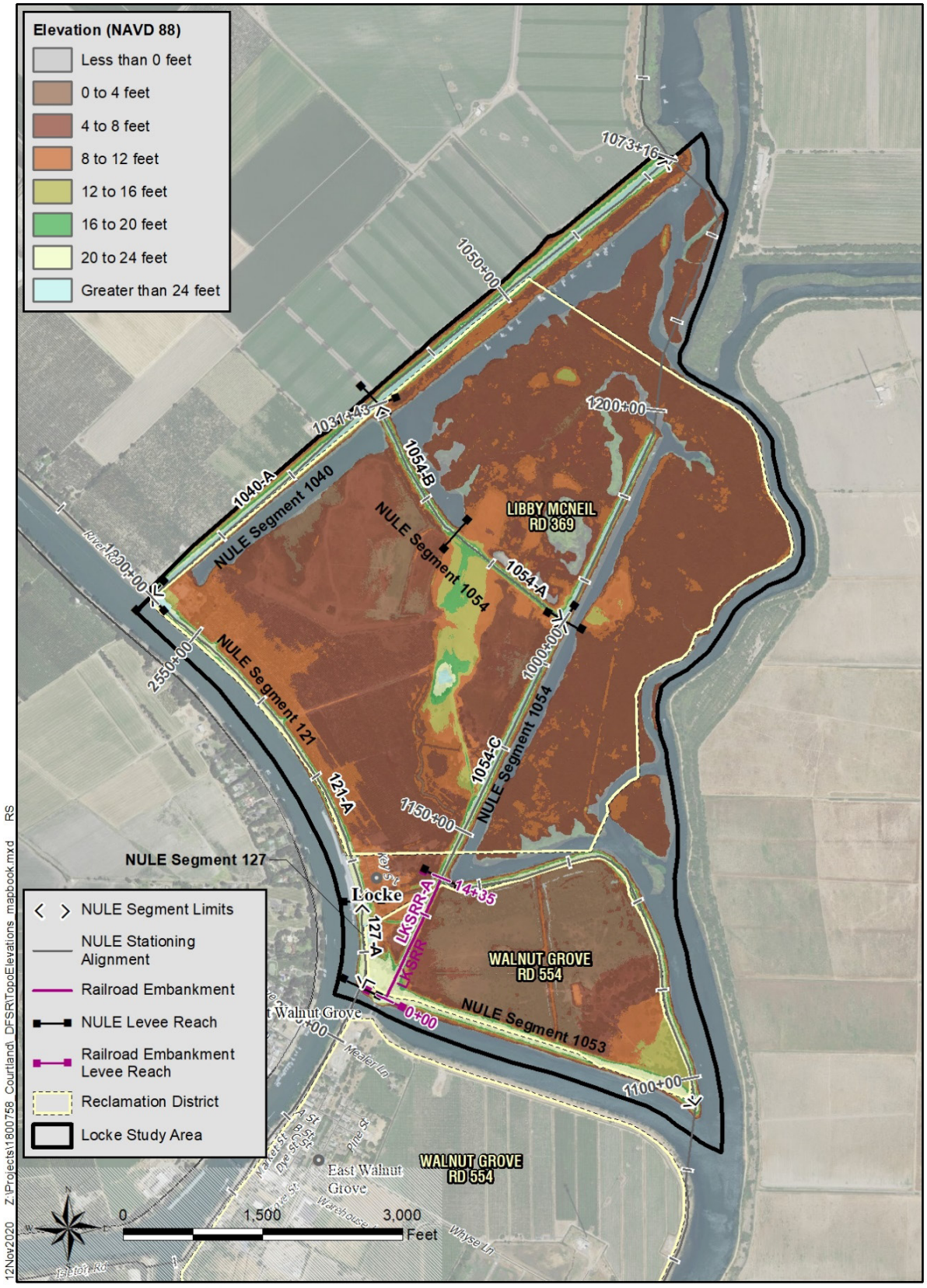


Figure 2-1. Study Area Ground Elevations and Levees.

The DWR NULE program reviewed and summarized NULE Segment geometry based on Light Detection and Ranging (LiDAR) topography collected for DWR's Central Valley Floodplain Evaluation and Delineation (CVFED) between October 2008 and February 2009. Documented geometry information for the levees in the study area is summarized in Table 2-1.

Table 2-1. Summary of Levee Geometry (URS, 2011a)

Levee Segment Location	NULE Segment	Approximate Levee Height	Approximate Crown Width	Approximate Landside Slopes	Approximate Waterside Slopes
Left Bank Sacramento River - RD 369 (SPFC levee)	121	12 to 13 ft. above the landside toe	40 to 55 ft.	1.8H:1V to 2.7H:1V	1.6H:1V to 2.5H:1V
Left Bank Sacramento River - RD 554 (SPFC levee)	127	12 to 14 ft. above the landside toe	80 to greater than 100 ft.	1.8H:1V to 3H:1V	1.3H:1V to 2.3H:1V
Delta Meadows Slough - RD 551/RD 369 (Non-SPFC levee)	1040	16 to 27 ft. above the landside toe	10 to 15 ft.	4.5H:1V to 6H:1V	3H:1V to 4H:1V
Right Bank Delta Meadows Cross Slough and Right Bank Snodgrass Slough - RD 369/RD 554 (non-SPFC levee)	1054	14 to 19 ft. above the landside toe, though some locations range from 7 to 14 ft.	15 to 40 ft.	1.7H:1V to 4H:1V	2.5H:1V to 3H:1V

2.1.2 Geomorphology

Geomorphology (bed and bank erosion and sediment deposition) mapping developed for the DWR NULE project indicates the levees protecting the community of Locke primarily overlie recent overbank deposits (Rob) likely consisting of interbedded sand, silt, and clay deposited during high-stage flow, overtopping channel banks (Figure 2-2). A few localized areas of historical slough deposits (Rsl) are also present. The slough deposits are likely to consist of silt, clay, and trace sand, fining upward from low-energy tidally or formally tidally influenced channel deposits. Parts of the Meadows Cross Slough levee and the Snodgrass Slough levee in RD 369 are mapped over pleistocene eolian deposits (Qe) which are likely to contain poorly to moderately cemented sand and silt. Historical tidal marsh deposits (Rpm) are mapped on the waterside of the Meadow Cross Slough and Snodgrass Slough levees. *See* Appendix A for additional information on existing geotechnical conditions within the study area, which includes the collection and evaluation of 11 recent CPT explorations and subsequent laboratory data that were gathered in 2019 as a component of this feasibility study.

Levees within the study area which are built on sandy soil materials are of particular note since these levees can be particularly impacted by through seepage and underseepage, which can result in levee failure if left unchecked. In these areas where the levees are more susceptible to seepage and underseepage, remediations to address these vulnerabilities are generally more costly, requiring deeper vertical cutoff walls or wider combination seepage/stability berms. Retrofitting these levees, which is required to secure FEMA accreditation, can often cost upwards of $15M or more per mile. Click here[1] to read FEMA's guidance for levee certification that lists a number of additional criteria that must be met in addition to the underlying seepage problems that are prevalent throughout the North Delta and other leveed areas within the Sacramento and San Joaquin River Basins.

[1] FEMA Guidance for Flood Risk Analysis and Mapping - Levees: https://www.fema.gov/sites/default/files/documents/fema_levee-guidance.pdf

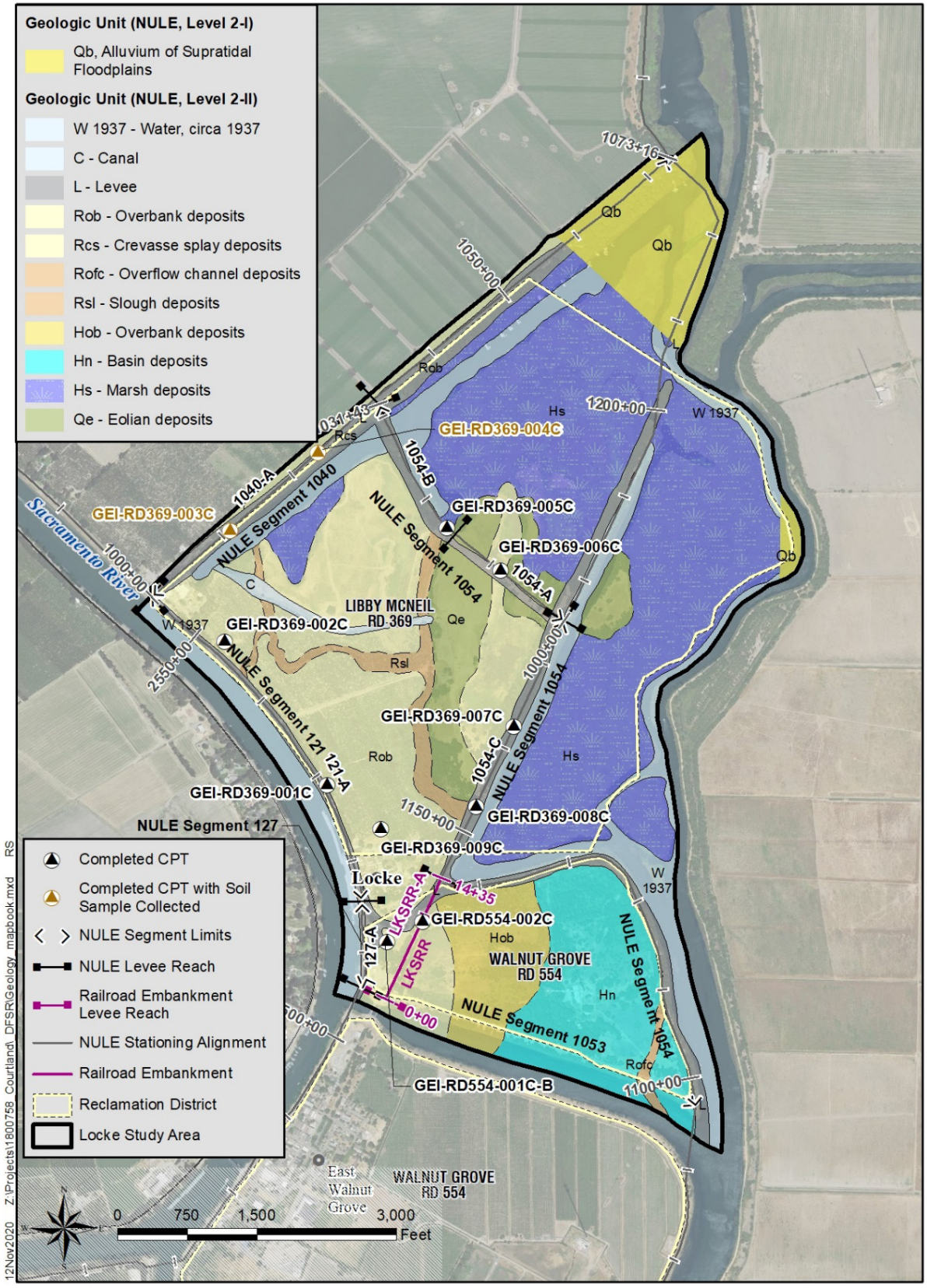


Figure 2-2. Geomorphology within the Study Area.

2.1.3 Population, Communities, and Land Use

According to the 2017 CVFPP Update and based on 2010 census data, the total population of the SAC 51 impact area (Locke), including Locke and the larger agricultural area, is 202 (DWR, 2017c). Income information for Locke separate and apart from the Walnut Grove census designated place (CDP) is not available. However, according to an annual American Community Survey conducted in 2016 and 2018, the median household income for the Walnut Grove CDP, inclusive of East Walnut Grove and Locke, declined from $53,634 to $47,400 (United States Census Bureau, 2010). Locke may be considered a disadvantaged community as defined by the state of California.

Sacramento County has designated Locke as a Special Planning Area (SPA). The community is subject to the County's SPA ordinance which drives land use planning and development. Allowed land uses in Locke and approved locations per the ordinance are shown in Figure 2-3.

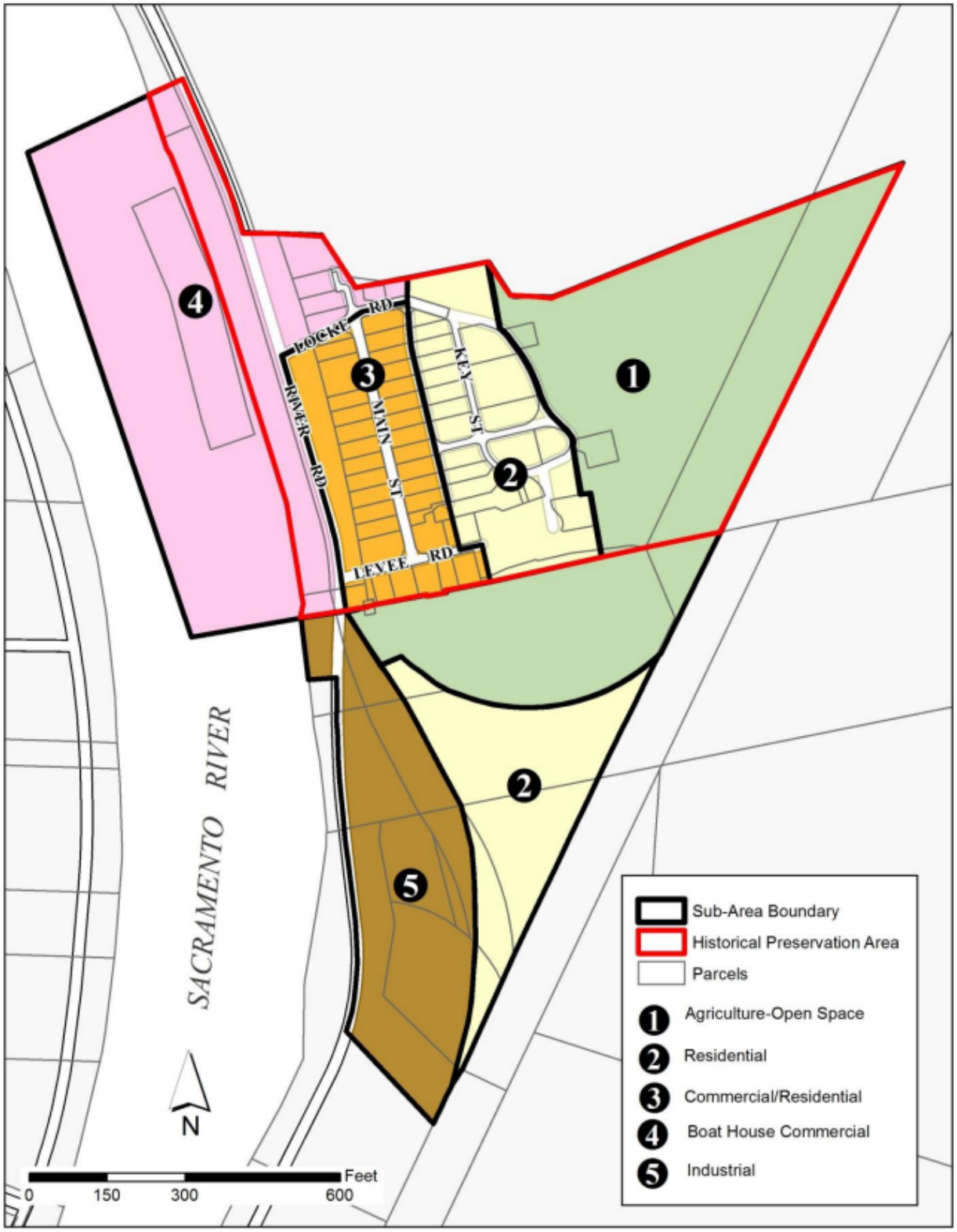


Figure 2-3. Locke Special Planning Area (County of Sacramento, 2016)

Managing Rural Floodplains to Avoid Increased Flood Risk

As stated in the Delta Plan, "to reduce the risk to lives, property, and State interests in the Delta, additional standards are needed to address new residential development… the policies in [the Delta Plan] are designed to reduce risk while *preserving the Delta's unique character and agricultural way of life.* **These policies should be construed as those required to provide the minimum level of flood protection and should not be viewed as encouraging development in flood prone Delta areas.** Consistent with existing law, urban development in the Primary Zone should remain prohibited."

Locke is within the Primary Zone of the Legal Delta which means that local and County general plans and land use decisions must also be consistent with the Delta Plan. However, limited development within Locke along with several other communities in the Delta (Courtland, Hood, Ryde, and Walnut Grove) is permitted within 23 California Code of Regulations (CCR) Section 5010 (*Locate New Urban Development Wisely)*, which states that "new residential, commercial, and industrial development must be limited to the following areas… the unincorporated Delta towns of Clarksburg, Courtland, Hood, Locke, Ryde, and Walnut Grove." Furthermore, although 23 CCR Section 5013 (*Require Flood Protection for Residential Development in Rural Areas)* requires floodproofing for some new residential developments in rural areas, §5013(a)(4) specifically excludes the same unincorporated Delta towns identified above, including Locke (Figure 2-4). While land use must still be consistent with the County's SPA ordinance, the exemption from Section 5013 allows for development within the immediate community to be unconstrained by Delta-specific floodproofing requirements. These land use requirements help prevent uninhibited growth which can sometimes result from improvements to the flood control system in other portions of the Central Valley outside of the Primary Zone of the Delta.

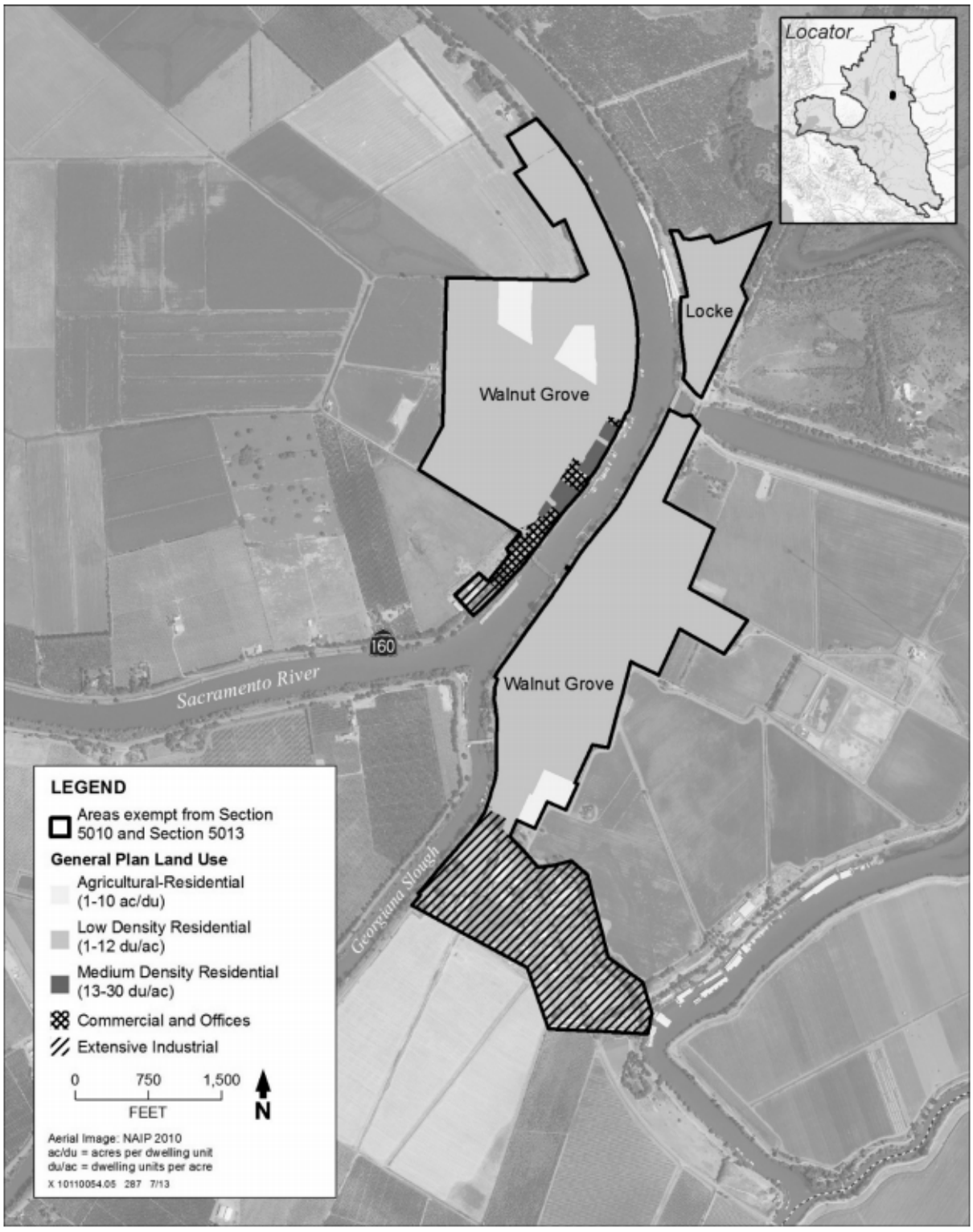


Figure 2-4. Locke Land Use under the Delta Plan (DSC, 2013)

2.1.4 Hydrology and Hydraulics

The Locke study area is bounded by the Lower Sacramento River and Snodgrass Slough and its tributary waterways. These waterways are also partially influenced by tidal conditions from the San Francisco Bay. The Sacramento River watershed is approximately 27,500 square miles and drains north to south. Flows in the Sacramento River are regulated by four major upstream reservoirs, namely Shasta, Oroville, New Bullards Bar, and Folsom. The upstream Yolo Bypass and Sacramento Bypass channels are currently designed and operated to divert as much as 75 percent of the total flood flows from the Lower Sacramento River. Systemwide improvements are planned and identified in the 2017 CVFPP Update to enlarge the Sacramento and Yolo Bypass and Weirs upstream of the Delta which will divert or shunt greater amounts of flood flows (greater than 75%) away from the Lower Sacramento River immediately adjacent to the Locke study area, including the community of Locke. Refer to Figure 1-4 – "Flood Stage Reductions as a Result of the BWFS Expansions and Modifications", located above in Section 1.7.2, that indicates a stage reduction of approximately 1 to 2 ft. at Locke due to the planned enlargements of the upstream bypasses and weirs.

Estimated existing 100-year flows and future 100-year peak flows adjusted for climate change and sea level rise which account for future systemwide improvements, along with predetermined USACE 1957 design flow and profile, are summarized in Table 2-2. Additional information on how these peak flows were estimated can be found in Appendix I. The existing 100-year peak flow in the Sacramento River from Steamboat Slough to Georgiana Slough is approximately 65,200 cubic feet per second (cfs). For this reach, the future 100-year peak flow is approximately 10 percent lower at 59,200 cfs, due to favorable upstream, system-wide improvements at the Sacramento and Yolo Bypass/Weirs.

Table 2-2. Sacramento River Existing and Future 100-Year Peak Flows and USACE 1957 Design Flows

Reach	Existing 100-Year Peak Flow (cfs)	Future 100-Year Peak Flow (cfs)	USACE 1957 Design Flows
Sacramento River, Steamboat Slough to Georgiana Slough	65,200	59,200	56,500

It should also be noted that, at some locations, the 100-year water surface profile "With Future Conditions" (inclusive of the upstream system-wide bypass/weir improvements, climate change adjustments and downstream sea level rise adjustments) is 1 to 2 feet higher than the USACE 1957 profile grade in the lower Sacramento River that is used as a guide for the operations and maintenance of the RD 369 perimeter levee system (*see* Figure 2-5 below).

The Sacramento River Basin Channel Capacity Atlas prepared by DWR in December of 2016 indicates that there may be a freeboard deficiency on the east/left bank of the levee system directly adjoining and upstream of Locke. The subject atlas also indicates the channel capacity

may be limited to only 63,100 cfs adjoining Locke at this location compared to the balance of this reach between Steamboat and Georgian Slough that has a larger conveyance capacity estimated at 68,700 cfs. This indicates the levee immediately upstream and adjoining the community of Locke is more susceptible to over-topping than any other portion of the Sacramento River levee system between Steamboat and Georgiana Sloughs. A close review of the existing levee crown elevation should be conducted in connection with any SPFC levee improvements proposed along the east/left bank levee (NULE Segment 121) protecting the community of Locke. *See* Appendix I for further details on the water surface elevations, current and future, that are anticipated for the Sacramento River and Snodgrass Slough located respectively along the west and east sides of the Locke study area.

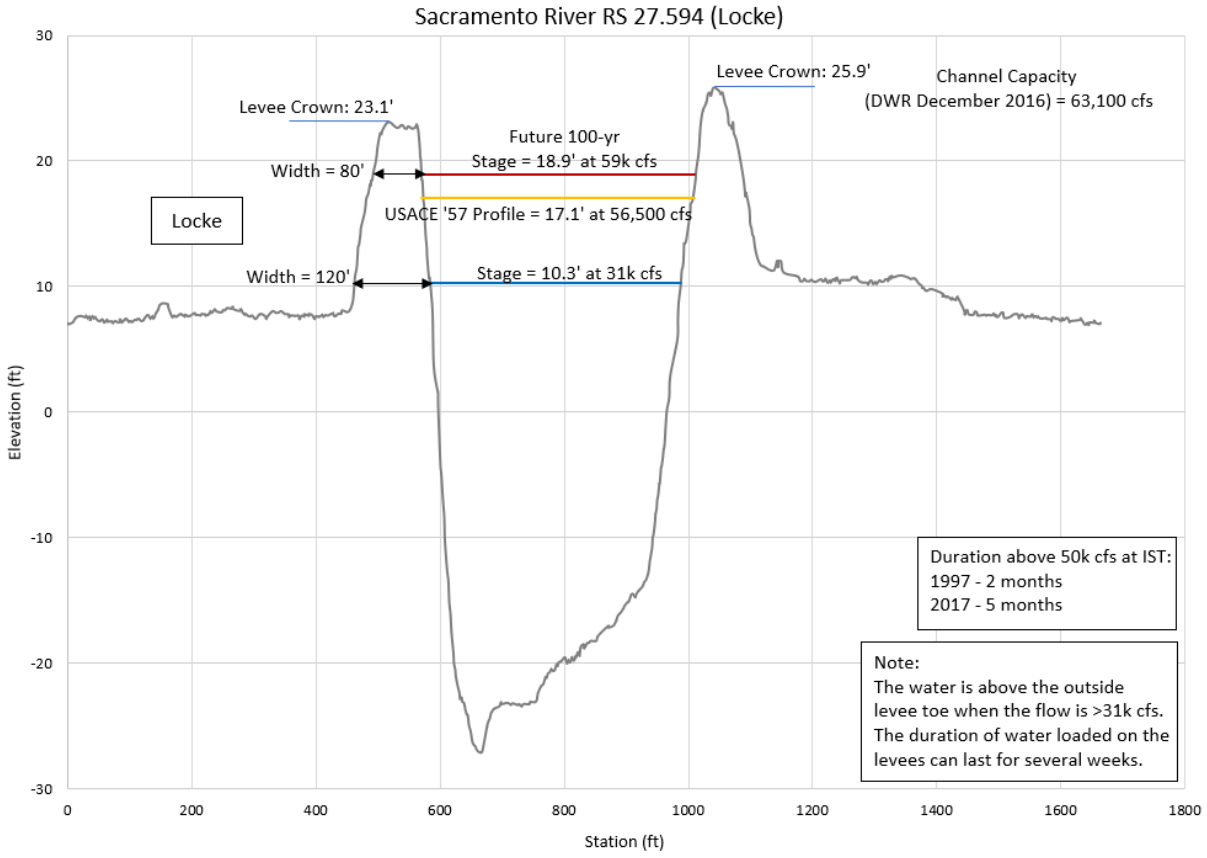


Figure 2-5. Cross Section at Sacramento River Station 27.594 at Locke Viewing Downstream

2.1.5 Water Resources and Water Conveyance

Delta waterways are important to North Delta communities and the State's water supply system. Locke lies along the Sacramento River and immediately upstream of the Delta Cross Channel. The Delta Meadows and Snodgrass Slough border Locke to the north and west. The Sacramento River and its adjoining levee system collectively provides vital agricultural water supply and flood protection to local farmers and also conveys water to areas throughout the State of California south of the Delta.

2.1.6 Existing Infrastructure

The community of Locke is served by the Sacramento Regional County Sanitation District, whose regional wastewater treatment plant is located on the north side of Elk Grove, approximately 15 miles northeast of Locke.

Critical infrastructure within the study area is shown in Figure 2-6. Critical infrastructure includes County maintained paved roads, boat launch, bridge, water wells, and oil/gas wells.

Infrastructure is a critical input in evaluating flood damage, which informs flood risk. The 2017 CVFPP Update inventoried structures, vehicles, highways, and streets within the Locke study area to evaluate the annualized EAD for the Locke study area, which were updated during the course of this study as part of the 2022 CVFPP Update. These inventories are largely provided within the discussion of flood risk to the study area in Section 3.1.1.4.

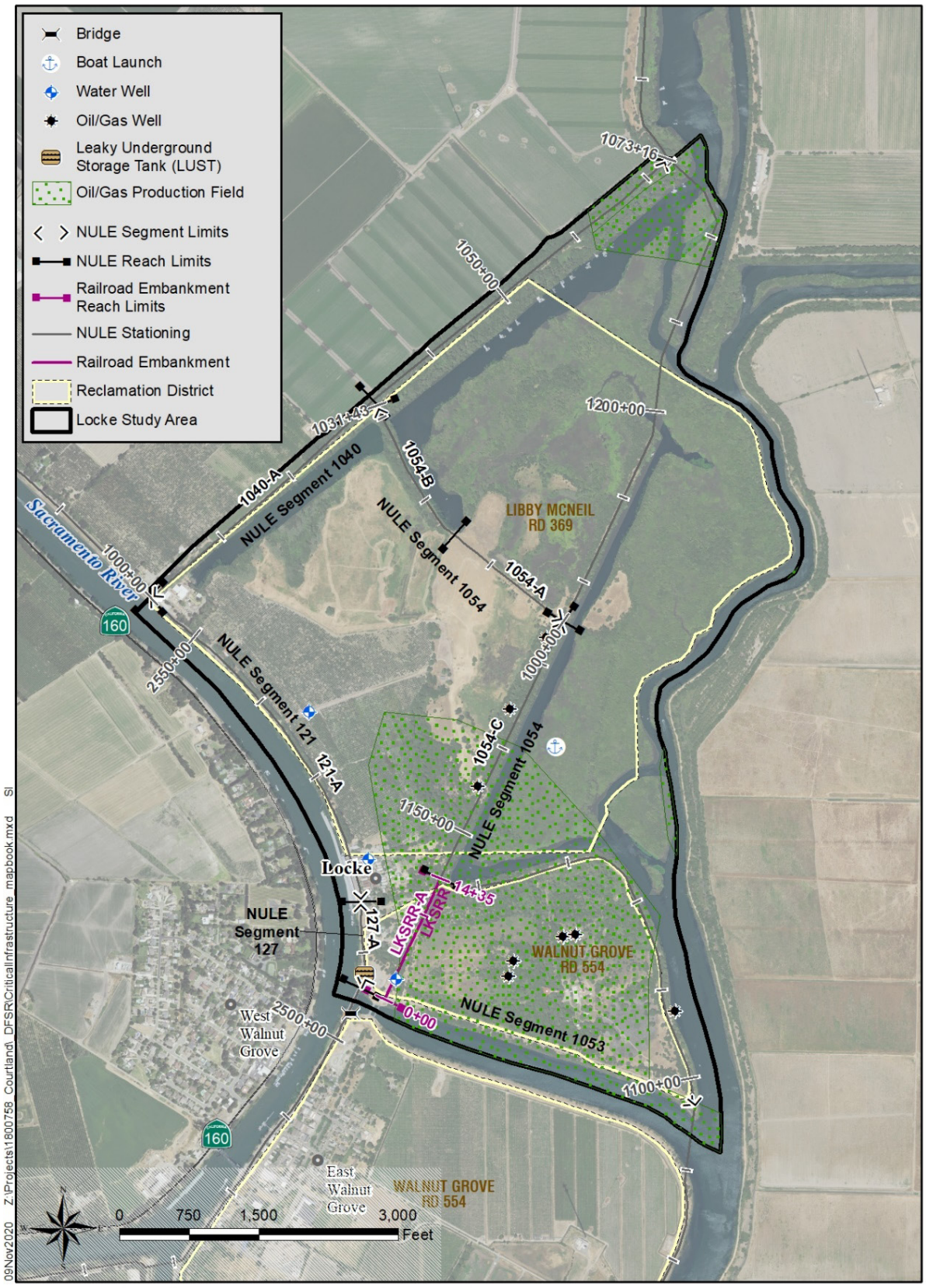


Figure 2-6. Critical Infrastructure within the Study Area

2.1.7 Biological Resources

According to the U.S. Fish and Wildlife Service (USFWS) National Wetland Inventory database, a mosaic of freshwater forested/shrub wetland, freshwater emergent wetland, and riverine features are found in the study area. The Sacramento River is the primary aquatic feature within the study area, located adjacent to the western boundary of the study area. The Meadows Slough is situated at the northwestern boundary of the study area and the Delta Meadows State Park.

The majority of the area bounded by the study area's levee system is designated as farmland (Figure 2-7). Prime farmland, which accounts for approximately 22 percent of the leveed area of interest, is located along a portion of Delta Meadows Slough, and along the Sacramento River north of the densely populated community of Locke. The remaining area is generally designated as farmland of local importance.

When conducting work on the waterside slopes, particularly below the ordinary high-water lines in any waterways in the north Delta, and particularly within the Lower Sacramento River and adjoining sloughs, work is normally limited to the short 3-month construction period of August 1 through October 31 due to the presence of special-status and endangered fish species and supporting habitat.

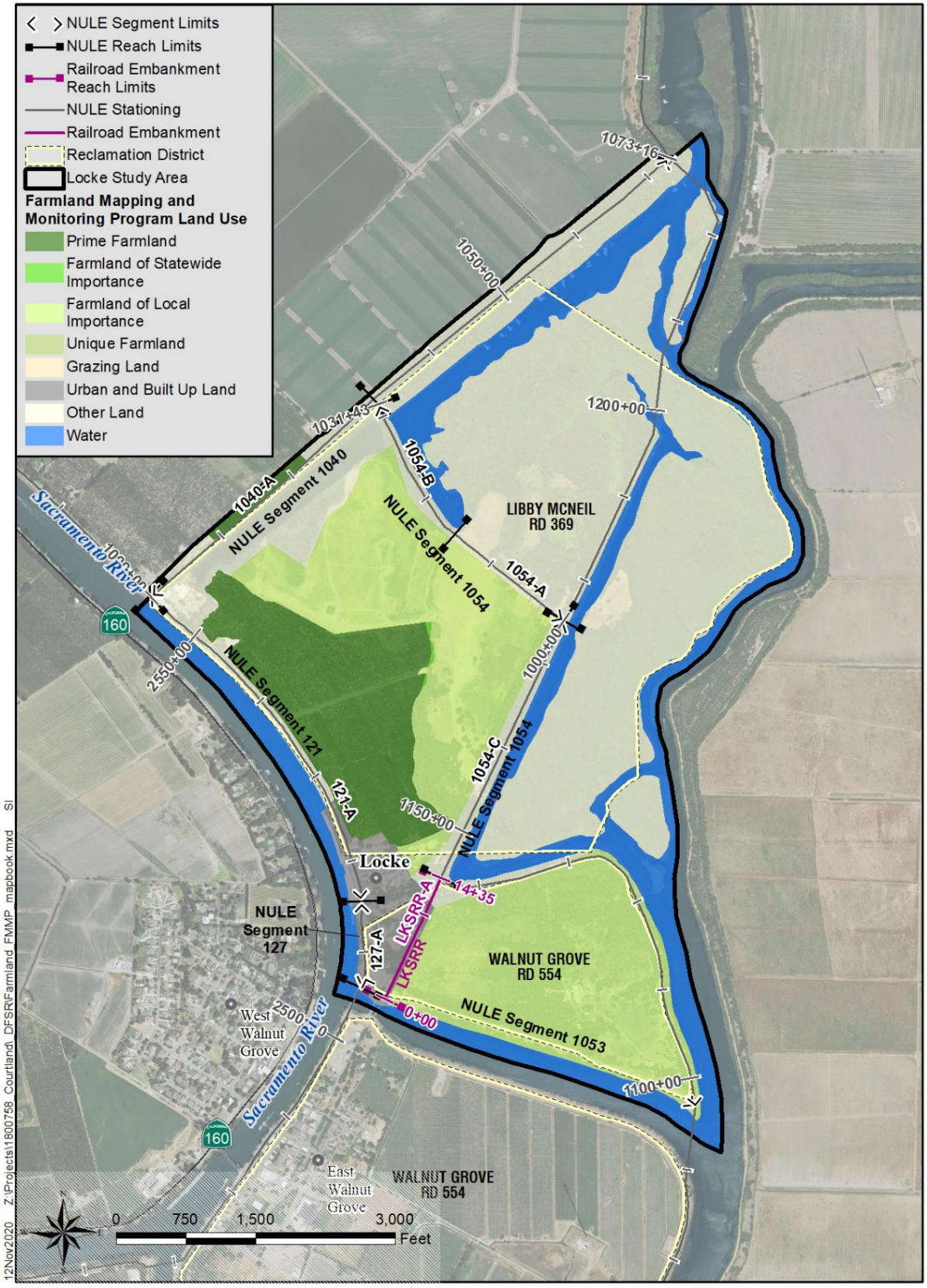


Figure 2-7. Farmland Designations within the Study Area

Vegetation classifications include a crosswalk between Central Valley Riparian Mapping Project (CVRMP) and the United States National Vegetation Classification Standard, whereby habitat is defined by CVRMP. There are eight vegetation communities within the study area (Figure 2-8). The majority of the study area is comprised of other vegetation types including riparian forest, riparian scrub, marsh, and seasonal wetland. Agricultural land in limited and is typically orchard of entirely pear.

Sixteen special-status plant species and 37 special-status wildlife species are documented or have potential to occur in the study area. The study area also supports suitable habitat for five special-status fish species. Designated USFWS and National Marine Fisheries Service (NOAA) critical habitat and Essential Fish Habitat also occur within the Sacramento River and border the study area.

See Appendix B for additional information on biological resources within the study area.

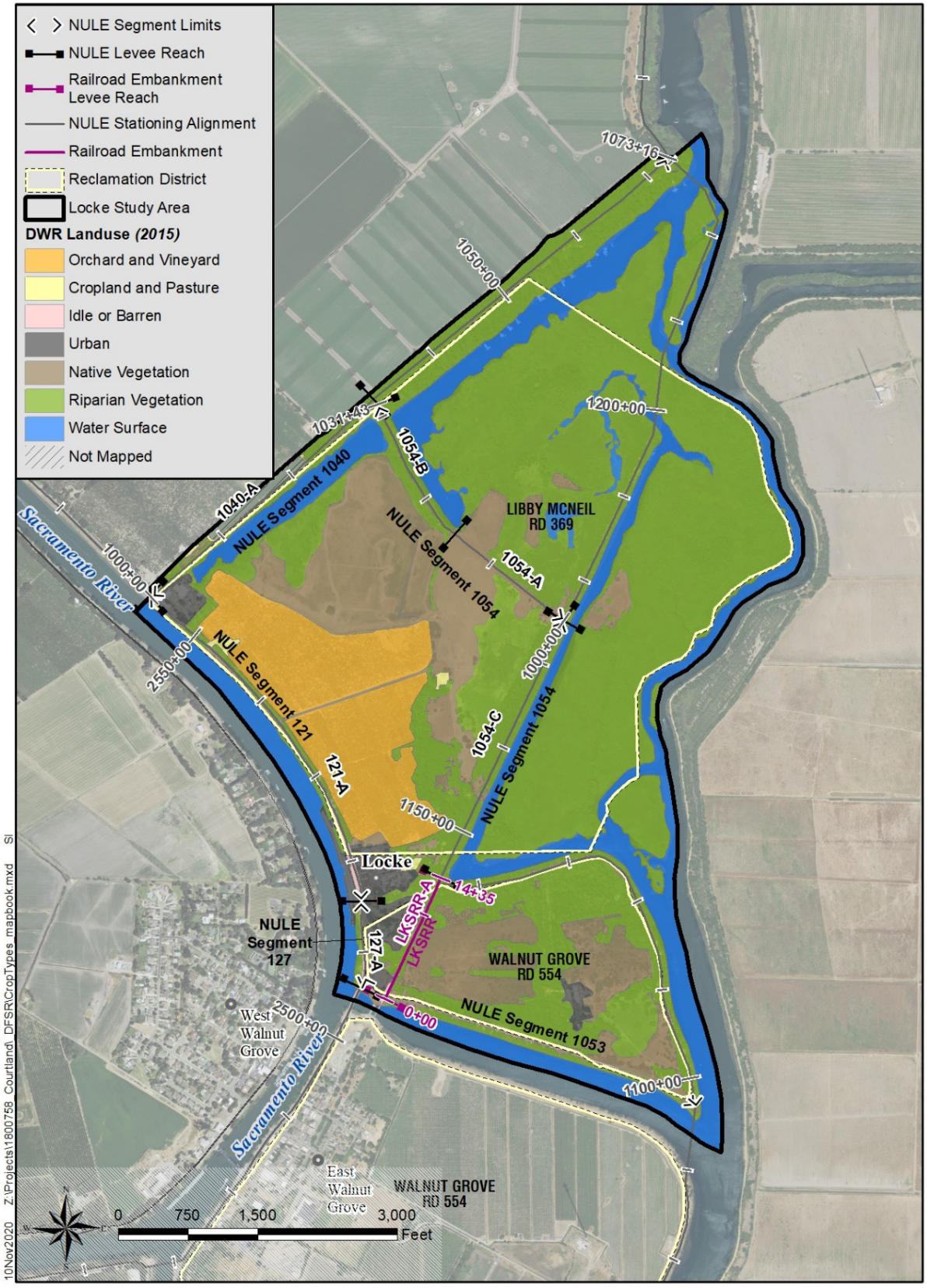


Figure 2-8. Crop Types within the Study Area

2.1.8 Cultural Resources

According to a records search conducted at the North Central Information Center (NCIC), a total of 13 cultural resources are within the study area. Of those, 2 are prehistoric archaeological sites, 1 is a multicomponent (containing both prehistoric and historic era artifacts) archaeological site, and the remaining 10 are built environmental resources dating to the historic era. Two of the built environment resources, the Walnut Grove Branch Line Railroad (P-34-001497) and the Locke Historic District (P-34-002357), have been determined eligible for listing in the National Register of Historic Places (NRHP) and the California Register of Historical Resources (CRHR); the Locke Historic District is comprised of 53 contributing elements, however the NCIC only provided information on 47 of those elements. Of the remaining 8 listed resources, 7 are individually eligible for listing but are also contributing elements to the Locke Historic District and the status of the remaining resource is unclear. The built environment resources are located throughout the project area but are concentrated in the town of Locke itself; some of the resources do not have specific addresses (such as the railroad).

The historic resources located within the Locke study area, including the Locke Historic District and the Walnut Grove Branch Line Railroad, are shown in Figure 2-9.

In addition to the above resources located within the Locke study area, the entire study area is itself also a part of the Sacramento-San Joaquin Delta National Heritage Area (SSJDNHA). Established on March 12, 2019, the SSJDNHA, the first National Heritage Area established in California, supports historic preservation, natural resource conservations, recreation, heritage tourism, and educational projects within and beyond the Primary Zone of the Delta, but otherwise has no effect on water rights, property rights, or hunting and fishing rights within the designated area.

See Appendix C for additional information on cultural resources within the study area.

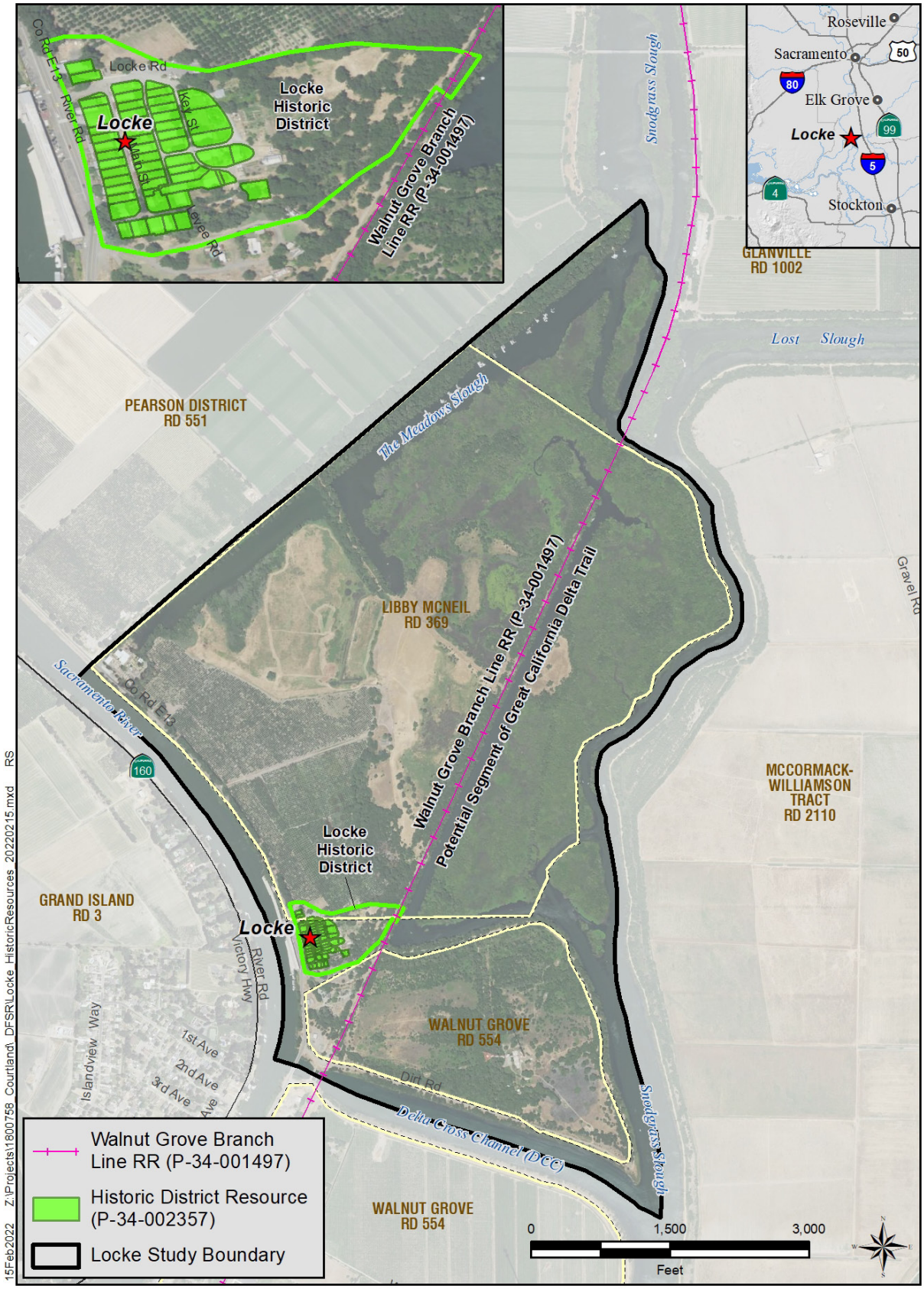


Figure 2-9. Historic Resources within the Study Area.

3. Problems, Opportunities and Constraints

3.1 Problems

In order for Locke to thrive into the future as the wonderful place that it is, the issue of flood risk must be addressed. There are about 5 miles of levee surrounding the Locke study area and a breach anywhere would cause widespread flooding putting the community of Locke at risk of significant flood damage, including the potential loss of lives.

Other issues for the study area include escalating NFIP insurance premium rates, vulnerability of levees protecting through-Delta water conveyance, compliance with current FEMA accreditation standards, agricultural sustainability, threatened ecosystems, and threats from climate change and sea level rise.

3.1.1 Flood Risk

In the 2012 CVFPP, flood threats to small communities were characterized using attributes related to flood frequency, potential flood depth, and proximity to the nearest river. These characterizations were then used to prioritize the small communities into four categories (DWR, 2012b):

- **Group A (Flood Threat Level: High Hazard)**: Communities subject to high flooding frequency (greater than 1 percent per year) and also subject to deep flooding conditions (potential flood depths exceeding 3 ft. on average).
- **Group B (Flood Threat Level: Moderate to High Hazard)**: Communities subject to high flooding frequency (greater than 1 percent per year), subject to sheet flooding conditions (potential flood depths of less than 3 ft. on average), and less than 2 miles from a major flooding source.
- **Group C (Flood Threat Level: Low to Moderate Hazard)**: Communities subject to high flooding frequency (greater than 1 percent per year), subject to sheet flooding conditions (potential flood depths of less than 3 ft. on average), and more than 2 miles from a major flooding source.
- **Group D (Flood Threat Level: Low Hazard)**: Communities that are not subject to high flooding frequency (less than 1 percent per year).

Of those small communities protected by SPFC levees throughout the entire Central Valley, a total of eight were prioritized as High Hazard, including the communities of Locke, Courtland, Hood, East Walnut Grove, West Walnut Grove, and Ryde. Consequently, flood risk to these communities, inclusive of the community of Locke, is the highest relative to flood threats in the larger Central Valley, warranting improved flood protection in these areas.

Within the context of this feasibility study, flood risk is the largest issue facing the Locke study area. In the event of a levee failure, particularly on the levee immediately fronting and upstream of the community, Locke and the larger study area could see both life loss and significant property damage.

Flood risk is used as a basis to develop and prioritize flood risk reduction MAs for the purposes of this feasibility study. Flood risk is defined as:

Flood Risk = Probability of a Levee Failure x Consequences of a Levee Failure

Probability of levee failure within the Locke study area has been historically evaluated by the DSC in the DLIS, by DWR in the FSRP, 2017 CVFPP Update, and through the NULE program. These estimates are provided in Section 3.1.1.2.

Within the context of this study, consequences of levee failure are defined in terms of life loss and property damage. Life loss and property damage as a result of flooding within the Locke study area has historically been evaluated by DWR as part of the 2012 CVFPP and 2017 CVFPP Update and are being re-evaluated as part of the 2022 CVFPP Update. Current life loss estimates for the Locke study area are provided in Section 3.1.1.3, and an inventory of property at risk of flooding is provided in Section 3.1.1.4.

The number of lives lost and the extent of property damage as a result of a levee failure also depend on several factors, including depth of flooding, inundation time, and floodwater velocity. Expected flood depths and inundation time within the study area have been estimated as part of the preparation of the Delta Flood Emergency Safety Plan (ESP) for RDs 369 and 554 and are summarized in Sections 3.1.1.5 and 3.1.1.6.

3.1.1.1 History

There is no record of flooding on RD 369 – Libby McNeil in recent decades. There has never been a levee failure or flood event in the northern portion of RD 554 located within the southern portion of the study area.

3.1.1.2 Probability of Levee Failure

As previously discussed, the probability of levee failure within the study area has been historically evaluated by DWR as part of the FSRP, the NULE program, the 2017 CVFPP Update, and by the DSC as part of the DLIS. The collective CVFPP and FSRP analyses aggregated the level of flood protection by impact area. The levels of flood protection offered by the current levee system(s) as detailed in the 2017 CVFPP Update were updated with new geotechnical information during the course of this study. Levee performance curves were collectively updated by DWR and Sacramento County for each of the project levee segments in the study area and are provided in Appendix E. With updates to these levee performance curves, the SAC 51 (RD 369) impact area is estimated to have a 29-year level of flood protection at the USACE 1957 Assessment Water Surface Elevation (AWSE). This is largely based upon the

performance conditions of the SPFC levee fronting community along the east or left bank of the Sacramento River, and not the lower rated non-SPFC levees east of Locke along Snodgrass Slough.

DLIS analyses suggest that the SAC 51 impact area has an estimated 50-year level of flood protection. Based upon empirical data and history provided above in Section 3.1.1.2, the latter estimate of a 50-year level of flood protection is more applicable, particularly when comparing to the current, modern standard of obtaining a 100-year level of flood protection in accordance with FEMA's accreditation standards, pursuant to 44 CFR §65.10.

DWR's NULE Geotechnical Assessment Report (GAR) qualitatively evaluated probability of failure for the Locke study area (Table 3-1). For each NULE segment, four potential failure mechanisms (underseepage, slope stability, through seepage, and erosion) were evaluated and the segment was categorized based on its overall vulnerability (low, moderate, high) to the various failure mechanisms. Segments were categorized as low, moderate, or high, based on the likelihood of either levee failure or the need to flood fight to prevent levee failure at the USACE 1957 design water surface elevation (WSEL). These analyses found NULE Segment 121 (RD 369) and NULE Segment 127 (RD 554) along the Sacramento River, adjacent to Locke and north to Delta Meadow Sloughs, to have a low likelihood of levee failure at the 1955/57 design WSEL. Along the northern edge of the RD 369 basin the levee common with RD 551, NULE Segment 1040, was assessed to have a moderate likelihood of levee failure at the assessed WSEL (assigned as 1.5 ft. below levee crest) based on potential vulnerability to underseepage and stability. For the rest of the basin, the Delta Meadows Cross Slough non-SPFC levees and the non-SPFC levees along Snodgrass Slough (NULE Segment 1054) were identified to be lacking sufficient data to fully assess the likelihood of levee failure at the assessed WSEL (assigned as 1.5 ft. below levee crest). Based on available site condition information, moderate to high underseepage, through seepage, and stability potential was identified for NULE Segment 1054 but past performance documentation was not available to correlate these risks. These same values are currently being updated by DWR during the course of this feasibility study.

Table 3-1. Summary of NULE GAR Assessment Results for the Locke Study Area (URS, 2011a)

Levee Segment Location	NULE Segment	Overall Segment Characterization	Results by Individual Failure Mechanism			
			Under-seepage	Slope Stability	Through Seepage	Erosion
Left Bank Sacramento River - RD 369 (SPFC levee)	121	Low	Low	Low	Low	Low
Left Bank Sacramento River - RD 554 (SPFC levee)	127	Low	Low	Low	Low	Low
Delta Meadows Slough - RD 551/RD 369 (Non-SPFC levee)	1040	Moderate	Moderate	Lacking Sufficient Data (Low to Moderate)	Low	Low
Right Bank Delta Meadows Cross Slough and Right Bank Snodgrass Slough - RD 369 & RD 554 (Non-SPFC levee)	1054[2]	Lacking Sufficient Data (Moderate to High)	Lacking Sufficient Data (Moderate to High)	Lacking Sufficient Data (Moderate to High)	Lacking Sufficient Data (Moderate to High)	Low

3.1.1.3 Life Loss

The 2017 CVFPP Update estimated potential life loss on an annualized basis for the subject impact area: SAC 51 (RD 369 and the northern portion of RD 554 located north of the Delta Cross Channel, inclusive of Locke). Life loss on an annualized basis was analyzed in the 2017 CVFPP Update for a series of scenarios over a 60-year period of 2007 to 2067. The baseline scenario included an approximation of system performance prior to 2007, before implementation of system improvements in the Sacramento basin. Four other scenarios were also analyzed which considered, to varying degrees, the impact of implementation of DWR flood control projects, non-structural systemwide actions including enhancement of flood preparedness and warning notifications, larger-scale actions such as widening the Sacramento Weir and Yolo Bypass system(s), climate change, sea-level rise and population and land use changes. For all five scenarios, no life loss on an annualized basis was estimated for the SAC 51 impact area, including for the 2007 baseline case (DWR, 2017c).

[2] NULE segment extends beyond RD 369, NULE assessment for segment as a whole

Life loss on an annualized basis was also estimated as part of the DLIS. From this analysis, expected annual fatalities for the Locke study area were also estimated to be zero (DSC, 2017).

A levee breach immediately fronting the community of Locke could result in floodwater depths in the community of Locke in excess of 10 feet combined with floodwater velocities in excess of 5 feet per second. Combined floodwater depths and velocities in this scenario would result in little to no warning time for evacuation, which poses imminent flood threats to the community of Locke and would very likely result in life loss.

Instantaneous flooding with combined high flood depths and velocities into homes is a messy, dangerous situation likely resulting in loss of lives and costly cleanup expenses.

3.1.1.4 Property Damage

Structure counts, agricultural acreage, vehicle counts, and total miles of highways and streets, along with their associated values, were quantified as part of the 2017 CVFPP Update. These inventories and their associated values were updated as part of the 2022 CVFPP Update efforts during the course of this study. Within the study area, the value of structures, vehicles, agricultural crops, and highways and streets total over $24.9M in 2020 dollars:

- Total estimated depreciated replacement value of the 71 structures in the Locke Study area (RDs 369 and 554): $22.5M
- Total estimated vehicle value: $1.4M
- Total estimated value of agricultural crops: $536,000
- Total estimated value of highways and streets: $463,000

Structures at risk of flooding are summarized in Table 3-2. The Locke study area contains approximately 71 structures, with the majority of these located within the community. As part of the 2017 CVFPP Update, depreciated replacement values for these structures and contents were defined for the SAC 51 impact area, which were updated as part of the 2022 CVFPP Update. As shown in Table 3-3, the total depreciated replacement value for the Locke study area escalated to 2020 dollars is over $22.5M, with residential and commercial structures comprising the majority of this value.

Table 3-2. Structures within the Locke Study Area (HDR, 2021).

CVFPP Impact Area (area in acres)	Total Structures Count				
	Residential	Commercial	Industrial	Public	Total
SAC 51 (inclusive of RD 369 and a portion of RD 554 north of the Delta Cross Channel) (760 acres)	41	23	4	3	71

Table 3-3. 2022 CVFPP Depreciated Replacement Value for Locke (HDR, 2021).

CVFPP Impact Area (area in acres)	Depreciated Replacement Value				
	Residential	Commercial	Industrial	Public	Total
SAC 51 (including RD 369 and a portion of RD 554 north of the Delta Cross Channel) (760 acres)	$13,170,000	$7,151,000	$1,252,000	$960,000	$22,533,000
Average Depreciated Value of Structures	$313,000	$311,000	$313,000	$320,000	$317,000

Notes: Costs are reported in quarter 1 2020 dollars

The total amount of vehicles and their estimated value, along with the acreage of agricultural crops in the study area and their estimated worth, are summarized for the study area in Table 3-4. and Table 3-5 below. In summary, the total vehicle value within the study area is nearly $1.4M in 2020 dollars, and pear orchard crops within the study area are valued at nearly $536,000 in 2020 dollars, with the majority of these crops adjacent to NULE Segment 121 in RD 369, north of Locke.

Table 3-4. Vehicle Count and Value for the Study Area (HDR, 2021).

CVFPP Impact Area (acres in acres)	Total Vehicle Count	Total Vehicle Value
SAC 51 (including RD 369 and a portion of RD 554 north of Delta Cross Channel) (760 acres)	154	$1,386,000

Notes: Costs are reported in quarter 1 2020 dollars

Table 3-5. Agricultural Acreage and Total Value for the Study Area (HDR, 2021).

CVFPP Impact Area (acres in acres)	Agricultural Acreage (acres)									Total Value
	Citrus	Deciduous Pears	Field	Grain	Pasture	Rice	Truck	Vineyard	Total	
SAC 51 (including RD 369 and a portion of RD 554) (760 acres)	0	80	0	0	50	0	0	0	130	$536,000

Notes: Costs are reported in quarter 1 2020 dollars

The total miles of highways and streets and their associated values are summarized for the Locke study area in Table 3-6 below. There are no highways within RD 369 or the portion of RD 554 north of the Delta Cross Channel. Within the Locke study area, streets totaling 2.6 miles in cumulative length are valued at $463,000 in 2020 dollars.

Table 3-6. Total Miles of Highways and Streets and Value for the Study Area (HDR, 2021).

CVFPP Impact Area (area in acres)	Highways Miles	Total Highways Value	Streets Miles	Total Streets Value	Total Value of Highways and Streets
SAC 51 (inclusive of RD 369 and a portion of RD 554) (760 acres)	0	$0	2.6	$463,000	$463,000

Notes: Costs are reported in quarter 1 2020 dollars

Baseline (or without project) EAD estimates for the Locke study area have also developed as part of the 2022 CVFPP Update efforts (Table 3-7). As previously discussed, EAD is a common metric used to estimate risk within the Delta and other components of the Sacramento River Flood Control Project (SRFCP). EAD is calculated on an annualized basis and represents the annual average expected damages through the consideration of potential flooding conditions. Baseline EAD estimates incorporate updated levee performance curves and are provided for existing conditions and future conditions. Baseline EAD values under existing conditions include the existing conditions of the flood management system(s) in the Central Valley and includes projects that have been authorized and have funding, or that have started construction or implementation under the 2022 CVFPP. Baseline EAD values under future conditions have the same features as the existing conditions, with the addition of the effects of inland climate change projections and sea level rise. As shown below in Table 3-7, the total baseline EAD for the Locke study area under existing conditions is estimated at nearly $363,000 in 2020 dollars. With the effects of climate change and sea level rise, baseline EAD for the Locke study area under future conditions is estimated at over $1.5M in 2020 dollars. It should be noted that the EAD analyses utilized the hydrologic and hydraulic (H&H) models developed specifically for the CVFPP 2017-2022 updates by DWR's consultant team, and not the H&H models prepared by the GEI Consultant Team in Appendix I.

Table 3-7: 2017-2022 CVFPP EAD Values for SAC 51 (HDR, 2021)

Impact Area	EAD[3], Existing Conditions	EAD[4], Future Conditions with Climate Change Adjustments
SAC 51: Locke	$363,000	$1,533,000

3.1.1.5 Flood Depths and Velocities

Inundation mapping was conducted in May 2017 for RD 369 as part of Sacramento County's Flood ESPs for the RDs collectively located in the North Delta and in Sacramento County. For the Locke study area, a hypothetical levee breach upstream of the community of Locke (along

[3] EAD as defined by the 2022 Without-Project Scenario from the 2022 CVFPP.
[4] EAD as defined by the Future Without-Project Scenario from the 2017 CVFPP.

NULE Segment 121) was modeled to estimate potential flood depths and inundation times within the study area.

Based on this analysis, flood depths and corresponding velocities are predicted to reach 10 feet along the SPFC levees located along the left bank of the Sacramento River, with flood depths increasing towards 15 feet near the terminus of the Delta Meadows Slough levee (NULE Segment 1040) and the Delta Meadows Cross Slough levee (NULE Segment 1054), as well as near the terminus of the Meadows Cross Slough levee and the Snodgrass Slough levee (former railroad embankment). Maximum flood depths within the study area as a result of a levee breach at this location are estimated to reach above 17 feet. In the community of Locke, flood depths are predicted to reach near 10 feet, with some areas flooding in excess of 10 feet near the border of RD 369 and RD 554 (Figure 3-1). As shown in Figure 3-1, denoted by the arrows extending from the hypothetical breach in RD 369, these flood depths are representative of a levee breach anywhere along NULE Segment 121 in RD 369, and depicts worse case flood depths that could occur in RD 369 with a levee breach along the Sacramento River in the project study area at or upstream of the community of Locke. Flood depths could actually be reduced by 5 to 6 feet or more as shown in Figure 3-1 down to the Base Flood Elevation (BFE) of 17 feet NAVD 88 indicated if a downstream relief cut could be implemented in the lower reaches of RD 551 into Snodgrass Slough (*see* Section 5.2.9 for more information).

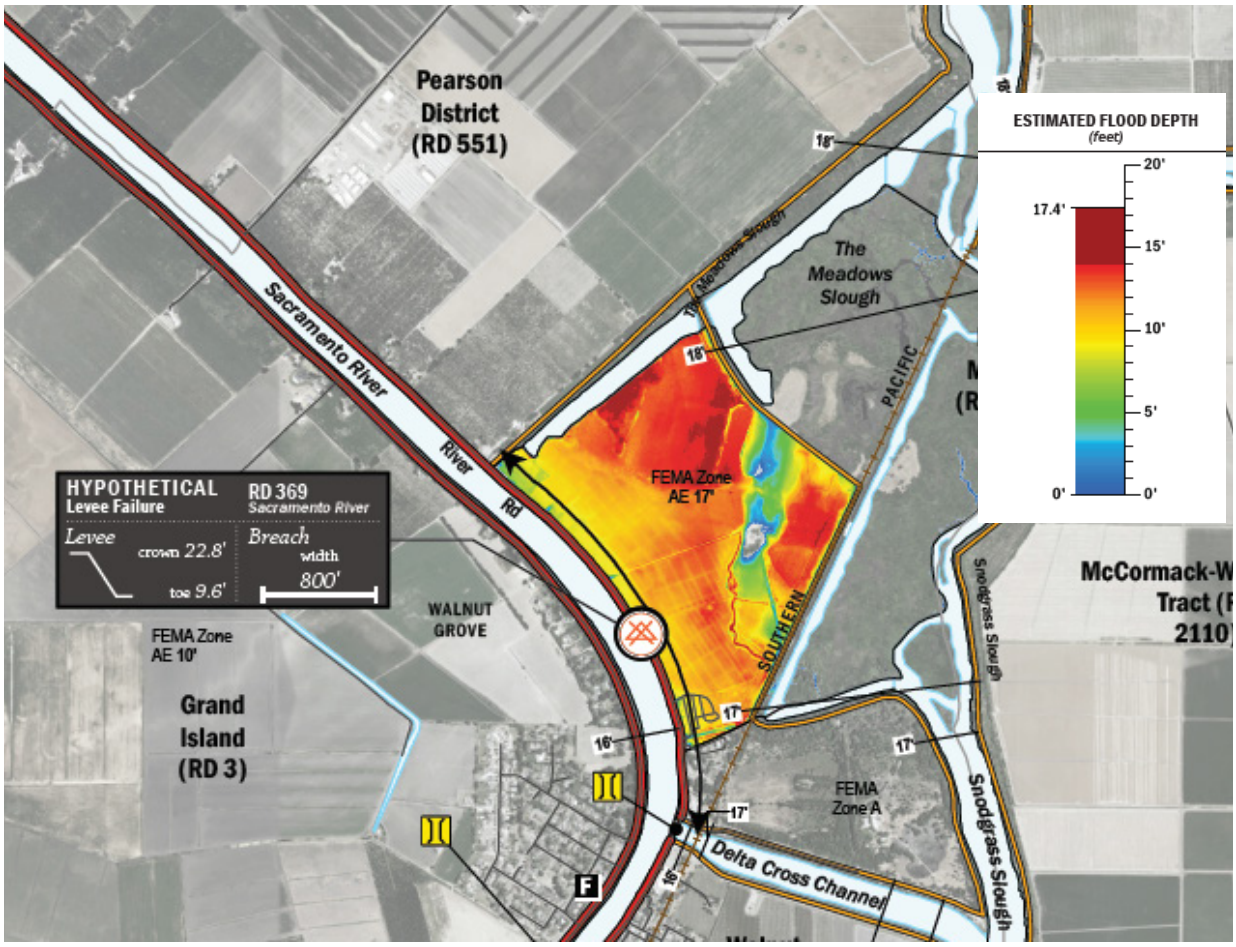


Figure 3-1. Study Area Maximum Flood Depths (Dynamic Planning + Science, 2017).

3.1.1.6 Inundation Time

Using the same breach location discussed in the preceding Section 3.1.1.5, the time to 1 foot of inundation for the Locke study area was estimated as part of the inundation mapping performed for the RD 369 Delta Flood ESP. For the majority of the study area, including the community of Locke, inundation to 1 foot is nearly instantaneous ranging between 0 to 2 hours.

For more information on flood risk and to view a hypothetical flood simulation of the Locke study area, visit the Locke Story Map developed by Sacramento County located here: [Locke Story Map - Sacramento County Small Communities Flood Risk Reduction Program](). [5]

[5] Locke Story Map - Sacramento County Small Communities Flood Risk Reduction Program: https://sacramentocounty.maps.arcgis.com/apps/MapJournal/index.html?appid=277f1bd2979b4cc2adb068ec234daa33

3.1.2 Escalating NFIP Insurance Premium Rates

Delta legacy communities are subject to deep flooding behind a combination of federal/State authorized (SPFC) levees and non-SPFC, private levees. However, most all Delta legacy communities have **not** flooded in the last 100 years due to oversized levees with surplus freeboard and low to moderate risk of levee failure.

Flood risk can be determined using information from FEMA's Flood Insurance Study (FIS) in conjunction with FIRMs. FIRMs delineate SFHAs, which are defined as areas that will be inundated by the 100-year flood event. These areas include lands and improvements behind levees that are not fully accredited by FEMA in accordance with 44 CFR §65.10. The current FIS for Sacramento County is dated August 16, 2012 (FEMA, 2012). The community of Locke, as shown in Figure 3-2, is located within Zone AE, which, as defined by FEMA, is "subject to inundation by the one-percent-annual-chance flood event determined by detailed methods." According to Figure 3-2 excerpted from the FEMA FIRM the majority of the Locke study area is subject to flooding in Zone AE to a BFE of 17 feet NAVD 88. It should be noted that the BFE of 17 feet NAVD 88 assumes that a relief cut can be deployed at the downstream, lower gradient of the subject study area. The southern portion of the study area in RD 554 north of the Delta Cross Levee is subject to flooding in Zone A, which, as defined by FEMA, is also subject to inundation by the one-percent-annual chance flood event; however, no BFEs are shown for this small portion of RD 554.

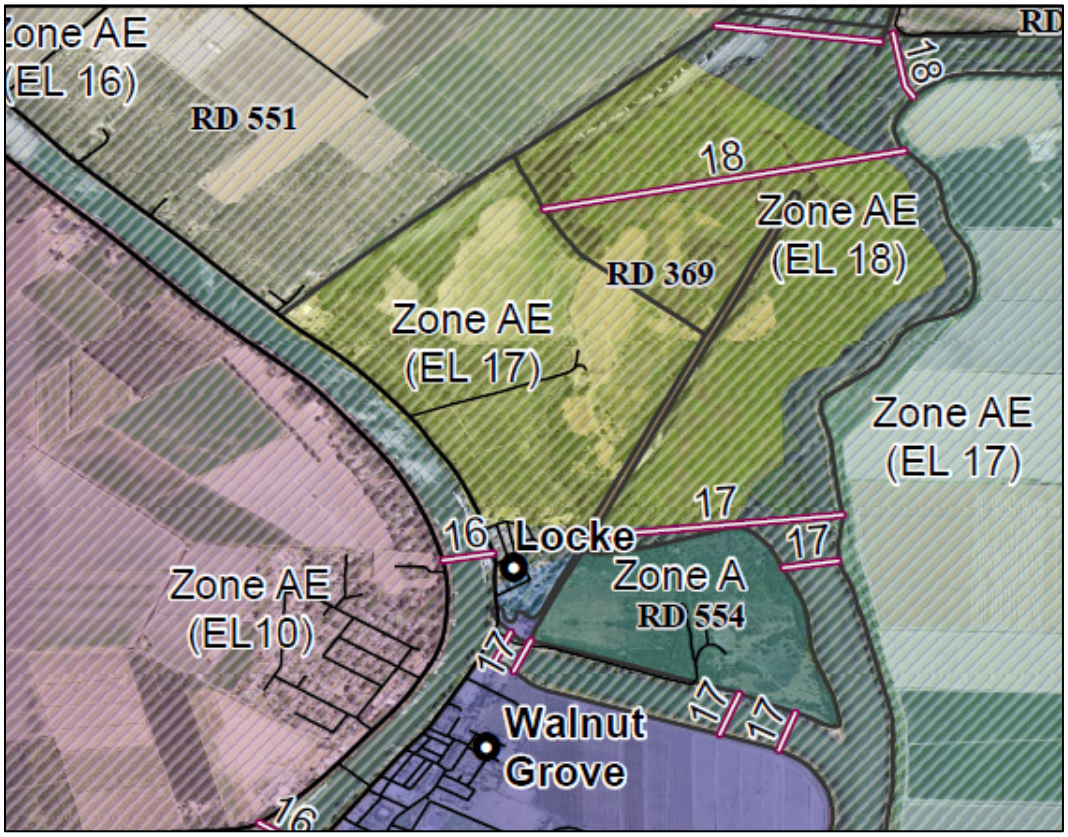


Figure 3-2. Locke's 100-Year BFE Floodplain Recognized by FEMA.

Flood insurance through the NFIP is mandatory for buildings with a federally backed mortgage located in a SFHA. These premiums have been steadily on the rise since the passage of flood insurance reform laws including BW-12 of 2012 and the HFIAA of 2014. Under HFIAA, policyholders can expect to see gradual increases in annual premiums until they reach a rate that the NFIP deems to be actuarially based. Effective April 1, 2018, NFIP annual premiums increased by eight percent from $866 per policy to $935 per policy, not including HFIAA surcharges or other fees (FEMA, 2017). In October 2019, FEMA announced that beginning on April 1, 2020, annual renewal premiums would increase by 11.3 percent (FEMA, 2019a). This rate restructuring has been postponed to October 2021 according to FEMA as of November 7, 2019 (FEMA, 2019b).

For those who do not already have a current NFIP policy, they will be rated by FEMA based on the elevation of the living quarters of their structure(s) relative to Locke's BFE of 17 feet NAVD 88. Sacramento County currently enjoys up to 40 percent discount on flood insurance costs due to the County's high Community Rating System (CRS) score, which is one of the top five CRS scores in the entire nation. Still, the rates are rising rapidly. Many NFIP policies in Locke are grandfathered in at low rates that increase each year until reaching the rate based on an elevation certificate. *For example: if the floor of a house is 4 feet below the FEMA BFE of 18 feet in Locke, with a cost of $200,000 per dwelling structure and $40,000 for structure contents, the new (non-grandfathered) NFIP premium would be $6,804 per year plus fees (and this is with the County's favorable 40 percent discount with its high CRS score).*

As NFIP flood insurance rates increase the number of insured structures decrease. As a result, the community of Locke is increasingly and significantly under insured. While there are an estimated 71 structures in the Locke study area valued with an estimated replacement value of $22.5M[6], there are only 5 NFIP policies (valued at $350,000 maximum per policy inclusive of structure contents, presently capped at $250,000/structure and $100,000 for structure contents) providing less than $2M[7] in coverage.

To remove the entire project study area from the current FEMA BFE of 17 feet NAVD 88, the entire combined perimeter levee system would require reparing and strengthening in-place to current, modern engineering standards, consistent with the FEMA 100-year accreditation standards contained in 44 CFR §65.10. Click here[8] to learn more about achieving a 100-year level of flood protection pursuant to the current FEMA accreditation standards.

Levees protecting the Delta Legacy Communities fall well short of meeting current seepage and stability criteria pursuant to 44 CFR §65.10.

[6] The FEMA open source data is aggregated by zip code. This estimate is representative of SAC 51 from the draft 2017 CVFPP Update – Technical Analyses Summary Expanded Report, 2017, and has been escalated to July 2020 dollars.
[7] These estimates are sourced from the FEMA Open Source policy database.
[8] FEMA Guidance for Flood Risk Analysis and Mapping - Levees: https://www.fema.gov/sites/default/files/documents/fema_levee-guidance.pdf

The current cost estimate of such levee repairs/improvements for strengthening in place to achieve FEMA accreditation for just the community of Locke and the entire study area are provided in Sections 6.2.6 and 6.2.6, respectively.

3.1.3 Vulnerability of Levees Providing Through-Delta Water Conveyance

> *"Maintenance and improvement of the current in-channel river conveyance system for the CVP and SWP water supply system(s) is a vastly better solution than a single-purpose tunnel as presently proposed by the Delta Conveyance Authority"* – Sacramento County Floodplain Administrator

There are more than 1,100 combined miles of SPFC and non-SPFC levees in the Delta which convey water to 750,000 acres of farmland within the Delta for irrigation. Some, but not all of these levees in concert with the adjoining river channels convey water toward the Clifton Forebay, which pumps the water south serving the needs of approximately 3M acres of agricultural lands and a population of 27M. Some of these same levees serve to protect the community of Locke, which relies on this critical infrastructure to sustain the local agriculture economy, thus preserving the community's rich agricultural and historical heritages. While the DWR NULE evaluations estimate a low likelihood of failure or the need to flood fight for the SPFC levees located along the left bank of the Sacramento River (NULE Segments 121 and 127), these levees are still vulnerable to climate change, which can intensify rain events and heighten flood risk, and the risk of a seismic event in the future which could cause the levees to fail.

Maintenance and improvement of the current in-channel river conveyance system for the CVP and SWP water supply system(s) is a vastly better solution than a tunnel as presently proposed by the Delta Conveyance Authority (DCA). It's cheaper, it's ecologically friendly, it protects the "Delta as a Place," and it reduces flood risk to the Delta Legacy Communities, including the community of Locke, located adjacent to the Delta Cross Channel. With or without the DCA, as presently proposed, through-Delta conveyance will continue to rely on the freshwater corridor established both upstream and downstream of the Delta Cross Channel. Presently there are 37 miles of non-urban SPFC levees upstream and 25 miles downstream of the Delta Cross Channel that help convey water through the Delta (a total of 62 miles of SPFC levees which comprise significant portions of the Delta's freshwater corridor) (Figure 3-3). Improving the 1 mile of SPFC levees to current, modern standards consistent with FEMA's 100-year accreditation standards within the project study area of Locke would constitute improving nearly 3 percent of the non-urban SPFC levees upstream of the Delta Cross Channel and nearly 2 percent of the total non-urban SPFC levees in the Delta's freshwater conveyance corridor.

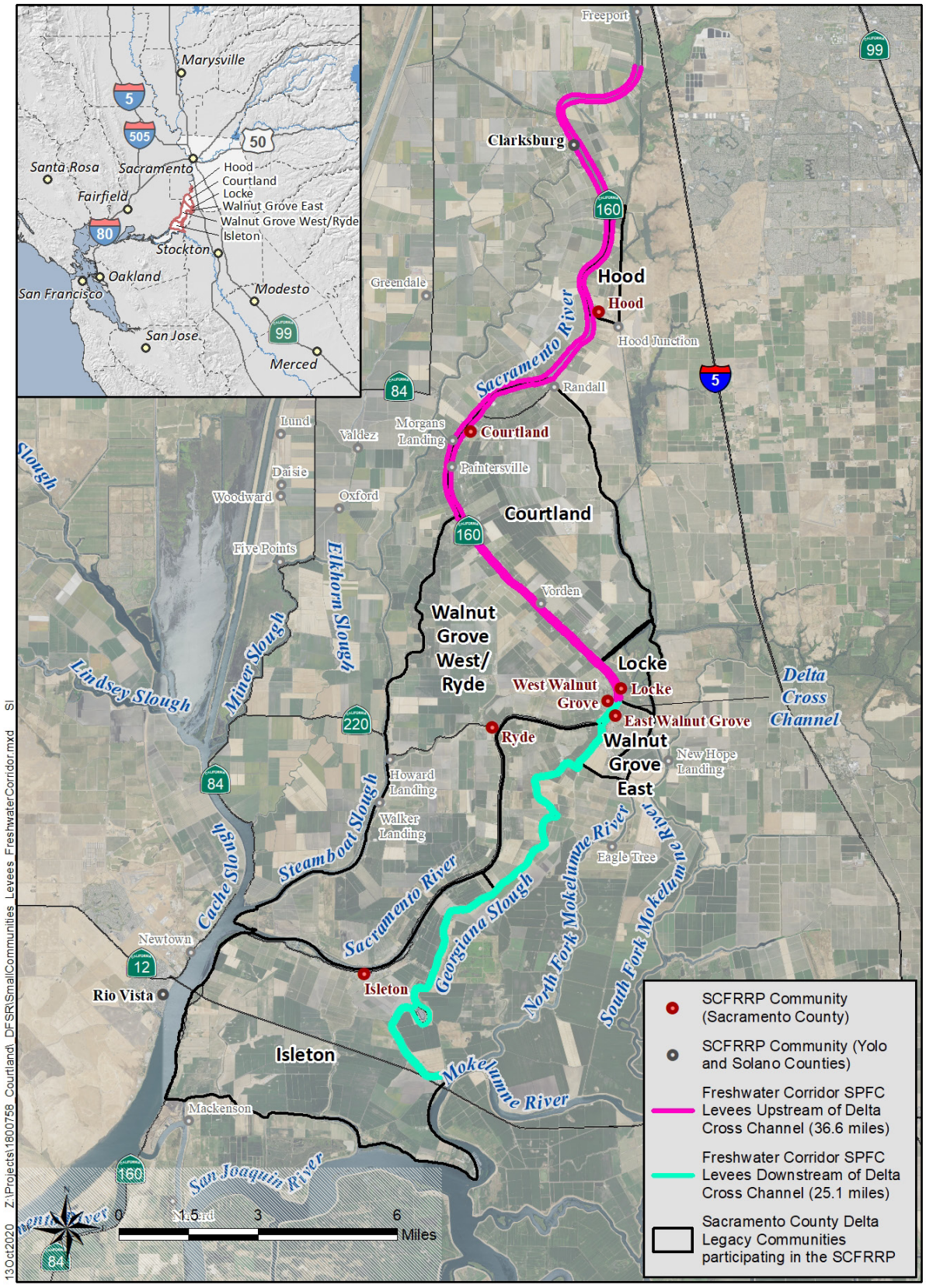


Figure 3-3. SPFC Levees which Comprise the Delta's Freshwater Corridor.

3.1.4 Agricultural Sustainability

Agricultural lands within the Delta and the immediate project study area are a key element of sustaining the economic health for the community of Locke. In 2001, FEMA began updating FIRMs, and as a result, many small communities, including the community of Locke in 2012, were subsequently mapped into SFHAs. As a result, these communities are subject to regulations set forth by the NFIP, including land use requirements for elevating or flood-proofing new and substantially improved structures, and the requirement to purchase a flood insurance policy through the NFIP for each structure with a federally backed mortgage (mandatory insurance purchase requirement). These requirements do not provide the flexibility needed to sustain agriculture within the community and can make reinvestments that are needed in support of the agricultural economy infeasible or unattainable.

3.1.5 Threatened Ecosystems

Many of the historic tidal wetland areas of the Delta have been lost to development and placement of levees with a configuration that does not support tidal inundation of areas to sustain viable habitat. Vulnerability to flow and temperature changes associated with Delta water supply conveyance (and naturally occurring drought) and predation of migrating fish species from invasive species is also an issue in certain areas of the Delta.

3.1.6 Threats from Climate Change and Sea Level Rise

Climate change and sea level rise have the potential to increase peak flows and flood stages in the Lower Sacramento River and Mokelumne/Cosumnes River systems, inclusive of Snodgrass Slough. As discussed in Appendix I, peak flows in the Sacramento River could increase by 4 percent for the 100-year flood and 2.3 percent for the 200-year flood as a result of climate change. Additionally, climate change combined with sea level rise could increase the 100-year flood stage in the Sacramento River between Steamboat Slough and Georgiana Slough at Locke by nearly 1.12 feet, with the 200-year flood stage along the same extent increased by 0.71 feet Increased flows and flood stages can not only result in more frequent flooding, which can lead to levee failure through greater hydro-dynamic pressures (and potential overtopping), but can also result in greater stresses to the levee system as levees are loaded more frequently with water for longer durations of time and *via* other mechanisms resulting from increased flow/flood stages (e.g., erosion). Note, however, that within the Locke study area, the effects of climate change and sea level rise are less pronounced along the mainstem of the Sacramento River, as a result of planned improvements in the upstream/adjacent bypass systems, than they are for the more isolated, unregulated watersheds associated with Snodgrass Slough.

It should be noted that the effects of climate change and sea level rise are partially neutralized along the Lower Sacramento River near the Locke study area due to the planned system-wide improvements of widening both the Sacramento and Yolo Bypasses and their associated weirs. The said enhancements to the weir and bypass systems will shunt or divert greater amounts of

water from entering the Lower Sacramento River downstream of the American River during high water stage conditions. The value of reducing flood stages in the Lower Sacramento River system by widening the Sacramento Weir and Yolo Bypass system(s) is briefly discussed above in Section 1.7.2 and shown in Figure 1-4.

Unfortunately, there are no bypass systems to accommodate increases in floodwater flows and stages in Snodgrass Slough that are heavily influenced by Morrison Creek and the larger downstream confluence flows and stages of the Cosumnes and Mokelumne Rivers. Thus, for the community of Locke there is a greater concern of climate change impacts to flood stages along Snodgrass Slough in relation to the Lower Sacramento River.

3.2 Opportunities

Opportunities to address the problems discussed above are summarized below.

3.2.1 Reduce Flood Risks

The levees protecting the Locke study area do not meet FEMA accreditation and current engineering standards to achieve a 100-year level of flood protection. When a levee is accredited by FEMA, the levee system is certified to meet current engineering standards contained in 44 CFR §65.10. These standards include criteria for through- and underseepage, freeboard, stability, settlement, encroachments, interior drainage, and other operations and maintenance criteria. These standards and criteria help to reduce the overall probability of levee failure and to ensure that communities and areas located behind the accredited levee(s) are protected during high water events. Since flood risk is partially characterized by the probability of levee failure, improving levees up to FEMA standards can help to reduce flood risk, thereby reducing the potential for life loss and property damage. A discussion surrounding the potential for life loss and property damage within the Locke study area is provided in the preceding Sections 3.1.1.3 and 3.1.1.4.

Securing levee improvements to FEMA accreditation standards can also enhance the resiliency and reliability of the through-Delta water conveyance system and help to ensure that water is conveyed as needed to agricultural farmland within the Delta and through the Delta to the SWP and CVP export pumps in the south Delta. Once a levee is accredited, the designation is shown on FIRM maps and can result in areas being mapped out of SFHAs. This can subsequently result in lower NFIP insurance premium rates. FEMA accreditation could also substantially reduce premiums for a community, flood-risk based insurance program that may be applicable for the community of Locke and possibly other nearby Delta Legacy Communities.

3.2.2 Agricultural Sustainability

Efforts to improve agricultural sustainability within the Delta, including the Locke study area, are outlined in the DPC's LURMP. The LURMP identifies methods of supporting long-term

viability of agriculture within the Delta region while being responsive to enhancing natural habitats and ecosystem restoration efforts by:

- Supporting the continued capability for agricultural operations to diversify and remain flexible to meet changing market demands and crop production technology
- Promoting the ability for agriculture operations to change the crops or commodities produced to whatever is most economically viable at the time
- Supporting the use of new crop production technologies that keep Delta agricultural operations competitive and economically sustainable

The DSC's Delta Plan also identifies policies and recommendations which seek to maintain Delta agriculture as a primary land use, food source, key economic sector, and as a way of life for the community of Locke and for the Delta as a whole. The purpose of these policies and recommendations is to address the impacts to local agriculture from changing markets, water conveyance facilities, and changing water quality. A subset of these policies and recommendations include:

- Improving existing levees
- Restricting urban development, while supporting farming and recreation
- Encouraging agritourism in and around legacy communities
- Promoting value-added crop processing

3.2.2.1 Agricultural Floodplain Ordinance Task Force

The Agricultural Floodplain Ordinance Task Force (AFOTF) is comprised of officials from FEMA, DWR, the CVFPB, RDs, levee districts, flood control agencies, counties, engineers, farmers, and non-governmental organizations. After forming in 2015, the AFOTF's goal was to develop administrative options of FEMA's NFIP to address sustainability of modern agriculture in deep floodplains. Administrative options were considered as they could be potentially implemented without changing law or regulation.

Administrative options to improve agricultural sustainability within the Sacramento Valley were summarized in a technical memorandum prepared in 2016. In total, the memorandum summarized nine recommendations which addressed how rules and practices could be modified to " (1) reduce or remove elevation and floodproofing requirements for new and substantially improved agricultural structures, and (2) reduce the cost of NFIP insurance premiums for agricultural structures with a federally backed mortgage to a more appropriate portion of the financial risk in the NFIP" (AFOTF, 2016). Further details and recommendations developed by the AFOTF are highlighted as item No. 9 in supporting Appendix H.

3.2.3 Potential Ecosystem Restoration and Recreational Enhancement Opportunities

Restoration opportunities adjacent to the Locke study area, some of which were previously identified in the Lower Sacramento-North Delta RFMP, potentially include:

1) enhancing existing riparian habitat along Snodgrass Slough and Meadows Slough and seasonal wetland (wet meadows) in the study area which represent some of the last remaining remnant habitat exhibiting pre-European settlement conditions, which provides habitat for Delta mudwort and Delta smelt,
2) enhancing the combination of wildlife habitat and recreation opportunities within the Delta Meadows State Park adjacent to the communities of Locke and East Walnut Grove,
3) Shaded Riverine Aquatic (SRA) habitat creation or enhancement in tandem with levee repairs.

See Appendix D for additional information on ecosystem opportunities within or adjoining the study area as well as Section 5.3.2 and accompanying Figures 5-12 and 5-13 for opportunities identified within and adjoining the Delta Meadows State Park Property.

Recreational enhancement opportunities are plentiful within and adjoining the immediate project study area that encompasses and includes the Delta Meadows State Park property largely located on and east of the RD 369 levee systems east of Locke and north of the Delta Cross Channel. In addition to providing recreational enhancements to Delta Meadows, opportunities exist for developing the former Walnut Grove Branch Line (WGBL) rail alignment as an initial segment of the Great California Delta Trail in the Central Delta. In addition to developing key segments of the subject Delta Trail, opportunities exist for creating a greater trailhead at Delta Meadows located on the north side of the Delta Cross Channel between Walnut Grove and Locke to serve as a regional recreational destination activity hub in the Central Delta as recommended in the DPC's Great California Delta Trail Master Plan of January 2022. *See* Section 5.3.3 and accompanying Figure 5-12 and Figure 5-13 for further recreational enhancement and educational multi-benefit opportunities within and directly adjacent to the Locke study area, including but not limited to Delta Meadows.

3.2.4 Enhance Resiliency and Reliability of Through-Delta Conveyance

Levees within the study area are vulnerable to earthquakes, climate change and sea level rise, and most levee reaches do not meet current 100-year FEMA accreditation standards. These levees are used to protect both people and property and help convey water used to support the agricultural economy within the community of Locke and beyond, including south of Delta interests. SPFC levees in the North Delta are particularly critical since they assist with the conveyance of water to and downstream of the Delta Cross Channel, which augments the flow of the Sacramento River water through the Delta to the collective SWP and CVP export pumps in the south Delta near Tracy. In the event of a levee failure, sea water intrusion from the San

Francisco Bay could enter areas that are critical to the distribution of fresh water, threatening water supply.

Over time, through the DWR Delta Levee Subventions and Special Projects local-state cost share programs, the levees have been maintained throughout the Delta, and some have been enlarged or geometrically improved to various Delta standard levels. Although not improving the Delta levees to modern 100-year FEMA accreditation criteria, continuing to maintain and improve levees within the Delta not only enhances flood protection for those people and properties within the study area and the Delta, but enhances the resiliency and reliability of through-Delta water conveyance. To promote this resiliency and reliability, levees both upstream and adjacent to the Delta Cross Channel along the Delta's freshwater corridor should be modernized to at least current 44 CFR §65.10 levee standards but also ultimately to a seismic standard to guard against earthquakes.

3.3 Constraints

3.3.1 Limited Local Funding Sources

LMAs partner with the State through the Delta Levee Subventions program to fund maintenance and repair of their flood control systems. However, the landscape by which levees are maintained by LMAs has drastically changed since levees were first constructed. Today, engineering design standards are more rigorous and environmental regulations are more stringent. In concert with deferred maintenance, these new requirements have increased costs to maintain the levee systems, and lack of funding is a common problem facing many LMAs. This is particularly notable in small communities with limited resources and reduced tax base. LMAs derive assessment valuation per acre for each parcel in proportion to benefits derived from reclamation operation. Notably, improvements on parcels including buildings are not included in the assessment calculation per provisions of the California Water Code. With residential properties often falling below an acre, there is thus a limitation on how much properties within these communities can be assessed (California Water Code § 50000 et seq.).

3.3.2 Proposition 218 Assessments and Other Funding Issues

Performing levee upgrades or improvements often requires a cost sharing between local and State agencies. State funding for investments in flood management systems has been largely supported by general obligation bonds (DWR, 2017a). Multiple State programs with the purpose of rehabilitating levees within the Delta have been established as a result of these bond funds, including the Delta Subventions Program and the Delta Levees Special Projects Program.

At the local level, LMAs rely primarily on taxes or special assessments on an acreage basis to make up their share of the funding for flood control projects. In 1996, California voters passed Proposition 218, the so-called "Right to Vote on Taxes Act." Proposition 218 amended the California Constitution by adding procedural and substantive requirements that must be met prior

to levying new assessments (California Special Districts Association, 2013). As a result, all new assessments that are used for flood management must be voter approved. This directly impacts a LMA's ability to raise funding for local flood management projects, and with limited local funding, LMAs are limited in their ability to partner in cost-sharing programs through the State.

Direct reclamation district assessments to homeowners are constrained by the California Water Code, and are approximately $25 per home, annually, in the community of Courtland. This is an order of magnitude lower than average assessments for flood protection in nearby urban areas (for comparison, Sacramento Flood Control Agency's assessment for a residential property located behind levees in Sacramento is over $250 annually, excluding costs for applicable flood insurance).

Direct reclamation district assessments to homeowners are constrained by the California Water Code, and are approximately $25 per home, annually, in the nearby upstream community of Courtland. This is an order of magnitude lower than average assessments for flood protection in nearby urban areas (for comparison, Sacramento Flood Control Agency's assessment for a residential property located behind levees in Sacramento is over $200 annually, excluding costs for applicable flood insurance).

For large repair and improvement projects, like what may be proposed in this feasibility study, LMAs must access a line of credit to implement repairs and/or improvements, but then substantial time may pass before cost-share reimbursements or assessment funds are available for repayment. Thus, large cash reserves are often needed in advance of securing project funds for the State or other entities.

Another difficulty is that LMAs are responsible for mitigation costs associated with repairs and maintenance. These costs increase over time, especially as offsite mitigation opportunities become limited and are a requirement under State cost-share programs.

In addition to assessing properties within the Locke study area for levee remediation repairs and improvements, said improvements and additional infrastructure may require additional O&M funds, and thus additional Proposition 218 Assessments may be required to address the incremental increases in O&M costs for new infrastructure such as a new cross levee.

3.3.3 Existing Delta Levee Standards

There are three agricultural levee standards that are widely used within the Delta: Hazard Mitigation Plan (HMP), PL 84-99, and the DWR Bulletin 192-82. These standards are summarized below in Figure 3-4. The HMP levee configuration is widely used in the Delta on non-SPFC levees and is regarded as providing the minimal level of flood protection that is required for federal disaster assistance eligibility.

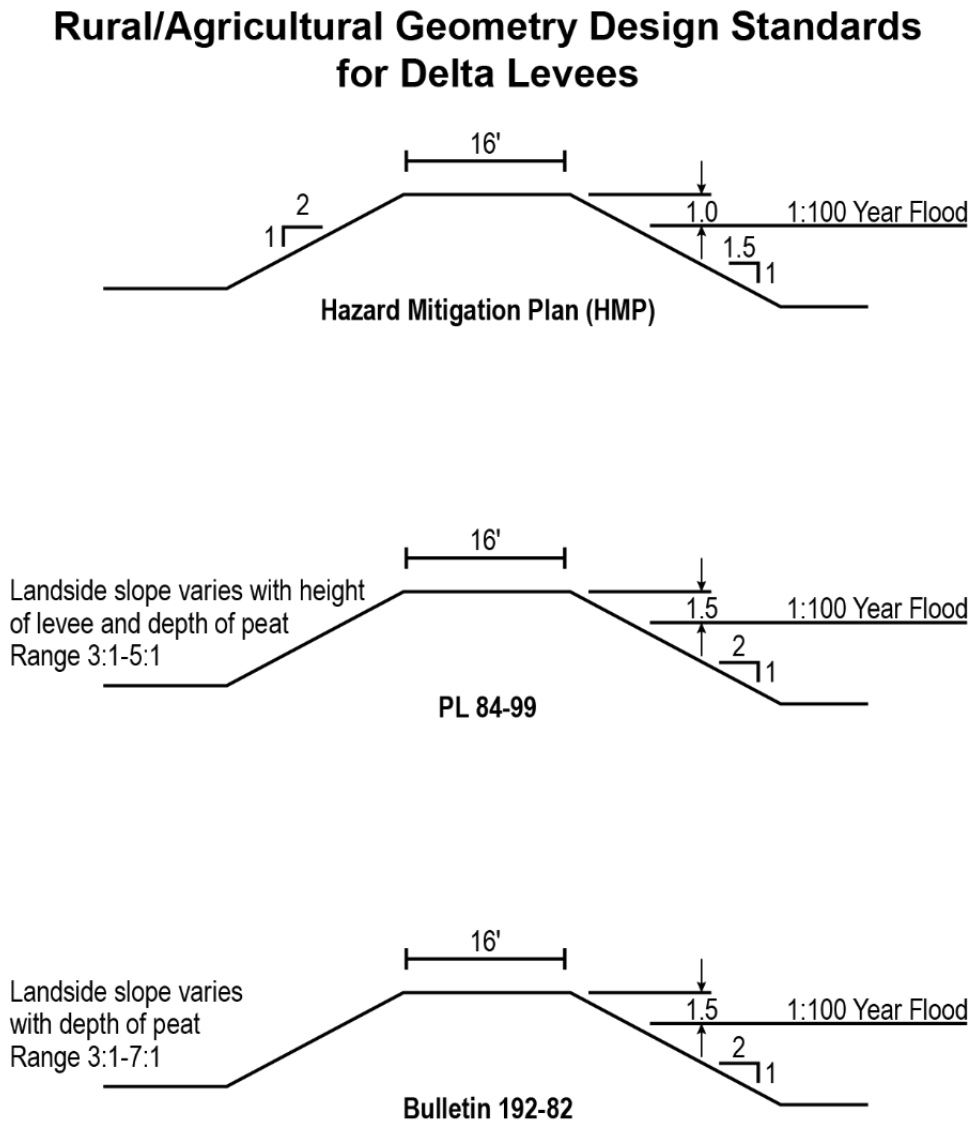


Figure 3-4. Rural/Agricultural Geometry Design Standards for Delta Levees

PL 84-99 guidance provides for somewhat better flood protection than the HMP standard, however it does not provide adequate protection from more extreme floods and earthquakes and does not provide a basis for adaption should sea level rise at an enhanced rate. The DWR Bulletin 192-82 standard is similar to the PL 84-99 criteria, except that it is designed relative to a one in three-hundred-year flood event (0.33% annual chance of flooding).

The three Delta levee standards mentioned above are focused on protecting agricultural portions of the Delta and fall substantially short of the FEMA accreditation standards for meeting a 100-year level of flood protection pursuant to in 44 CFR §65.10 generally used for urban levees (Figure 3-5). The economic sustainability of the Delta Legacy Communities cannot be assured when applying the lower agricultural levee standards previously established for the Delta.

Urban Geometry Design Standards for Delta Levees

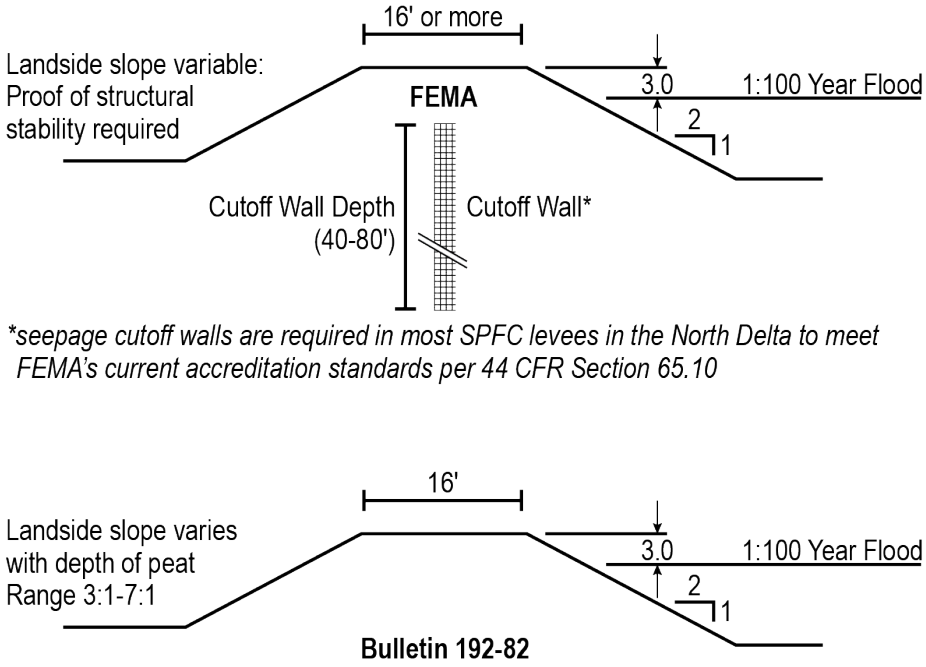


Figure 3-5. Urban Levee Geometry Design Standards for Delta Levees

Agricultural levees within the Delta and those offering protection to the Locke study area are largely improved to the PL 84-99 or Bulletin 192-82 geometry standards. However, FEMA accreditation requires levees to also meet USACE criteria contained in 44 CFR §65.10 generally used for urban levees, which goes beyond simple geometry standards. As previously discussed, this includes criteria for through and underseepage, stability, settlement, erosion, and other operations and maintenance criteria. Currently, very few Delta levees outside of urban areas meet the USACE criteria required for FEMA accreditation.

If Locke hopes to be mapped by FEMA as Zone X (as they were before 2012 outside of the floodplain), the entire 5-mile-perimeter levee system of the Locke study area may require certification, or a smaller segments, such as one fronting the community paired with a cross levee, must be collectively improved and constructed to obtain a 100-year level of flood protection pursuant to 44 CFR §65.10.

3.3.4 Delta Plan Land Use Constraints

As previously discussed in Section 2.1.3, the Delta Plan prescribes requirements for land use and floodproofing. However, there are a number of other requirements in the Delta Plan aimed at protecting, restoring, and enhancing the Delta which constrain development within the Delta Legacy Communities located in the Primary Zone of the Deltas. Levee improvements made within the study area must be consistent with these Plan requirements, in addition to local

ordinances or regulations. By prioritizing protection and enhancement of the Delta, the Delta Plan effectively restricts the loss of agricultural lands and/or the displacement of Delta Legacy Communities. This can limit structural levee remediations to more costly alternatives, such as cutoff walls, over less costly alternatives, such as seepage/stability berms since these berms are constructed on the landside toe of the levee and often require a displacement of agricultural lands or structures with a setback of anywhere from 150 to 350 feet.

Additionally, the Delta Reform Act established a certification process for projects within and affecting the Delta. This requires any State or local agency proposing to undertake a "covered action" to submit to the DSC a written certification of consistency with detailed findings as to whether the covered action is consistent with the Delta Plan (California Water Code, § 85225). The project must not have significant adverse impacts on the achievement of the coequal goals or affect implementation of government-sponsored flood control programs to reduce risks to people and property in the Delta. Development of a consistency determination is usually prepared concurrently and alongside the regulatory documentation for a project, and thus represents a variable cost.

3.3.5 Biological Constraints

As described in Section 2.1.7, the study area contains sensitive vegetation communities and habitat for several special-status species. Project activities that have the potential to affect these sensitive resources will require additional studies and environmental permits, prior to project implementation.

Major biological constraints to projects in the study area include limited work windows in the three-month period of August 1 through October 31 to perform any in-water work below the ordinary high-water line due to restrictions tied to the presence of several special status and endangered species within the Delta. Repairs of waterside erosion sites have been deferred around Locke due to the permitting difficulty of completing these projects. There is also significant difficulty in obtaining space for mitigation for any impacts to existing vegetation along the levees. Many past projects in the study area attempted to be "self-mitigating" but this can only occur where the space and opportunity exist on a project site. There are limited (or no) mitigation credits remaining to purchase for SRA impacts in the area.

Any levee improvement project will need to consider biological impacts and resulting mitigation measures. *See* Appendix B for additional information on biological resources within the study area. It is hoped that a programmatic biological mitigation program can be established leading to a practical and effective program to repair and strengthen the levees surrounding the community of Locke, and possibly other neighboring Delta Legacy Communities as well.

3.3.6 Cultural Resources Constraints

As described in Section 2.1.8, a total of 13 cultural resources were identified during the records search and from information provided by Sacramento County of but only two have been formally

evaluated for their eligibility for listing in either the NRHP or CRHR. However, before implementation of any project activities, a smaller area of potential effect (APE) would need to be defined and any resources within the APE would be formally evaluated for their cultural or historical significance during the project's California Environmental Quality Act (CEQA)/National Environmental Protection Act (NEPA) permitting process. This evaluation involves consultation with interested Tribes/tribal organizations and consultation under Section 106 of the Historic Preservation Act (with a concurrence from the State Office of Historic Preservation).

If any significant resources are determined to likely be affected by project construction, then proper treatment of the resource would be determined. Since one form of treatment for cultural resources is avoidance, this could represent a constraint for implementation of a project element. Even if resources are not avoided and the project moves forward for construction, a cost would be incurred during excavation, archiving, or development of interpretive facilities and information, required to mitigate effects to the cultural resource.

See Appendix C for additional information regarding known and potential cultural resources within the project study area of Locke and how they need to be addressed prior to any ground disturbing activities. Appendix C also further describes the National Heritage Designation Area within the study area and greater Delta, as well as the significance of Locke as being a State historic district as the only community in California built for and by Chinese Americans.

3.3.7 Additional Regulatory Considerations

A permit under Section 14 of the Rivers and Harbors Appropriation Act of 1899, as amended, and codified in 33 U.S. Code 408 (Section 408 Permission) is required for permanent or temporary alteration or use of facilities that were built as part of a USACE civil works project (the Sacramento-San Joaquin Flood Control Project, along the Sacramento River portion of the study area). A Section 408 permission is generally needed for any work on SPFC levees and within easements generally within 15 to 20 feet of the landward levee toe, unless the work is classified as maintenance. However, maintenance and repair activities conducted by LMAs on SPFC levees for which they have O&M responsibilities that do not require Section 408 permission may still require coordination or concurrence from the USACE Sacramento District.

Additionally, a permit under Section 10 of the Rivers and Harbors Act of 1899 (applicable to construction of any structure in or over any navigable water of the U.S.) may be needed for work along the Sacramento River and portions of Snodgrass Slough, depending on the nature of project implementation. The law applies to any dredging or disposal of dredged materials, excavation, filling, rechannelization, or any other modification of a Navigable Waters of the U.S., particularly any navigable waters in the North Delta.

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4. Plan Formulation

The problems and opportunities described above led to the formulation of the study goals (Section 1) and planning objectives, detailed in this Section. These goals and objectives provide solutions for Locke while capitalizing on opportunities to maximize multi-benefit projects and investment efficiency. Additionally, these goals and objectives, as well as stakeholder input, are utilized to measure how well plan flood risk reduction MAs meet the objectives of this study.

4.1 Planning Objectives

To achieve the study goal of modernizing SPFC levees to meet FEMA 100-year certification criteria, several broad objectives were identified as a framework for developing the preliminary suite of flood risk reduction elements and ultimately the final array of flood risk reduction MAs for Locke. In prioritized order, these include:

- Reducing risk to life
- Reducing risk to property damage
- Reducing probability of levee failure
- Limitation of high insurance premiums
- Improved flood preparedness and response
- Enhance resiliency and reliability of through-Delta water conveyance
- Foster environmental stewardship

These objectives help to address the problems described in the preceding Section and are aligned with the State's interest as expressed within the framework of the CVFPP, the 2014 RFMP, SCFRRP, and the goals of other Delta agencies, where possible.

4.1.1 Reducing Risk to Life

Reducing risk to life is the first objective used to meet the goal of achieving 100-year flood protection for the Locke study area. Life loss is the most devastating consequence of flooding. Prior to and since the establishment of the flood management system in the mid-1900s, catastrophic flooding and life loss has been documented in California, particularly in the Central Valley. Deficiencies in the flood control system, fast-moving floodwaters, deep floodplains, and lack of preparedness and emergency response procedures have all contributed to this life loss. Most of these are of similar concern to the Locke study area.

The risk of life loss is of greatest concern for the Locke study area within the densely populated community of Locke. Should a levee breach occur along the Sacramento River immediately

upstream and fronting the community, floodwaters would likely inundate the community at high velocities and depths, leaving little time to respond or evacuate, resulting in substantial life loss. Section 3.1.1.5, including Figure 3-1, provides in detail how and where the greatest risk of life loss exists to the community of Locke and the greater study area encompassed by RD 369.

Reducing risk to life is achieved by reducing flood risk. As described earlier, flood risk within the community and the larger study area is of concern and is based on the probability of flooding and the consequences of levee failure. By implementing flood risk reduction measures which reduce overall flood risk, either by reducing the probability of flooding or reducing the consequences of levee failure, risk of life loss is similarly reduced.

4.1.2 Reducing Risk to Property Damage

Property damage is another significant consequence of flooding. According to USACE, as documented in the 2017 CVFPP Update, flooding in 1986 and 1997 together caused over $1 billion in damage to the areas protected by the SRFCP. Within the Locke study area, as previously discussed in Section 3, the value of land and structural improvements, agricultural crops, vehicles, and highways and streets are valued at over $24.9M. These inventories and their associated values for the Locke study area are provided in Section 3.1.1.4, including baseline values of EAD under existing conditions and future conditions with climate change adjustments (Table 3-7). A levee failure could result in substantial property damage in Locke and the larger study area, particularly in the event of a breach on the levee immediately fronting or just upstream of the community within RD 369. Additionally, damage to property as a result of flooding could also have a ripple effect within the community, with economic impacts sustained due to damages to businesses, homes, and agricultural operations. This study prioritizes flood risk reduction MAs which reduce the risk to property damage and to achieve the goal of 100-year flood protection for the study area. The net reductions in EAD values for several structural-based MAs developed specifically for the subject Locke study area are provided in Section 6.3.1.2, with Table 6-6 and Table 6-7 providing a summary comparison of net EAD reductions for current baseline conditions and future conditions with climate change adjustments.

4.1.3 Reducing Probability of Levee Failure

Since flood risk is defined as the product of probability of levee failure and the consequences of levee failure, reducing the probability of levee failure is integral to reducing flood risk and thus achieving the goal of 100-year flood protection.

Reducing the probability of levee failure for the Locke study area can be accomplished by implementing a number of measures:

- Addressing/repairing potential erosion concerns identified by GEI Consultants along the Delta Meadows Cross Slough right bank levee (portion of NULE Segment 1054) and Snodgrass Slough

- While repairing known deficiencies also strengthen in-place the existing perimeter levee system(s) to offer improved levels of protection to the community
- Conduct annual inspections of the SPFC and non-SPFC levee system(s) protecting the community of Locke and correct any known deficiencies inclusive of non-compliant encroachments that may pose a threat to the structural integrity of the levee system
- Enhance existing flood warning, preparedness, flood-fight and response systems and practices as identified in the Flood ESPs developed by Sacramento County
- Secure 100-year FEMA Certification for the community of Locke and possibly for the entire Locke project study area pursuant to 44 CFR §65.10

4.1.4 Limit of High Insurance Premiums

As previously noted in Section 3.1.2, of the estimated 71 structures in the Locke study area valued at an estimated $22.5M, there are only five NFIP policies (valued at $350,000 maximum per policy inclusive of structure contents, presently capped at $250,000/structure and $100,000 for structure contents) providing less than $2M[1] in coverage. Rising insurance premiums over the last decade are a contributing factor to this differential and are an increasing problem within the study area. Lowering flood risks, and thus increasing flood protection, is a key action that can be taken to pay less for flood insurance each year under the existing NFIP or under a new community-based flood insurance program.

4.1.5 Improved Flood Preparedness and Response

Improved flood preparedness and response is another objective used to complement the goal of 100-year flood protection. Improved preparedness and emergency response can limit the loss of life and property damage as a result of flooding by developing the framework needed to enhance the understanding of local flood risks, foster communication, and to promote public awareness of flood risks, thus reducing flood risk.

4.1.6 Enhancing Resiliency and Reliability of Through-Delta Water Conveyance

As previously noted, the vulnerability of levees protecting through-Delta water conveyance is a problem within the study area. Levees within the study area are vulnerable to through seepage and underseepage, earthquakes, climate change and sea level rise, and in many places, do not meet current engineering and FEMA accreditation standards. These levees are used to protect both people and property and support the agricultural economy within the community of Locke and the adjoining project study area. SPFC levees in the North Delta are particularly critical since they also convey water to the Delta Cross Channel, which augments the flow of the Sacramento River water through the Delta to the collective SWP and CVP export pumps in the

[1] These estimates are sourced from the FEMA Open Source policy database.

south Delta near Tracy. In the event of a levee failure, sea water intrusion from the San Francisco Bay could enter areas of the freshwater corridor that are critical to the distribution of fresh water, threatening water supply to areas south of the Delta.

Continuing to improve levees within the Delta along the freshwater corridor not only enhances flood protection for those people and properties within the study area and the Delta, but it also contains the multi-benefit of enhancing the resiliency and reliability of through-Delta water conveyance. The existing through-Delta water conveyance system conveying water to the collective SWP and CVP export pumps in the south Delta provides water to over 3M acres of agricultural lands and to over 27M Californians south of the Delta.

4.1.7 Environmental Stewardship and Multi-Benefits

In 2010, DWR formally adopted an Environmental Stewardship Policy to advance a department-wide "Total Resource Management" approach to planning and design of projects. By building environmental benefits into projects on a meaningful scale, DWR supports sustainability from an engineering, economic, social, and environmental perspective. The CVFPP includes the supporting goal of integrating recovery and restoration of key physical processes, self-sustaining ecological functions, native habitats, and species into flood management improvements (DWR, 2017b). Additionally, the SCFRRP increases the State cost-share for projects which advance multi-benefit flood protection for small communities (protection of State facilities, contribution to the State's sustainability objectives, water supply, and open space and recreation) (DWR, 2017e).

Waterside levee repairs such as known erosion sites can provide opportunities to introduce more SRA habitat valuable to fisheries and other aquatic species.

4.2 Future Baseline Conditions

The future baseline conditions provide the basis to formulating flood risk reduction MAs and assessing their benefits and impacts. Since impact assessment is the basis for plan evaluation, comparison, and selection, clear definition and full documentation of future baseline conditions are essential (DWR, 2014). These conditions are influenced by climate change, development, and land subsidence, and are summarized as the future without project condition. Future baseline conditions in the Lower Sacramento River also consider system-wide benefits that are being implemented upstream in the Sacramento and Yolo Bypass/Weirs that have the added benefit of diverting more flood waters into the bypasses and lowering flood stages in the Lower Sacramento River in the North Delta downstream of Sacramento.

By incorporating EAD assessments for existing baseline conditions (consistent with the values and methodologies utilized by DWR for the 2022 CVFPP update) and comparing them to future baseline conditions (consistent with the adjustments for climate change and sea level rise utilized by DWR for the 2017 CVFPP update) this feasibility study was able to compare net reductions in

EAD values for various MAs under existing and future conditions. Appendix E provides more details on the EAD methodologies, net reductions in EAD values for various levels of flood risk reductions measures, and findings based on existing conditions and future conditions that include adjustments for climate change and sea level rise.

4.2.1 Climate Change and Sea Level Rise

Climate change is expected to significantly affect California's water resources in the form of changes to the hydrologic regime, sea level rise, and warmer temperatures. Although sea level rise is a minor issue in the North Delta, Californians will face a higher flood risk due to more rain and decreasing snowfall. Snow will melt faster and earlier in the season meaning more frequent flooding and less opportunity for natural storage in the mountains and will result in higher flood flows in the Delta. Reservoirs may fill earlier due to changing runoff patterns and operators will need to release water earlier in the season to make space for flood storage.

As discussed previously in Section 3.1.6, climate change and sea level rise have the potential to increase peak flows and flood stages in the Sacramento River. Peak flows in the Sacramento River could increase by 4 percent for the 100-year flood and 2.3 percent for the 200-year flood as a result of climate change. Additionally, sea level rise is expected to increase the 100-year flood stage in the Sacramento River between Steamboat Slough and Georgiana Slough by nearly 1.12 feet on average, with the 200-year flood stage along the same extent increased by 0.71 feet on average. Increased flows and flood stages can not only result in more frequent flooding, which can lead to levee failure through overtopping, but can also result in greater stresses to the levee system as levees are loaded with water for longer durations of time and *via* other mechanisms resulting from increased flow/flood stages (e.g., erosion). However, note that within the Locke study area, the effects of climate change are less pronounced along the mainstem of the Sacramento River, as a result of improvements in the upstream/adjacent bypass systems, than they are for the more isolated, non-regulated watersheds of Snodgrass Slough and the Cosumnes River.

Climate change and sea level rise also have the potential to impact the estimates of flood damage, or EAD, under future conditions within the Locke study area. The effects of inland climate change projections and sea level rise were incorporated into the EAD analyses performed as part of this study using a median estimate consistent with the methods and results of the 2017 CVFPP Update. These effects are described in greater detail in Section 6.3.1.2 and a full inventory of potential EAD values for the Locke study area under future conditions is provided in Appendix E.

4.2.2 Development in the Floodplain

Improvement of levees can induce population growth and encourage development within the floodplain. This is true for all areas within the Central Valley, except for those areas within the Primary Zone of the Legal Delta. As noted in previous Sections, development within the Primary

Zone of the Delta, including the Locke study area, is constrained by the Delta Plan and SPA ordinances which limit new residential, commercial, and industrial development. As such, future development within the study area is not expected to be substantial as a result of either removing the entire community of Locke from the current (2012) FEMA 100-yr. floodplain with a Base Flood Elevation (BFE) of 17.0 NAVD 88.

4.2.3 Land Subsidence in the Delta

While land subsidence is prevalent through large portions of the Delta due to underlying peat soils and land use practices, the effects are most pronounced within the central Delta and are least pronounced along the perimeter of the legal Delta. As such, the Locke study area, particularly underlying and adjacent to most of its perimeter levee system, is not subject to notable subsidence.

Substantial land subsidence in the study area, particularly along the alignment of the SPFC levee system along the left bank of the Sacramento River, is not expected in the future.

4.3 Alignment with Goals and Policies of Delta Agencies

Along with meeting the goals, policies, and intended outcomes of the CVFPP, actions required to meet the objectives outlined above also need to be in alignment with the goals and policies of Delta agencies. Projects and MAs should be qualitatively measured against the requirements of various Delta planning and regulatory agencies. A multitude of broad policies and goals are described in various planning documents drafted by the DPC, DSC, and Conservancy and an exhaustive matrix of potentially relevant Delta goals and policies is included in Appendix G.

4.3.1 Delta Protection Commission

DPC's LURMP includes several broad goals regarding land use and sustainability in the Delta. Specific to the study area is a goal to direct new non-agriculturally oriented non-farmworker residential development within the existing unincorporated Delta towns (Walnut Grove, Clarksburg, Courtland, Hood, Locke, and Ryde), to help encourage a critical mass of farms, agriculturally-related businesses and supporting infrastructure to ensure the economic vitality of agriculture within the Delta. Improved flood protection would indirectly contribute to this goal. Further LURMP goals are summarized in Appendix G.

DPC's Economic Sustainability Plan does not include a detailed evaluation of Locke. However, the report mentions that all Delta levees should be brought to the HMP standard, if not to the more stringent PL 84-99 Standard. Many broad policies generally applicable to the study area are summarized in Appendix G.

4.3.2 Delta Stewardship Council

The Delta Reform Act (California Water Code §85306) requires that the DSC, in consultation with the CVFPB, recommend Delta Plan priorities for State investments in levee operations, maintenance, and improvements in the Delta, including project levees that are part of the SPFC and non-SPFC levees that are constructed and maintained by LMAs.

The Delta Plan outlines a process to prioritize O&M State investments in Delta levees, O&M and levee improvements, and sets interim priorities to guide budget and funding for levee improvements, as detailed in Table 4-1. Levee improvements in the Delta should attempt to be responsive to the 3 x 3 goals established by the DSC in the Delta Plan outlined below in Table 4-1.

Table 4-1. 3x3 Goals of the DSC for State Investment in Delta Integrated Flood Management.

Goals	Localized Network	Levee Network	Ecosystem Conservation
1	Protect existing urban and adjacent areas by providing 200-year flood protection.	Protect water quality and water supply conveyance in the Delta, especially levees that protect freshwater aqueducts and the primary channels that carry fresh water through the Delta.	Protect existing and provide for a net increase in channel-margin habitat.
2	Protect small communities and critical infrastructure of statewide importance (located outside of urban areas).	Protect floodwater conveyance in and through the Delta to a level consistent with the State Plan of Flood Control for project levees.	Protect existing and provide for net enhancement of the floodplain habitat.
3	Protect agriculture and local working landscapes.	Protect cultural, historic, aesthetic, and recreational resources (Delta as Place).	Protect existing and provide for net enhancement of wetlands.

As described previously, the DSC also developed an overall DLIS, that: 1) quantifies flood risk, by considering the threats to Delta levees and the assets protected by these levees and 2) prioritizes investments for levee repairs, improvements, and rehabilitation, as Very High, High, or Other Priority. Generally, the priorities address the relationship between the flood risk of each island or tract, and the number of State interests that island's or tract's assets encompass (people, property, ecosystem, water supply, and Delta as place). The entirety of the Locke study area is currently designated as "Other Priority" under the DLIS prioritization. However, this prioritization is largely based upon levee geometry and availability of freeboard to the noted project area in comparison to other tracts within the Delta. Geotechnical evaluations by DWR under the NULE program, including recent explorations conducted in 2019 specifically for this study, collectively confirm there are significant deficiencies with known seepage concerns. The noted deficiencies warrant immediate attention and repair to reduce the risk of flooding to the Delta Legacy Community of Locke.

The Delta Plan includes many performance measures (including net reductions in EAD values) focused on reducing flood damages and loss of life, multi-hazard coordination, levee improvements, water supply reliability, sustainability, and recreation and economic opportunities associated with the Delta Legacy Communities. Additional Delta Plan goals generally applicable to the study area are summarized in Appendix G.

4.3.3 Delta Conservancy

The Conservancy's Delta Public Lands Strategy includes integrated conservation for publicly funded lands in the Delta and identifies small areas in and adjacent to the study area for implementation of tidal marsh, dryland habitat, and "urban greening" around the developed area of Locke. Additional Conservancy goals generally applicable to the study area are also summarized in Appendix G.

5. Preliminary Suite of Flood Risk Reduction Elements

The following Section details the structural and non-structural preliminary suite of flood risk reduction elements considered as part of this feasibility study. These elements will be used to form MAs which can be implemented by the community of Locke as funding sources are identified and become available. Potential multi-objective components which could be incorporated as part of the structural elements and non-structural measures are also discussed.

5.1 Structural Elements

Structural elements are those that repair or improve the existing levee/flood control system as it exists today. Structural elements considered in this feasibility study include strengthen-in-place levee repairs and improving the levee system to meet the objectives outlined in Section 4.1.

Structural elements discussed in this Section propose various remediations, such as cutoff walls, stability berms, seepage berms, combination seepage/stability berms, and rock slope protection (RSP), to address levee vulnerabilities within the study area. A potential cross levee is also presented as a measure to improve the flood control system in the Locke study area. A brief discussion of these remediations is provided below. The proposed remediations are feasibility level, developed using limited available data, and new, but limited geotechnical data and analyses. Additional geotechnical explorations and analysis are recommended to refine these remediations, and to ensure they are designed to FEMA criteria in an effort to secure FEMA accreditation for the community of Locke and the larger study area in the future.

Cutoff Wall: A cutoff wall is a vertical trench in the levee filled with a slurry material that becomes nearly impermeable. It is used to reduce permeability through and under levee systems that may be susceptible to seepage. Cutoff walls are designed and installed to depths necessary to minimize through seepage and underseepage vulnerabilities. One advantage to this method is that it stabilizes the levee by constructing a barrier at either the levee centerline or near the levee waterside hinge-point and does not require the displacement/reclamation of land on the landside toe, as required by other methods to address seepage as described below. A typical cutoff wall is shown in Figure 5-1.

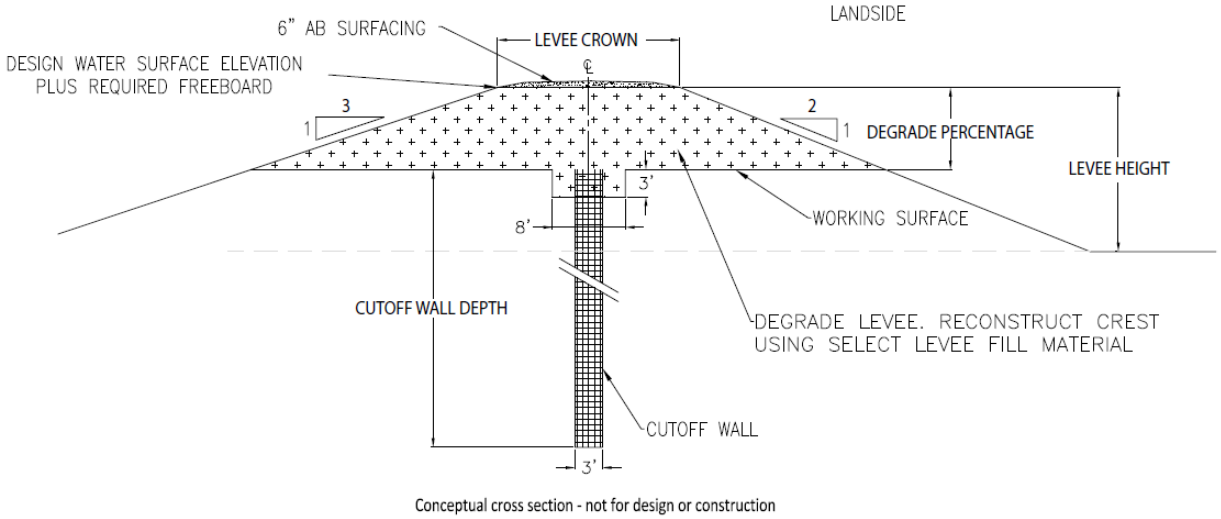


Figure 5-1. Typical Cutoff Wall.

Stability Berm: Stability berms are earthen berms constructed on the levee landside slope to address through seepage and stability vulnerabilities. When a levee is only vulnerable to through seepage, a stability berm can be a more cost-effective alternative to a cutoff wall. However, this remediation requires construction on the levee landside and results in a loss of usable land. The overall width and depth of the stability berm depends upon the degree to which the levee is vulnerable to stability. A typical stability berm is shown in Figure 5-2.

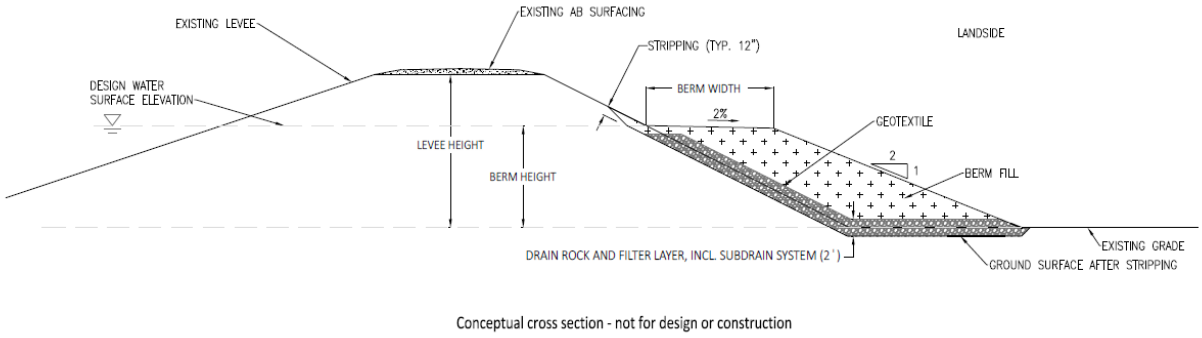


Figure 5-2. Typical Stability Berm.

Seepage Berm: Seepage berms are earthen berms constructed on the levee landside to address underseepage. These berms are constructed on the levee landside toe and extend outwards away from the levee anywhere from 150 to 350 feet in width in order to lengthen the seepage path. As a result, construction of seepage berms requires more land than construction of stability berms. A typical seepage berm is shown below in Figure 5-3.

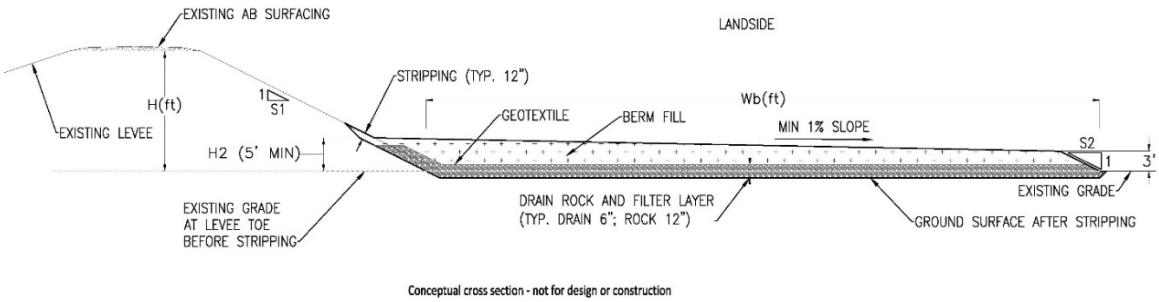


Figure 5-3. Typical Seepage Berm.

Combination Seepage and Stability Berm: Combination seepage and stability berms are constructed to address levees which have both underseepage and through seepage vulnerabilities. A typical combination seepage and stability berm is shown in Figure 5-4.

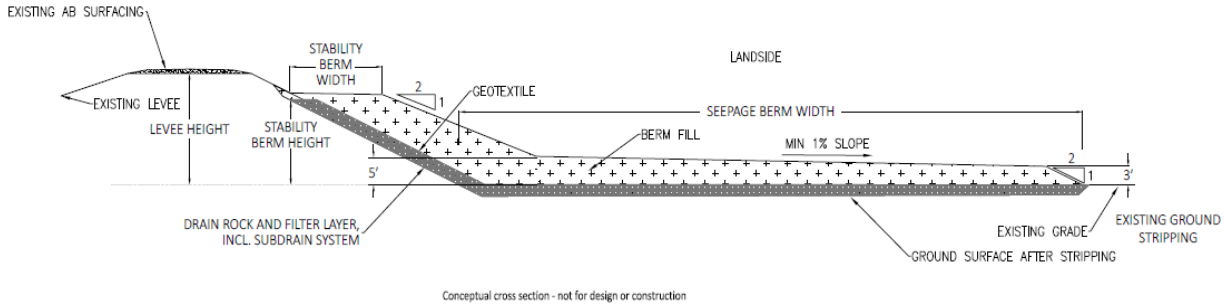


Figure 5-4. Typical Combination Seepage and Stability Berm.

Rock Slope Protection: RSP is used to address erosion through the placement of riprap on the waterside slope of the levee. A typical RSP detail is provided in Figure 5-5.

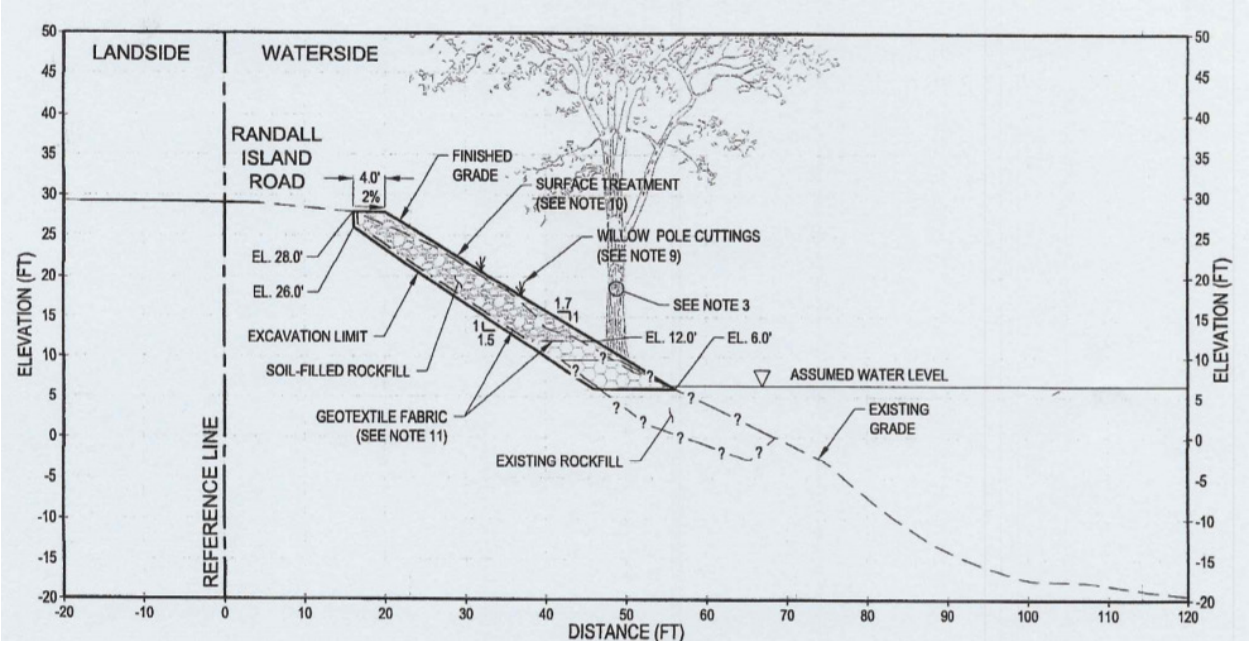


Figure 5-5. Typical RSP Detail for Remediation of Erosion Within the Study Area (AECOM, 2020).

5.1.1 Previously Identified Repair Needs

A number of studies and evaluations have identified various issues within the study area associated with through seepage, underseepage, stability, and erosion. The following is a summary of these studies and evaluations.

5.1.1.1 Repair and Strengthen-in-Place Sacramento River SPFC Left Bank Levee West of Locke within RDs 369 and 554 (NULE Segment 121 in RD 369 and a Portion of NULE Segment 127 in RD 554)

As previously discussed, a breach on the levee immediately adjacent to and upstream of the community in RD 369 poses great risk to Locke and the larger study area. A levee failure in RD 369 from either the Sacramento River or Snodgrass Slough would likely result in significant property damage and life loss as a result of high floodwater depths and velocities and little time to evacuate. This flood risk reduction element repairs and strengthens roughly 0.93 miles of levee immediately adjacent to the community of Locke along the left bank of the Sacramento River between Delta Meadows Slough at the upstream end (common boundary with the southern, downstream boundary of RD 551) to approximately 300 feet north of the northwest entrance of the Delta Cross Channel at the downstream end. The northern, upstream 0.8-mile portion (NULE Segment 121) is part of the RD 369 levee system, and the remaining 700-feet (NULE Segment 127) is part of the RD 554 levee system.

Improvement of this portion of levee was investigated as part of the NULE Phase 1 study, as documented in the NULE GAR and in the 2014 RFMP. This feasibility study leverages data from the NULE Phase 1 study along with additional data from CPTs collected in 2019 to develop two remedial alternatives for this segment of levee.

Remediations for this element, and those discussed throughout Section 5, were developed considering through seepage, underseepage, slope stability, erosion, and freeboard. Additional information regarding the data used to develop these remediations and how levee vulnerabilities were identified can be found in Appendix A. As depicted in Figure 5-6 and summarized in Table 5-1, this element primarily addresses through seepage and underseepage by reach using available data. Two remedial alternatives are provided to address the vulnerabilities associated with each reach. Further geotechnical investigations in connection with obtaining FEMA accreditation are warranted to confirm the levee fronting the community may or may not be vulnerable to slope stability and erosion and to confirm there are no freeboard deficiencies, in addition to the known vulnerabilities to through seepage and underseepage.

In addition to addressing through- and under-seepage, a potential freeboard deficiency may exist along this reach of SPFC levee immediately upstream and adjoining the community, as depicted in DWR's Sacramento River Basin Channel Capacity Atlas, December 2016.

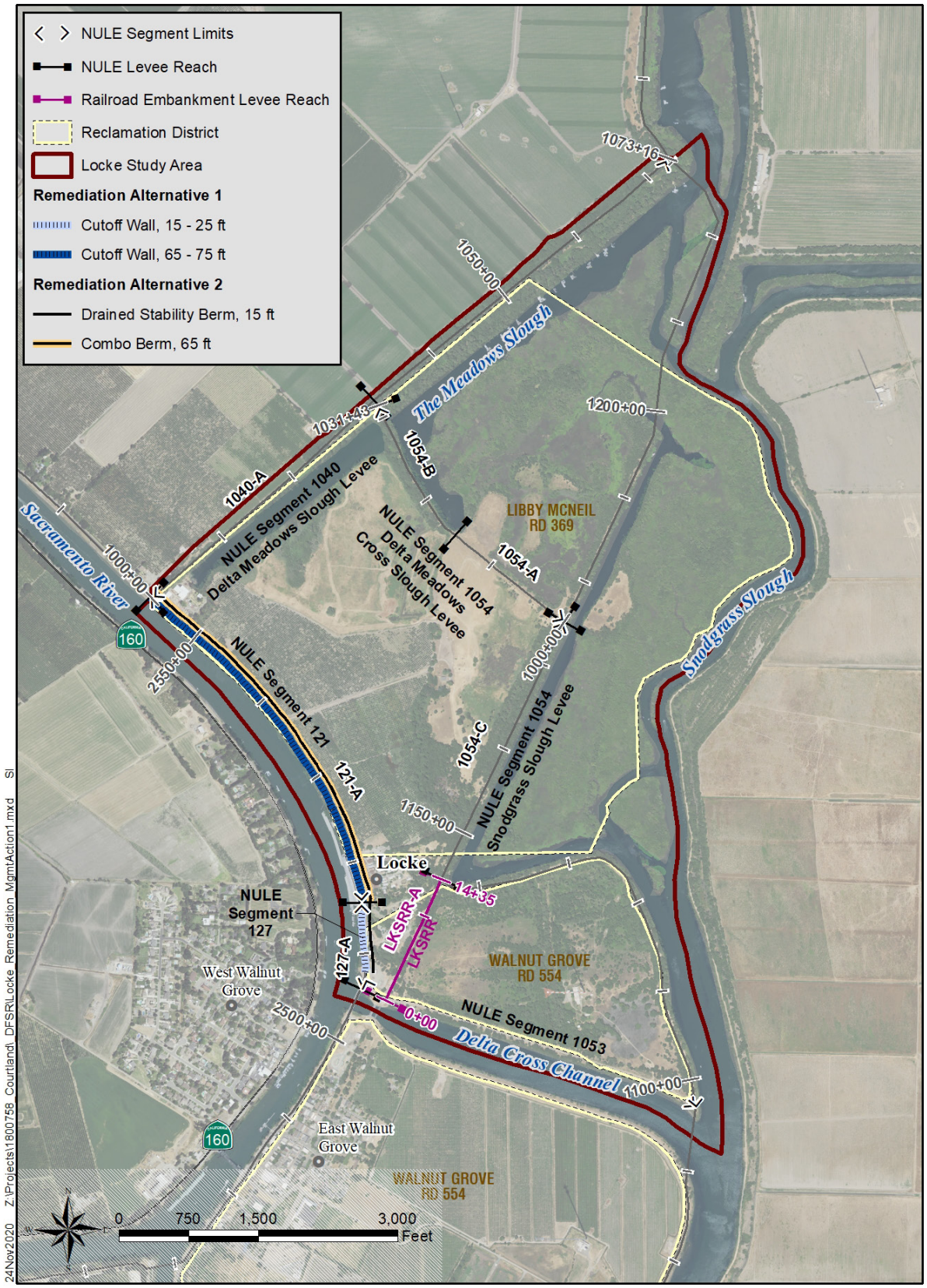


Figure 5-6. Remedial Alternatives to Repair and Strengthen the Sacramento River Left Bank SPFC Levee West of Locke, Within RDs 369 and 554

Table 5-1. Summary of Remedial Alternatives to Repair and Strengthen the Sacramento River Left Bank SPFC Levee West of Locke, within RDs 369 and 554

Levee Segment Location	NULE Segment	Reach	Start Station	End Station	Reach Length (ft.)[1]	Remediation Alternative 1	Remediation Alternative 2	Vulnerability	
								Under-Seepage	Through-Seepage
Left Bank Sacramento River – RD 369	121	121-A	2515+48	2556+52	4,100	75-ft.-deep cutoff wall	65-ft.-wide, 9-ft.-tall combination seepage and stability berm	X	X
Left Bank Sacramento River – RD 554	127	127-A	2506+08	2515+48	900	15-ft.-deep cutoff wall	15-ft.-wide, 8-ft.-tall, drained stability berm	-	X

Note: [1]Reach lengths rounded to the nearest 100 feet

5.1.1.2 Repair and Strengthen-in-Place Non-SPFC Levees and Former Railroad Embankments Easterly of Locke in RDs 369 and 554

This element repairs and strengthens a 1.2-mile portion of NULE Segment 1054 comprised of the Delta Meadows Cross Slough right bank cross levee (0.6 mile) and the adjoining Snodgrass Slough right bank levee (0.6 mile) in RD 369, as well as the most northerly 0.20 mile of the adjoining railroad embankment which extends from the south side of the Snodgrass Slough right bank levee to the northwest entrance to the Delta Cross Channel primarily in RD 554. As depicted in Figure 5-7 and summarized in Table 5-2, this element primarily addresses through seepage, underseepage, slope stability, and erosion by reach using available data. Two remedial alternatives are provided to address the vulnerabilities associated with each reach. Further geotechnical investigations in connection with obtaining FEMA accreditation are warranted to confirm vulnerability to slope stability and to confirm there are no freeboard deficiencies, in addition to the known vulnerabilities to through seepage and underseepage.

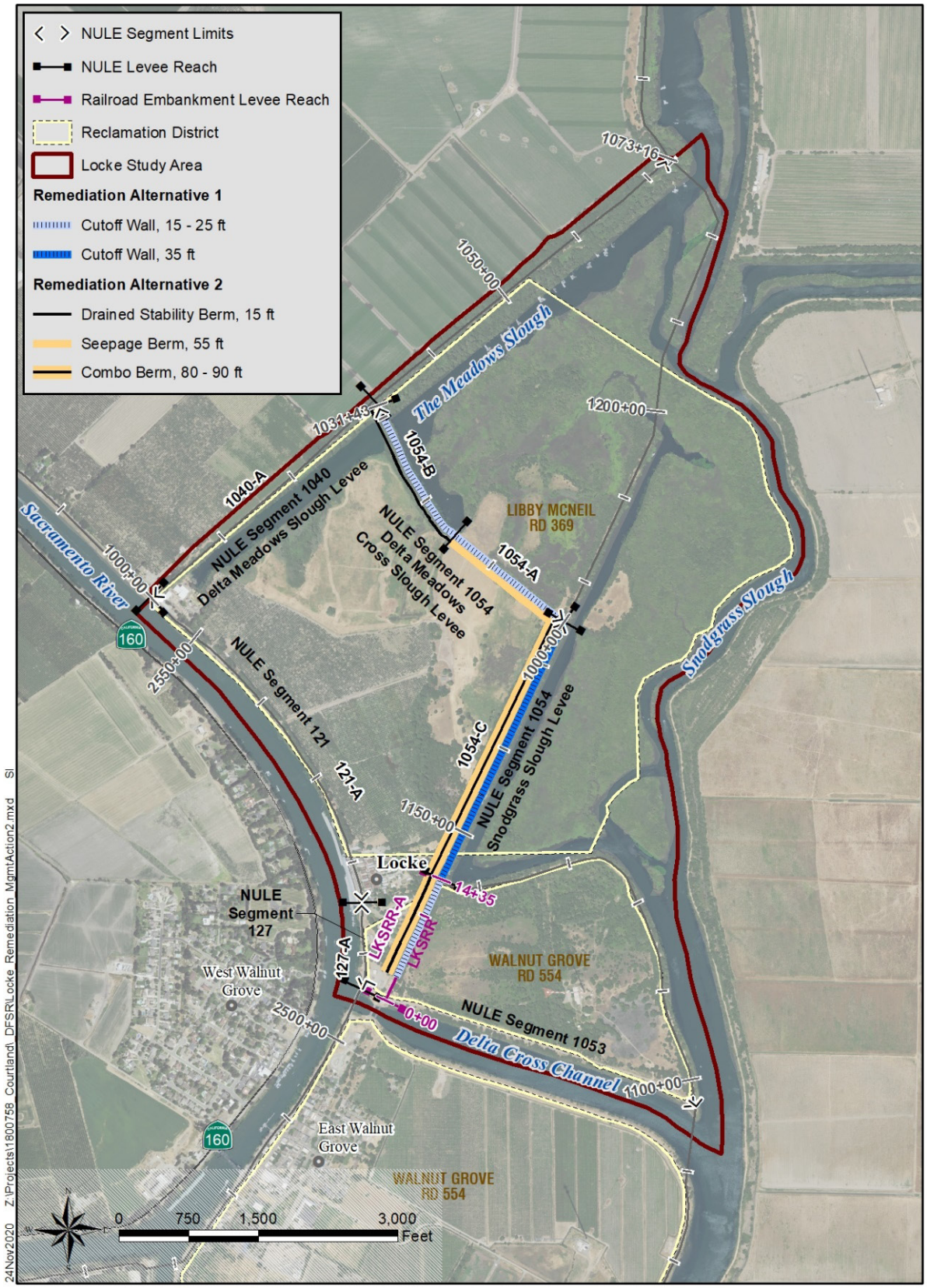


Figure 5-7. Remedial Alternatives to Repair and Strengthen Non-SPFC Levees and Former Railroad Embankments Easterly of Locke within RDs 369 and 554

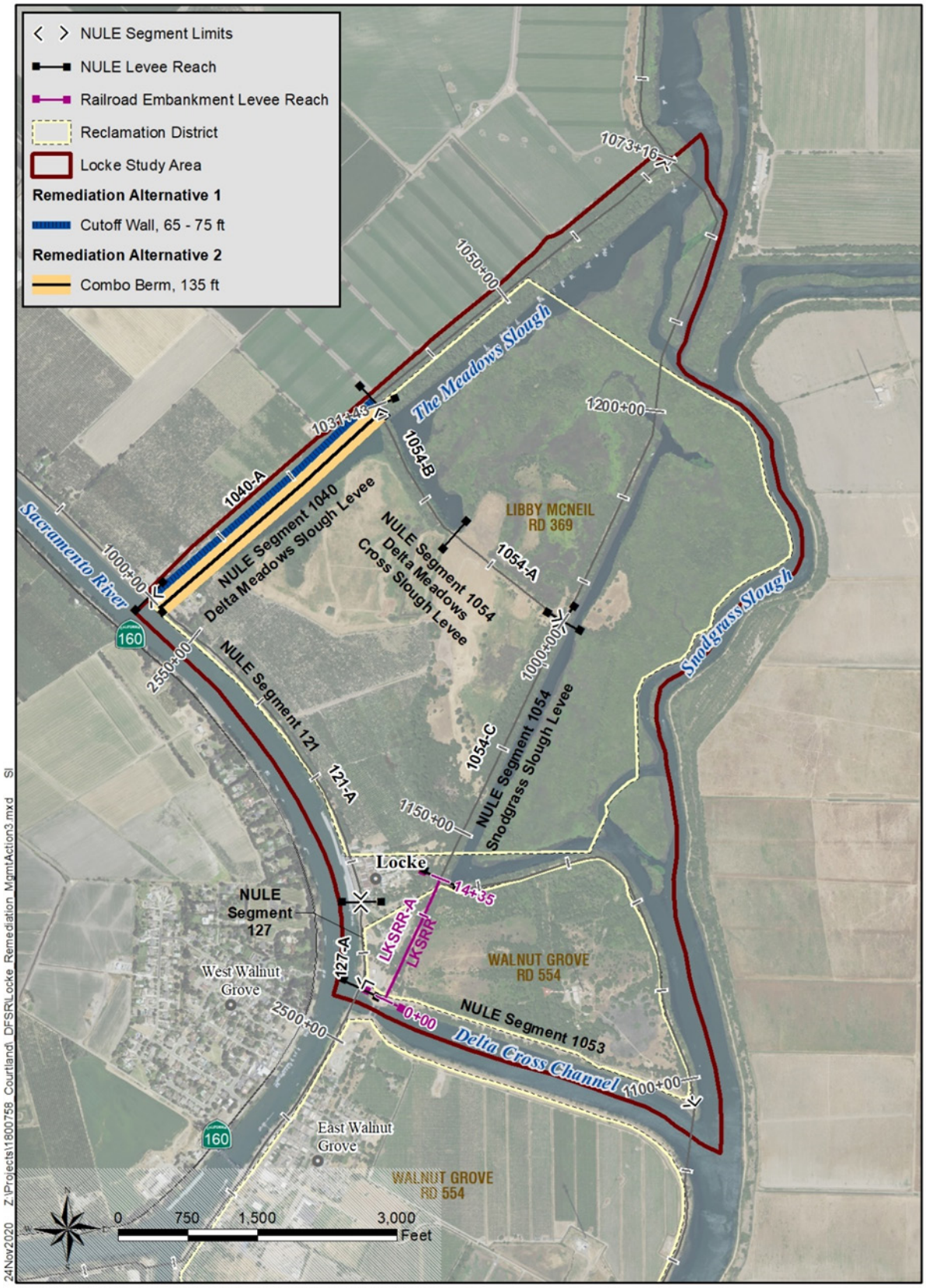
Table 5-2. Summary of Remedial Alternatives to Repair and Strengthen the Non-SPFC Levees and Former Railroad Embankments Easterly of Locke in RDs 369 and 554 (portion of NULE Segment 1054), and the RD 554 Railroad Embankment

Levee Segment Location	Reach	Start Station	End Station	Reach Length (ft.)[1]	Remediation Alternative 1	Remediation Alternative 2	Vulnerability			
							Under-Seepage	Through-Seepage	Slope Stability	Erosion
Meadows Cross Slough Right Bank Cross Levee (portion of NULE Segment 1054) – RD 369	1054-A	1000+00	1015+00	1,500	25-ft-deep cutoff wall 65-ft.-wide RSP	55-ft-wide seepage berm 65-ft.-wide RSP	X	-	-	X
	1054-B	1015+00	1032+00	1,700	15-ft.-deep cutoff wall 100 ft. wide RSP (1,000 feet)	15-ft.-wide, 8-ft.-tall, drained stability berm 100-ft.-wide RSP (1,000 feet)	-	X	-	X*
Snodgrass Slough Right Bank Levee (portion of NULE Segment 1054) – RD 369 and 554	1054-C	1144+42	1175+11	3,100	35-ft.-deep cutoff wall 110 ft. wide RSP (500 ft.)	90-ft.-wide, 9-ft.-tall combination seepage and stability berm 110-ft.-wide RSP (500 ft.)	X	X	X*	X*
Locke South Railroad Embankment – RD 554	LKSRR-A	0+00	14+35	1,400	20-ft.-deep cutoff wall	80-ft.-wide, 9-ft.-tall combination seepage and stability berm	X	X	-	-

Notes: * Only affects a portion of the reach
[1]Reach lengths rounded to the nearest 100 feet

5.1.1.3 Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee North of Locke within RD 551 (portion of NULE Segment 1040 in RD 551)

This elements repairs and strengthens the 0.6-mile westerly portion of the Delta Meadows Slough levee (NULE Segment 1040, RD 551) which extends easterly from the Sacramento River east (or left) bank levee to Snodgrass Slough along the common southern border of RD 554 and the northern border of RD 369. As depicted in Figure 5-8, this element primarily addresses through seepage and underseepage using available data. Two remedial alternatives are provided to address the vulnerabilities on the westerly 0.60-mile portion of the Delta Meadows Slough left bank levee: a 65-foot- deep cutoff wall (Remediation Alternative 1) or a 135-foot-wide, 15-foot-tall combination seepage and stability berm (Remediation Alternative 2). Further geotechnical investigations in connection with obtaining FEMA accreditation are warranted to confirm this segment of NULE Segment 1040 may or may not be vulnerable to slope stability or erosion and to confirm there are no freeboard deficiencies, in addition to the known vulnerabilities to through seepage and underseepage.


NULE Segment Limits
NULE Levee Reach
Railroad Embankment Levee Reach
Reclamation District
Locke Study Area
Remediation Alternative 1
Cutoff Wall, 65 - 75 ft
Remediation Alternative 2
Combo Berm, 135 ft
1073+16
1050+00
1200+00
1031+43
The Meadows Slough
1054-B
1040-A
NULE Segment 1040
Delta Meadows Slough Levee
LIBBY MCNEIL
RD 369
NULE Segment 1054
Delta Meadows
Cross Slough Levee
1054-A
Sacramento River
1000+00
160
2550+00
NULE Segment 121
1000+00
Snodgrass Slough
1054-C
NULE Segment 1054
Snodgrass Slough Levee
121-A
1150+00
Locke
NULE
Segment
127
14+35
LKSRR-A
LKSRR
WALNUT GROVE
RD 554
West Walnut
Grove
127-A
2500+00
0+00
NULE Segment 1053
Delta Cross Channel
1100+00
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East Walnut
Grove
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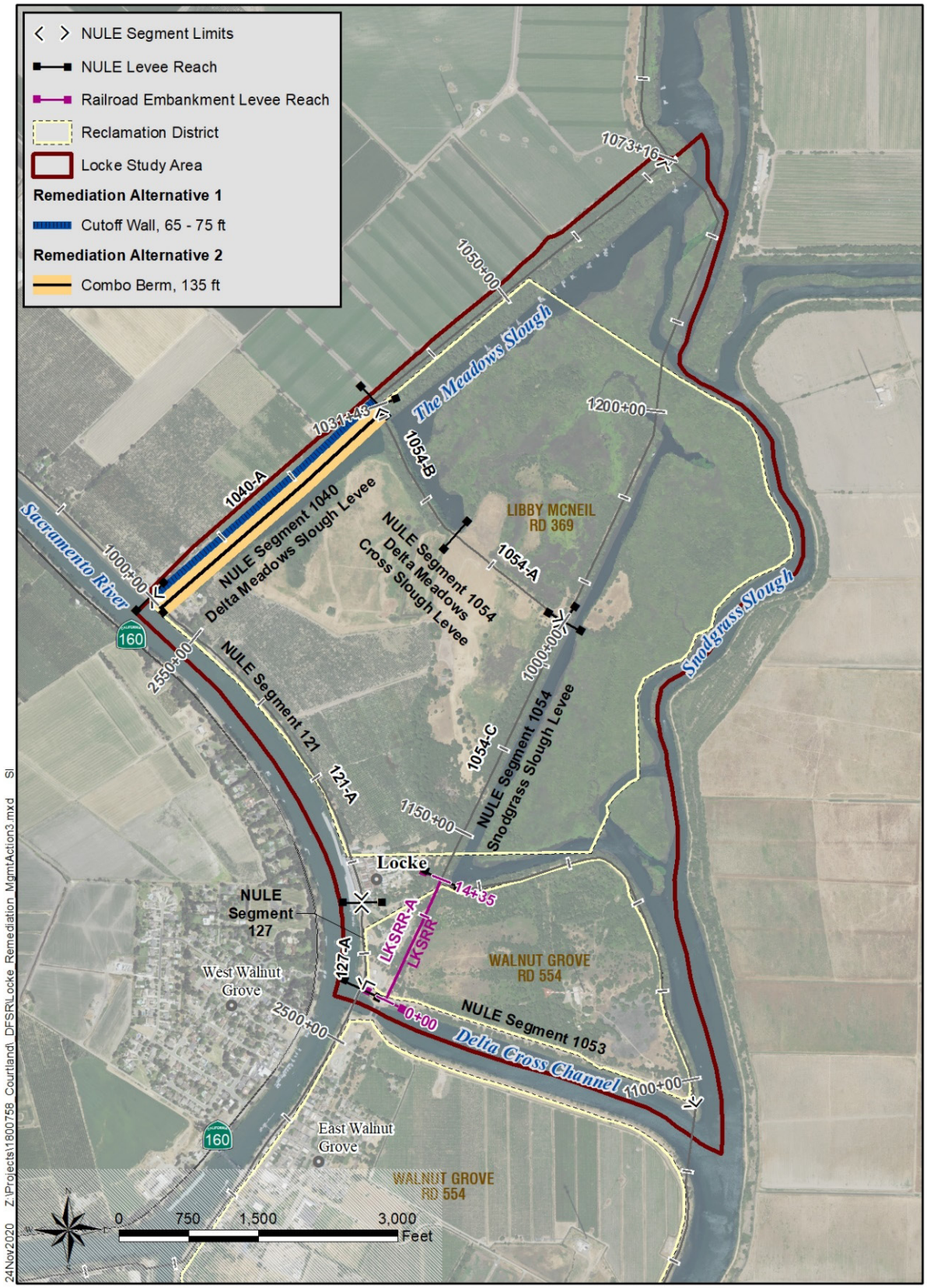

Figure 5-8. Remedial Alternatives to Repair and Strengthen the Delta Meadows Slough Non-SPFC Levee North of Locke Within RD 551 (portion of NULE Segment 1040 in RD 551)

5.1.2 Additional Remediations and Improvements

Additional remediations to improve flood protection for the community of Locke and the larger study area were investigated as part of this feasibility study and are provided below.

5.1.2.1 Potential Cross Levee in RD 369 North of Locke

This flood risk reduction element would consist of constructing a cross levee north of Locke in RD 369 to protect the community from floodwaters originating from the north into RDs 551 or 369 from either the Sacramento River or Snodgrass Slough. The cross levee would extend from approximately 1,000 feet north of Locke along the left bank of the Sacramento River for a distance of approximately 1,600 feet (0.30 mile) easterly to the Snodgrass Slough right bank levee (NULE Segment 1054, RD 369) (Figure 5-9). The proposed cross levee would be constructed with a 20-foot-wide crown width, 3H:1V landside and waterside slopes, and levee crest elevation of 20 feet, assuming design WSEL of 17 feet NAVD 88 and 3 feet of freeboard (Table 5-3). The cross levee would be maintained by RD 369 but funded by the community, DWR and possibly others. Liability for the cross levee could be held by RD 369, DWR, and/or by the community, to be determined depending upon funding sources. If the cross levee doesn't become a part of the SPFC the liability of the levee would likely be held by non-state and anon-federal interests; and if it becomes a part of the SPFC system, then the State would likely hold the liability.

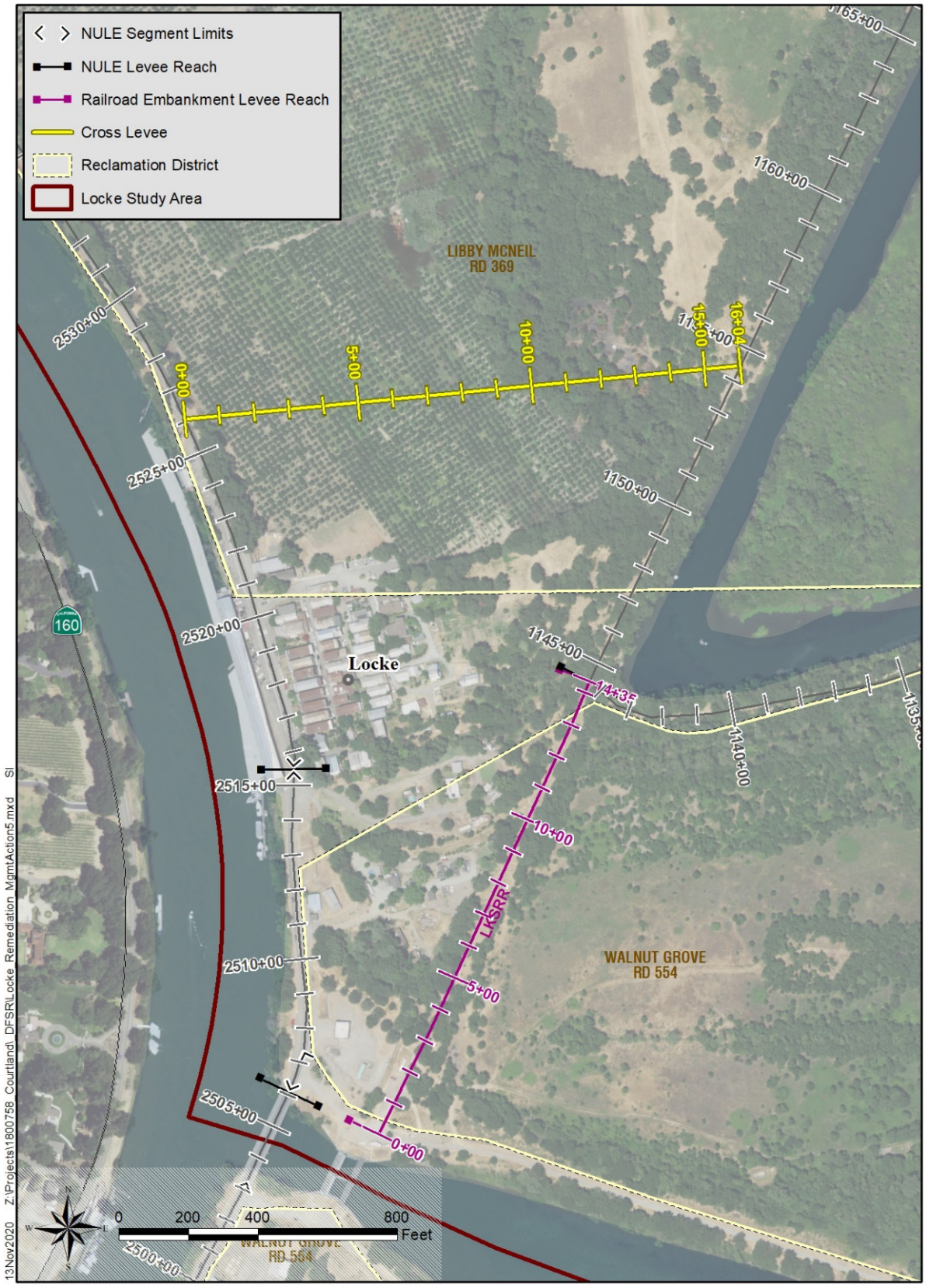

Figure 5-9. Conceptual Alignment of Potential Cross Levee North of Locke in RD 369

Table 5-3. Locke Cross Levee Alignment Dimensions

Crown Width	Landside Slope (H:V)	Waterside Slope (H:V)	Crest Elevation	Average Cross Levee Height
20 ft.	3:1	3:1	20 ft. NAVD 88	11.4 ft.

5.1.2.2 Secure 100-Year FEMA Certification, with Potential Cross Levee North of Locke Paired with Perimeter Levee Improvements South of the Proposed Cross Levee

This element builds on the previous collection of elements by repairing and strengthening nearly 0.75 miles of levee within the study area in accordance with FEMA standards for freeboard, seepage, erosion, and stability and settlement concerns pursuant to 44 CFR §65.10. Levee repairs and improvements would be made to the following levee segments in concert with a 0.30-mile-long cross levee north of Locke to form a levee system, which could be certified by FEMA: 1) 0.35 mile of SPFC levee along the left bank of the Sacramento River of Locke (portions of NULE Segment 121 and NULE Segment 127); 2) 0.20 miles of non-SPFC levee along the right bank of Snodgrass Slough (portion of NULE Segment 1054 in RD 369), and; 3) 0.20 mile of improvements to the northerly former railroad embankment which extends from the south side of the Snodgrass Slough right bank levee towards the northwest entrance to the Delta Cross Channel (Figure 5-10). In addition to the proposed structural remediations previously described, certain FEMA design criteria, O&M requirements, and documentation requirements specified in 44 CFR §65.10 are also addressed. These FEMA accreditation requirements are discussed briefly below.

Freeboard: Riverine levees must provide a minimum freeboard of 3 feet above the 100-year water-surface level, preferably that addresses both climate change and sea level rise. An additional 1 foot above the minimum is required within 100 feet on either side of structures (such as bridges) riverward of the levee or wherever the flow is constricted.

Embankment Protection: Engineering analyses must be submitted that demonstrate no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability. The factors to be addressed in such analyses include but are not limited to expected flow velocities (especially in constricted areas); expected wind and wave action; ice loading; impact of debris; slope protection techniques; duration of flooding at various stages and velocities; embankment and foundation materials; levee alignment, bends, and transitions; and levee side slopes.

Embankment and Foundation Stability (Including Through Seepage and Underseepage): Engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided shall evaluate expected seepage during loading conditions associated with the base flood and shall demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability. An alternative analysis demonstrating

that the levee is designed and constructed for stability against loading conditions for Case IV as defined in the USACE manual, "Design and Construction of Levees" (EM 1110-2-1913, Chapter 6, Section II), may be used. The factors that shall be addressed in the analyses include, depth of flooding, duration of flooding, embankment geometry and length of seepage path at critical locations, embankment and foundation materials, embankment compaction, penetrations, other design factors affecting seepage (such as drainage layers), and other design factors affecting embankment and foundation stability (such as berms).

Settlement: Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained within the minimum standards set forth in paragraph (b)(1) of this section. This analysis must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in the USACE manual, "Soil Mechanics Design - Settlement Analysis" (EM 1100-2-1904) must be submitted.

Design Criteria

Closures/Encroachments: All openings must be provided with closure devices that are structural parts of the system during operation and design according to sound engineering practice.
Interior Drainage: An analysis must be submitted that identifies the source(s) of such flooding, the extent of the flooded area, and, if the average depth is greater than 1 foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters.
Other Design Criteria: In unique situations, such as those where the levee system has relatively high vulnerability, FEMA may require that other design criteria and analyses be submitted to show that the levees provide adequate protection. In such situations, sound engineering practice will be the standard on which FEMA will base its determinations. FEMA will also provide the rationale for requiring this additional information.

Operations Plans and Criteria

Closures: Operation plans for closures must include the following: • Documentation of the flood warning system, under the jurisdiction of federal, State, or community officials, that will be used to trigger emergency operation activities and demonstration that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure. • A formal plan of operation including specific actions and assignments of responsibility by individual name or title. • Provisions for periodic operation, at not less than 1-year intervals of the closure structure for testing and training purposes.
Interior Drainage Systems: Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood protection purposes only if the following minimum criteria are included in the operation plan: • Documentation of the flood warning system, under the jurisdiction of federal, State, or community officials, that will be used to trigger emergency operation activities and

demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system.

- A formal plan of operation including specific actions and assignments of responsibility by individual name or title.
- Provision for manual backup for the activation of automatic systems.
- Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes. No more than 1-year shall elapse between either the inspections or the operations.

Other Operations Plans and Criteria: Other operating plans and criteria may be required by FEMA to ensure that adequate protection is provided in specific situations. In such cases, sound emergency management practice will be the standard upon which FEMA determinations will be based.

Maintenance Plans and Criteria

Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is being sought or when the plan for a previously recognized system is revised in any manner. All maintenance activities must be under the jurisdiction of a federal or State agency, an agency created by federal or State law, or an agency of a community participating in the NFIP that must assume ultimate responsibility for maintenance. This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, maintenance plans shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.

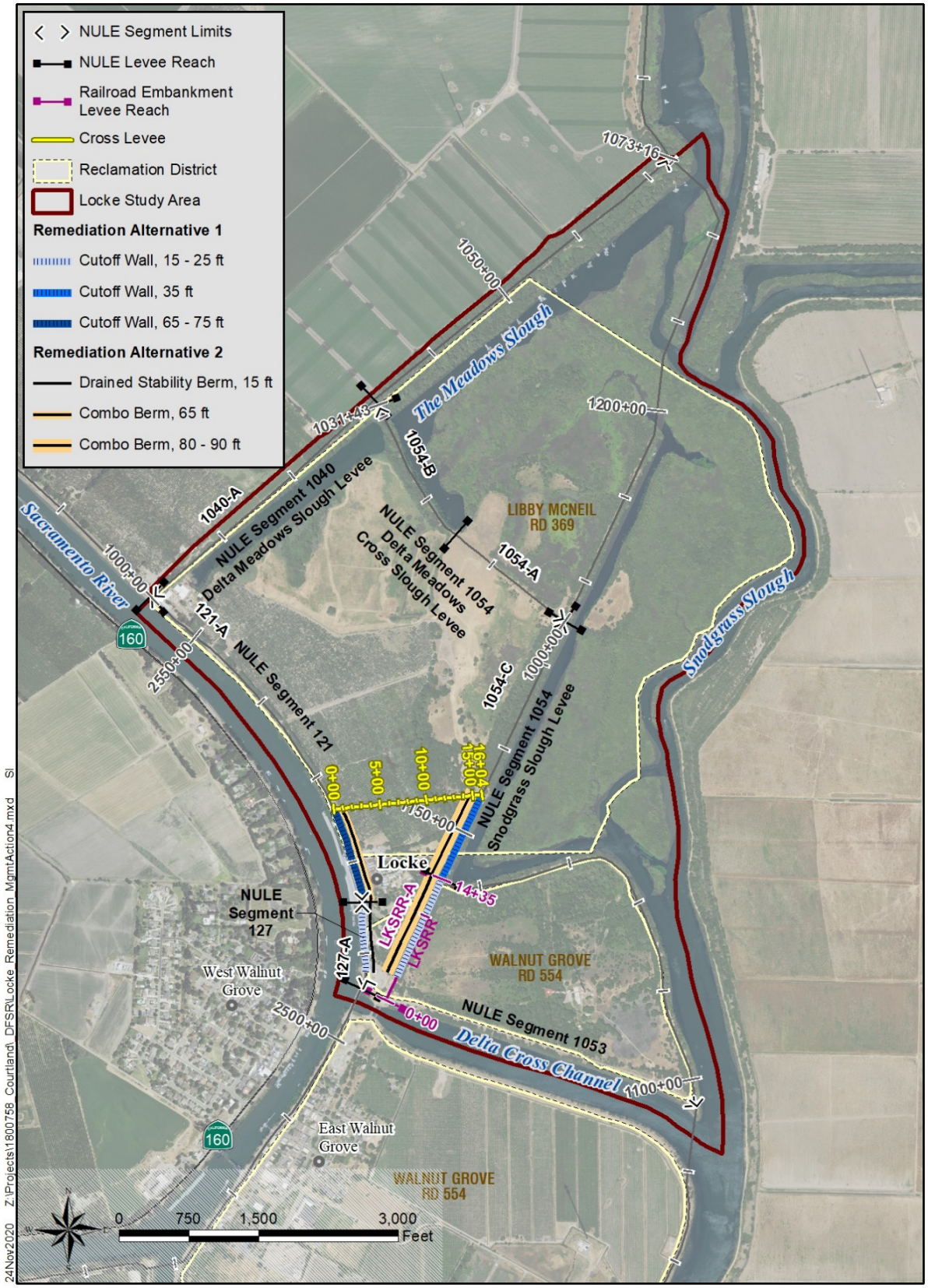

Figure 5-10. Potential Cross Levee North of Locke Paired with Remedial Alternatives to Repair and Strengthen Levees South of Potential Cross Levee.

5.1.2.3 Secure 100-Year FEMA Certification, for Entire RD 369 Perimeter Levee System and 0.60-mile Westerly Portion of Delta Meadows Slough South Levee (RD 551 South Levee)

This element builds on the previous collection of elements by improving and repairing the collection of levee segments primarily in RD 369 in accordance with FEMA standards for freeboard, seepage, erosion, and stability and settlement concerns pursuant to 44 CFR §65.10. Levee repairs and improvements would be made to the following levee segments (2.93 miles in total) to form a levee system which could be certified by FEMA: 1) 0.93 miles of SPFC levee along the left bank of the Sacramento River upstream and downstream of Locke (NULE Segment 121, RD 369, and the northerly 700 foot portion of NULE Segment 127, RD 554); 2) Delta Meadows Slough Non-SPFC levee (portion of NULE Segment 1040 in RD 551, 0.6 mile); 3) Delta Meadows Cross Slough and Snodgrass Slough right bank non-SPFC levees (portion of NULE Segment 1054 in RD 369, 1.2 miles); and 4) the most northerly 0.20 mile of the adjoining former railroad embankment which extends from the south side of the Snodgrass Slough right bank levee towards the northwest entrance to the Delta Cross Channel in RD 554 (Figure 5-11). In addition to the proposed structural remediations previously described, certain FEMA design criteria, O&M requirements, and documentation requirements specified in 44 CFR §65.10 are also addressed. These FEMA accreditation requirements are discussed briefly above in Section 5.1.2.2.

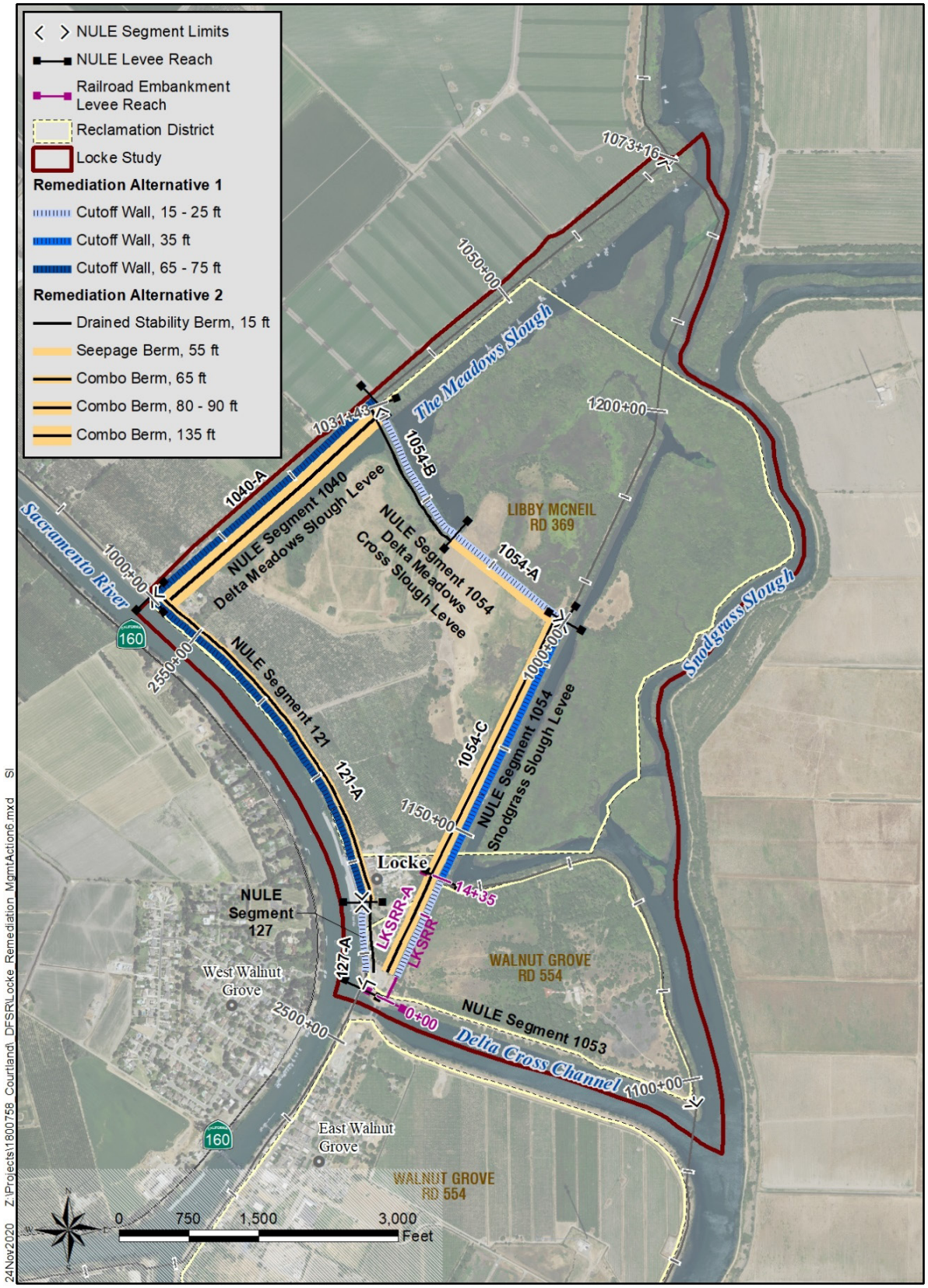

Figure 5-11. Proposed Improvements of RD 369 Perimeter Levee System, (Including 0.60-mile Westerly Portion of RD 551's Delta Meadows Slough non-SPFC Levee

5.1.2.4 Sacramento River Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke with Potential Cross Levee

This element combines the flood risk reduction elements described within Sections 5.1.1.1 and 5.1.2.2. To secure 100-year FEMA certification for the community of Locke, levee repairs and improvements would be made to the following levee segments in concert with a potential 0.30-mile-long cross levee north of Locke to form a levee system which could be certified by FEMA: 1) 0.35 mile of levee along the left bank of the Sacramento River of Locke (portions of NULE Segment 121 and NULE Segment 127); 2) 0.20 mile of levee along the right bank of Snodgrass Slough (portion of NULE Segment 1054 in RD 369), and; 3) 0.20 mile of improvements to the northerly railroad embankment which extends from the south side of the Snodgrass Slough right bank levee to the northwest entrance to the Delta Cross Channel (as previously depicted in Figure 5-10). In addition to the proposed structural remediations previously described, certain FEMA design criteria, O&M requirements, and documentation requirements specified in 44 CFR §65.10 are also addressed. This element also repairs and strengthens the remaining 0.60 miles of levee along the left bank of the Sacramento River north of the proposed cross levee as previously depicted in Figure 5-6.

5.2 Non-Structural Measures

Non-structural measures improve flood system performance and reduce exposure, vulnerability, and consequences of flooding. The suite of non-structural measures can be implemented in most cases with or without modifying the existing levee and flood control system. The full suite of non-structural measures considered in this feasibility study for the Community of Locke and the adjoining North Delta Legacy Communities within Sacramento County are described in detail in Appendix H and summarized below:

1. Deferred Vegetation Removal and Levee Crown Maintenance/Improvement with All-Weather Access Roads
2. Improved Governance Between Neighboring LMAs/RDs and Community
3. Voluntary Elevation of Structures
4. Wet or Dry Floodproofing
5. Acquisition and Relocation
6. Flood Emergency Safety Plans
7. Sacramento County Office of Emergency Services (OES) Decision Support Tool
8. Local Hazard Mitigation Plan and Relief Cuts
9. Alternatives to FEMA National Flood Insurance Program (NFIP) – Private, Community-Based Flood Insurance
10. NFIP Flood Insurance Enhancements *via* AFOTF
11. Mokelumne River Conveyance Improvements & Staten Island Overflow Area

12. Improve FEMA CRS Score for Sacramento County/Isleton
13. Land Use Regulations and Limitations
14. SWIFs & Periodic Inspections with USACE
15. Public Education/Public Awareness

The key non-structural measures identified above and within Appendix H that are community-specific to the Locke study area and warrant further discussions and descriptions are described in more detail below. All of the above non-structural measures identified above were presented to the Locke Study Area planning committee with most measures deemed acceptable, as summarized in Section 7.3. Appendix H also provides a description of why some measures may be more applicable to neighboring Delta Legacy Communities or why they may not be applicable to each specific Delta Legacy Community.

5.2.1 Deferred Vegetation Removal and Levee Crown Maintenance (portions of Delta Meadows Cross Slough Levee, Snodgrass Slough Levee, and Delta Meadows Slough Levee)

Portions of the Delta Meadows Cross Slough right bank levee (NULE Segment 1054, RD 369) are overgrown with vegetation. In general, excessive vegetation compromises the integrity of the levee system because it interferes with inspection, patrol, and flood fight activities. However, well-managed vegetation can help strengthen levees with extensive roots systems without significantly impacting inspection, patrol, and flood fight activities, while providing important fisheries and wildlife habitat benefits. Currently, DWR requires that woody vegetation be managed – that is, trimmed or removed – to provide visibility and access for inspection, patrol, and flood fighting activities. This non-structural measure removes vegetation along the Delta Meadows Cross Slough right bank levee (portion of NULE Segment 1054, RD 369), as well as along select portions of the Snodgrass Slough right bank levee (portion of NULE Segment 1054, RD 369) and the Delta Meadows Slough levee (portion of NULE Segment 1040-A, RD 551), primarily in support of providing better access for flood fight activities.

This non-structural measure also improves and maintains the levee crown roadways of the same portions of levees discussed above. Maintaining well-graded, year-round surfacing of the crown roadways not only facilitates all-weather access to the levee system but provides for proper drainage of rainwater and ensures a serviceable road under adverse conditions.

5.2.2 Improved Governance between Neighboring LMAs and RDs and Community

The RDs in the North Delta are protected by a system of leveed channels, upstream reservoirs and bypasses, and other structures that now comprise the SRFCP. The goal of the SRFCP is to reduce the chance of flooding to communities and agricultural lands in the Sacramento Valley and the Delta, including the Delta Legacy communities in Sacramento County. Under the

Standardized Emergency Management System (SEMS), Sacramento County establishes an Operational Area (OA). Traditionally, LMAs have not been included in planning or exercises. LMAs have relied mainly on DWR as their primary flood fight trainer, resources provider, and the next link in the SEMS chain of command rather than the local OA management structure. The Sacramento County Delta Flood ESP, written in June 2017, is an effort to improve communication between Sacramento County and the Delta LMAs by providing a better understanding of the river system, providing rescue and evacuation mapping, laying out the flood emergency response process, formulating detailed hazard information for LMAs, and providing flood response trainings.

To improve economies of scale, there is the potential for RD 369 – Libby McNeil to join forces (personnel, consultants, and equipment) with RD 554 – Walnut Grove or other adjacent RDs (RD 551 – Pearson District) to streamline costs and collaborate on reducing flood risks. RDs 369 and 554 have reportedly joined forces with other neighboring Districts in developing a Notice of Intent (NOI) to file a SWIF application with the CVFPB and the USACE. The SWIF assesses deficiencies and prioritizes levee repairs along the left bank of the Sacramento River, including the SPFC levee segments that provide protection to the communities of Courtland, Locke, and East Walnut Grove.

Due to assessment limitations imposed by the California Water Code, RD 369 and other similar RDs are limited to assessing properties within their District(s) by acreage and not by property improvements. Thus, it may be advantageous for the RDs to work closer together in potentially developing an improved assessment and or Geologic Hazard Abatement District (GHAD) for implementing flood risk reduction measures specific to the community. Framework exists for community-specific assessments similar to the County assessments that are in place for regional sanitation services, water supply and storm drainage services that are provided by the County and/or others beyond those provided by RDs 369 and 554.

5.2.3 Voluntary Elevation of Structures

Raising structures within the National Historic District of Locke is not a preferred nor a recommended option that would essentially change historic characteristics as the only community in the United States built in its entirety for and by Chinese Americans, dating back to 1915. However, there a few structures within in the study area that are outside the National Historic District that may be potential volunteer candidates for raising.

The voluntary structural elevation program collectively administered by FEMA and Sacramento County (and possibly others), is a flood risk reduction element that involves physically raising existing structures to an elevation 1.5 feet or greater above the FEMA BFE resulting from natural overland flows and/or a levee breach. For the Locke study area, the current BFE is set at 17 feet NAVD 88. This is a common and effective way to minimize damage from flooding and is a key flood protection provision of the NFIP.

Hydraulics and hydrologic modeling of the Lower Sacramento River system indicates that the structures in the study area would require raising between 5 and 10 feet to be elevated to or above the maximum floodplain. Elevations of this height may require additional seismic (and other practical) considerations to ensure stability and continued utility of the structures in question.

Below is a summary table (excerpted from Appendix H) that indicates the number and types of structures located within the community of Locke (SAC 51). The table also indicates the likely minimum cost of raising each of the noted structures, acknowledging that commercial and industrial structures will undoubtedly be more than the current estimate of $170,000/each to raise residential structures.

Table 5-4. Total Count and Cost to Elevate Structures in Locke Study Area

Community	CVFPP Impact Area	Total Structure Count and Cost to Elevate @$170,000/Structure				
		Residential	Commercial	Industrial	Public	Total
Locke	SAC 51	41	23	4	3	71
		$6,970,000	$3,910,000	$680,000	$510,000	$12,070,000

5.2.4 Wet or Dry Floodproofing

Damages to structures behind levees can be greatly reduced through effective floodproofing. Floodproofing can be cost effective for most structures where maximum depths of potential flooding are not expected to exceed 5 feet. However, agricultural-related structures have been known to be flood-proofed for flood depths far exceeding 5 feet If the flood depth at a site is above the practical height limits of available floodproofing barriers, an alternate mitigation method, such as raising of structures should be considered.

Though the base flood depth in the Locke study area is 17 feet NAVD 88, wet or dry floodproofing could be implemented for select structures in the study area where maximum potential flood depths are not expected to exceed 5 feet.

5.2.5 Acquisitions or Relocations

This flood risk reduction element involves acquiring land or relocating dwelling units, businesses, or agricultural structures to reduce flood risk. This element is included for comparison purposes, but it is not a preferred or recommended action for the subject Delta Legacy Community of Locke due to relocations of homes and businesses being disruptive to residents and the overall uniqueness of the National Historic District of Locke. DWR and others have suggested select communities subject to either deep or repetitive flooding should consider relocation to higher ground that is not subject to flooding. Relocating entire communities within

the Delta, particularly the historic Delta Legacy Community of Locke, is inconsistent with the goals and objectives of both the Delta Plan and the SSJDNHA designation.

5.2.6 Improved Emergency Response – Flood Emergency Safety Plans and County OES Decision Support Tool

Flood ESPs are one tool aimed at improving emergency response within Sacramento County. Public information, posted at the County's webpage, includes the following for individual RD ESPs: a Delta Area Flood Map, flood depth maps, how long it will take to flood the individual RDs, evacuation routes, and time-tables indicating the duration of time in hours, days, weeks, or months to pump-out and entirely drain the individual RDs, depending upon the rate of pumping capacity.

The Flood Operation Decision Support System (FODSS) tool is another effort aimed at improving emergency response within Sacramento County. Funded by DWR and sponsored by the County of Sacramento, California Governor's Office of Emergency Services (OES), the FODSS tool aims to improve emergency response, emergency management and coordination during high water and flood emergencies within the county.

5.2.7 Local Hazard Mitigation Plan and Relief Cuts

The Sacramento County Local Hazard Mitigation Plan (LHMP) is a multi-jurisdictional plan that geographically covers the entire area within Sacramento County's jurisdictional boundaries (planning area), including RD 369 and RD 554. The LHMP identifies hazards within Sacramento County, including those from floods and levee failure, assesses the vulnerability of the planning area to these hazards, and identifies mitigations to reduce or eliminate long-term risk to life loss and property damage from these hazards. The County of Sacramento developed the initial LHMP in 2005 and was last updated in 2016. The Sacramento County LHMP is updated every 5 years and is currently scheduled for a new update in 2021 that will likely include a greater discussion regarding potential relief cuts in RD 369.

As a mitigation measure, which can be used to reduce risk to life loss and property damage as a result of flooding or levee failure, potential locations of relief cuts could be formalized within the LHMP. The levee system protecting the Locke study area acts somewhat as a bowl with the water filling up to the top of the lowest downstream levee, typically at the lowest elevations in the study area. However, a carefully planned relief cut excavated into the levee at the lower downstream end of the Locke study area into Snodgrass Slough during or immediately following a breach event in the northerly portion of RD 359 would allow the water to escape or drain out of the RD before filling up the entire basin. For example, if there is 5 feet of freeboard (of 5 ft. differential of water stage) at the lower downstream end of the RD, the relief cut could potentially reduce flood depths by as much as 5 feet over the entirety of the RD, while waiting for the lower downstream levee reach to overtop. Personnel from RDs 369, 554, and adjoining downstream Districts will determine if a relief cut will be necessary should flooding occur.

Potential Benefits of a Community-Based Flood Insurance Program

- Potential source for project finance to reduce risk to community and assets
- Improved understanding of underlying risks and resilience opportunities
- Communities could renegotiate contracts every 5 to 7 years and decide how much risk to retain and how much to transfer
- Project financing would not be accounted for as debt on the community's balance sheet, providing added flexibility to the community
- Insurance could cover additional items such as funding for continuity of services, community equipment, and other items that are currently self-insured
- See Appendix J for further details for a Community-Based Flood Insurance Program for Locke and other nearby Delta Legacy Communities

However, in most cases there is no written description nor agreement for a planned relief cut. Potential relief cut locations should be identified, further evaluated, and formalized while updating the LHMP which addresses both RD 369 and RD 554. Any relief cut releasing flood waters from RD 369 into Snodgrass Slough would require coordination with downstream RDs (RD 554, RD 563, and others) as there may be coinciding high stage conditions within the Snodgrass Slough, Cosumnes River, and Mokelumne River basins.

5.2.8 Alternatives to NFIP – Community- and Flood-Risk Based Insurance Programs

The NFIP is managed by FEMA, through its subcomponent, known as the Federal Insurance and Mitigation Administration (FIMA). It is currently the only federally-backed flood insurance program, so the introduction of alternative flood insuring options for homeowners (such as private community-based flood insurance) carries the advantage of offering potentially more favorable terms to residents within any of the noted Delta Legacy Communities of Sacramento County, including the City of Isleton.

A review of FEMA's current and planned mapping procedures, insurance, requirements, insurance rates, and policies indicates that agricultural facilities in leveed areas of the Sacramento Valley, including Locke, have been bearing a disproportionately large share of the financial burden of the NFIP. Private sector involvement in the flood insurance industry could protect this area's flood insurance premiums by matching rates to risk through an emerging market for private community-based flood insurance policies.

As NFIP premiums continue to increase for residents in Locke, private insurers are entering the market. They are taking advantage of better flood mapping, modeling, the accessibility of increasingly high-resolution national data sets, innovations in statistical analysis, and sophisticated global financial markets to fill the affordability gap. In 2019, over 10,000 private insurance policies were written in California (Wholesale & Specialty Insurance Association, 2019).

Private insurers use their own models to establish the price of a policy. For example, the nonprofit First Street Foundation recently released a nationwide flood model accessible from any mobile device similar to many used by private insurers. It is an easily understood, easily

accessible nationwide tool for presenting flood risk information. By visiting FloodFactor.com[1] a resident of Locke can easily get a general picture of their flood risk. Flood risk is specified by assigning a risk score from 1 to 10. The score is based on cumulative likelihood of flooding at different flood depths based on riverine analyses which indicate flood depths can exceed 10 feet in certain North Delta Communities.

Flood risk information obtained from sites like FloodFactor.com will be different than flood information produced by DWR or FEMA because the methods to assess risk are different.

An alternative to individual NFIP homeowner policies is a community-based flood insurance program. A community-based flood insurance program would have the opportunity to lower flood insurance costs by working with an insurer to provide better risk information and by actively implementing agreed upon mitigation measures. A community might choose to: (1) sell their risk to an insurer;(2) finance the risk through capital markets; or (3) implement a combination of risk financing mechanisms. By actively managing the flood risk, the community flood risk program would provide the opportunity to both reduce flood insurance premiums and finance levee improvements and/or implement non-structural measures identified herein in Section 5.2, and in Section 7.3.

One way that a community might choose to implement a community-based flood insurance program is through the establishment of a Homeowners Association (HOA) or a GHAD. A GHAD is a state-level public agency for the purpose of providing prevention, rapid response, and funding to address hazardous geologic conditions. They were established in 1979 by the Beverly Act to allow local residents to develop self-funding mechanisms that address the long-term abatement and maintenance of structures that protect real property from geologic hazards.

The City of Isleton has already taken the initial steps in June to July of 2021 to formalize a path for property owners within its city limits to aggregate their resources and establish a community-based flood insurance program that can be used to augment and/or replace the current set of NFIP policies held within the City of Isleton. The County is also encouraging the unincorporated North Delta Legacy of Locke to consider alternatives to the current NFIP, including a community-based flood insurance program that could be administered with or without developing a GHAD. A similar community-based flood insurance program is being considered for the San Francisquito Creek JPA, located in the south Bay Area (*see* Appendix J, prepared by Kathleen Schaefer, P.E., CFM, former FEMA regional administrator of NFIP).

5.2.9 NFIP Flood Insurance Enhancements via AFOTF

The AFOTF *via* its Technical Memorandum of December 28, 2016, has recommended as many as seven administrative refinements of the NFIP to sustain agriculture as a wise use of the floodplain in leveed SFHAs. The NFIP administrative refinements (and amendments proposed by H.R. 830) are focused on improving agricultural sustainability while collectively reducing

[1] https://www.floodfactor.com/

flood risks. The recommendations address how rules and practices could be modified to: (1) reduce or remove elevation and floodproofing requirements for new and substantially improved agricultural structures, and (2) reduce the cost of flood insurance for agricultural structures with a federally backed mortgage to a more appropriate risk-based portion of the financial risk in the NFIP. The key elements include the following, of which most are applicable to the Locke study area:

a) Levee relief cuts with emergency operation plans and floodplain management ordinance
b) Zone X for certified levee reaches: The partial accreditation of a basin or levee reach could potentially lead to lower NFIP insurance rates as portions of levee systems are approved.
c) Wet floodproofing rules for agricultural structures
d) Insurance rates for nonaccredited levees: The AFOTF recommends that FEMA use sound actuarial science to amend its insurance rates to reflect flood protection provided by a non-accredited levee as documented by a civil engineer.
e) Insurance rates for agricultural structures
f) Insurance rates for wet floodproofed structures
g) Add levee risk management activities to FEMA CRS

5.2.10 Mokelumne River Conveyance Improvements/Flood Easements

In October 2010, a Final Environmental Impact Report (EIR) was published by DWR for the North Delta Flood Control and Ecosystem Restoration Project. The purpose of this project was to implement flood control improvements in a manner that benefits aquatic and terrestrial habitats, species, and ecological processes. Specifically, improvements were sought which were expected to reduce damage to land uses, infrastructure, and the Bay-Delta ecosystem resulting from overflows caused by insufficient channel capacities and catastrophic levee failures in the North Delta study area. One option analyzed and presented in this EIR included dredging components of the channel along the North and South Forks of the Mokelumne River. Dredging is expected to directly reduce flood stages in the Mokelumne River and Snodgrass Slough providing a flood risk reduction benefit to the adjoining nearby communities, including Locke. Another option yielding similar results involves raising levee segments along these reaches. The implementation of these screened alternatives has the potential to directly reduce flood risk for the Locke study area which is impacted by high water stages in Snodgrass Slough.

Another option specific to this area which could reduce flood risks to the study area involves allowing flood stages along the North and South Forks of the Mokelumne River to overtop into Staten Island, or portions thereof, and serve as a flood relief overflow area. This option's feasibility stems largely from the fact that this area is sparsely populated, and its use for a flood easement would allow for significant lowering of water stages in the North Delta Region adjoining and upstream of the North and South Forks of the Mokelumne River.

In addition to the 2010 Final EIR published by DWR for the North Delta Flood Control and Ecosystem Restoration Project there have been a series of other documents developed by DWR and the California Federal Bay Delta Program to reduce flood risks and improve water conveyance through the North Delta following the flooding of the RD 563 portion of Walnut Grove (East) and Thornton within the New Hope Tract during February 1986. These documents are described in more detail in Appendix H. The documents suggest improving channel capacity in the Mokelumne River on either side of Staten Island and/or securing flood easements on Staten Island to accept excess flood waters would significantly reduce flood stages upstream in Snodgrass Slough for the nearby communities of East Walnut Grove, Locke and possibly as far upstream as Courtland and Hood.

5.2.11 Improve FEMA CRS Score for Sacramento County

Sacramento County, *via* its floodplain administrator program, is a very active participant of the NFIP, and through its County-wide Flood Protection Ordinance the County strives to reduce flood risks throughout the unincorporated areas of Sacramento County while also attempting to reduce NFIP premium policy rates. Through different flood mitigation activities outlined within the NFIP, Sacramento County has been able to reduce flood insurance through the FEMA CRS. Since 1992, Sacramento County has steadily improved its CRS score and as of May 2017, Sacramento County has maintained a Class 2 designation, which has yielded a 40 percent reduction of NFIP insurance premiums for SFHAs (an average reduction of $547 in annual NFIP premiums), within Sacramento County, including the entire Locke study area. The County currently has the opportunity to improve their CRS score to achieve the highest possible Class 1 designation by implementing and participating in Emergency Action Plans (EAPs) and associated Table Top Exercises for nearby, upstream dams/reservoirs (namely Folsom Reservoir, and possibly others) that could have a sizeable impact on flooding portions of Sacramento County if said reservoir(s) were to fail and cause flooding. This last jump from a CRS Class 2 to Class l designation would result in the last available 5 percent decrease in NFIP premiums and would place Sacramento County as the second highest ranked CRS community in the entire Country behind Roseville.

5.2.12 Public Education and Awareness

There are currently three programs within the Delta that provide public education, awareness, and notifications about flood risk. One is the Delta Flood Preparedness Week hosted annually by the DPC. As part of this effort the DPC provides calendars that consolidate important flood-related information specific to the Delta including emergency phone numbers and websites with flood education as well as safety information.

A second is the Sacramento County Program for Public Information that aims to increase awareness through informational materials (such as the Storm Ready Booklets) and multiple levels of outreach, ranging from radio spots to specific stakeholder engagement. This program

can act as a conduit of flood risk information and coordination directly with the community members of Courtland.

The third program is the California DWR Flood Risk Notification Program that includes sending annual notices in advance of the flood season to every property owner who is located behind a SPFC levee within the Delta. The individual notices include the property owner's address and informs the owners their property may be exposed to potential flood risk from the failure of the levee system. The notice also suggests each property owner visit DWR's Flood Risk Notification[2] and enter their address to get the most information on State-Federal levees in their area.

5.3 Multi-Objective Components

There are several opportunities for including multi-objective components during construction of structural elements and implementation of select non-structural measures. Multi-objective options could offer benefits outside of the Locke Legacy town boundary and benefit the broader community within and beyond the larger study area.

5.3.1 Water Quality and Water Supply, including Through-Delta Conveyance Reliability and Operational Flexibility

Repairing and strengthening the SPFC levee reaches along the east, left bank of the Sacramento River between Freeport and the Delta Cross Channel in the north Delta (which includes MA 9, RD 755 – Randall Island, RD 551 – Pearson District, RD 369 – Libby McNeil/Locke, and RD 554 – East Walnut Grove) would also improve the reliability and resiliency of conveying through-Delta CVP and SWP water in the Lower Sacramento River to the Delta Cross Channel. Within the Locke study area, improving the 1 mile of the SPFC levee along the left bank of the Sacramento River between Delta Meadows Slough and the northwest entrance to the Delta Cross Channel would improve 3 percent of the non-urban SPFC levees between Freeport and the Delta Cross Channel (total of 37 miles), and 2 percent of the SPFC levees which comprise the freshwater corridor within the Delta (total of 62 miles).

5.3.2 Ecosystem Restoration/Enhancement

Ecosystem restoration opportunities must be balanced with flood management requirements and in support of continued agricultural land uses in the Delta. Restoration opportunities adjacent to Locke include: (1) enhancing existing riparian habitat along Snodgrass Slough and Meadows Slough and seasonal wetland (wet meadows) in the study area which represent some of the last remaining remnant habitat exhibiting pre-European settlement conditions, which also provides habitat for Delta mudwort and Delta smelt, (2) enhancing the combination of wildlife habitat and recreation opportunities within the Delta Meadows State Park adjacent to the communities of

[2] https://water.ca.gov/myfloodrisk

Locke and East Walnut Grove, and (3) in concert with potential erosion repairs with rock slope protection or other means, potential opportunities may exist for enhancements to the SRA along the left bank levee of the Sacramento River. Potential opportunities for ecosystem restoration and recreational/educational enhancements in the project area, inclusive of the Delta Meadows State Parks Property and adjoining areas are highlighted in Figure 5-12 and Figure 5-13.

Opportunity for SRA habitat enhancement of the Sacramento River could be a potential extension and offer greater connectivity to the SRA opportunities outlined in the Lower Sacramento-North Delta RFMP of 2014 between Sacramento RM 35 and RM 46 within MA9 between Freeport and Courtland. *See* Appendix D for a discussion of ecosystem opportunities within the project area and within the greater north Delta region.

5.3.3 Public Recreation and Education Multi-Benefit Opportunities

The Delta Legacy Communities and encompassing study areas provide a unique mix of modern working agricultural lands, wildlife habitat and viewing opportunities, pastoral landscapes, and a glimpse into history. This provides an opportunity to encourage public education and recreation opportunities for community residents and visitors from outside the Delta and to provide economic stimulus from Delta-centric tourism to the project study area. Opportunities exist within the historic District of Locke including the Locke Boarding House Museum State Park, Delta Meadows State Parks Property, the USBR Delta Cross Channel, and the adjoining Delta Legacy Community of East Walnut Grove, just south of the Delta Cross Channel.

Cross Levee Community Loop Trails

A potential cross levee alignment on the north side of Locke could have a wider crown (approximately 20 ft.) and could easily be modified to act as a community trail[3] for walking or biking, which would allow residents and community visitors to more easily avoid traffic on River Road. The cross levee trail could also include signage and interpretive information for users regarding the rich history of the area.

This cross levee trail could also connect to the Sacramento River levee west of Locke, and to the existing railroad embankment, running along the southeast edge of Locke, where the levee would also be improved, to create a circular public access loop around the entire Historic District of Locke. Minor brush clearing and all -weather surfacing along the Delta Meadows cross levee would improve the ability for the RD to conduct flood fighting activities and would also create another opportunity for a longer loop trail around a larger portion of the study area. This wider loop trail option would also provide connectivity for visitors to the existing boat-in campground at Delta Meadows State Park, down to the Historic District of Locke.

[3] Delta Protection Commission (DPC). January 20, 2022. Great California Delta Trail Master Plan. Available at: https://delta.ca.gov/recreation-and-tourism/

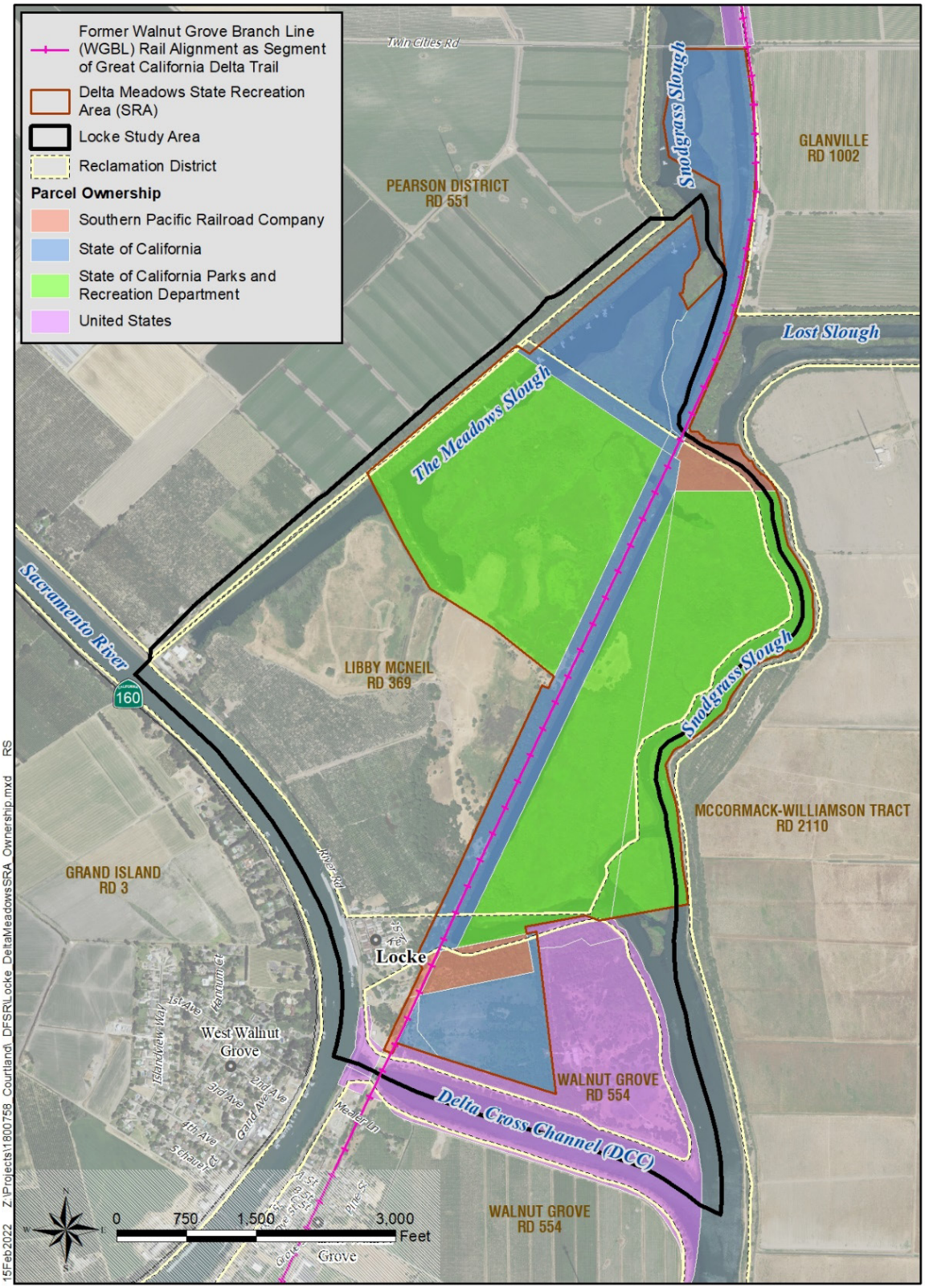

Figure 5-12. Delta Meadows State Parks Property and USBR Property Including Former Walnut Grove Branch Line (WGBL) Rail Alignment as Segment of Great California Delta Trail North and South of Delta Cross Channel

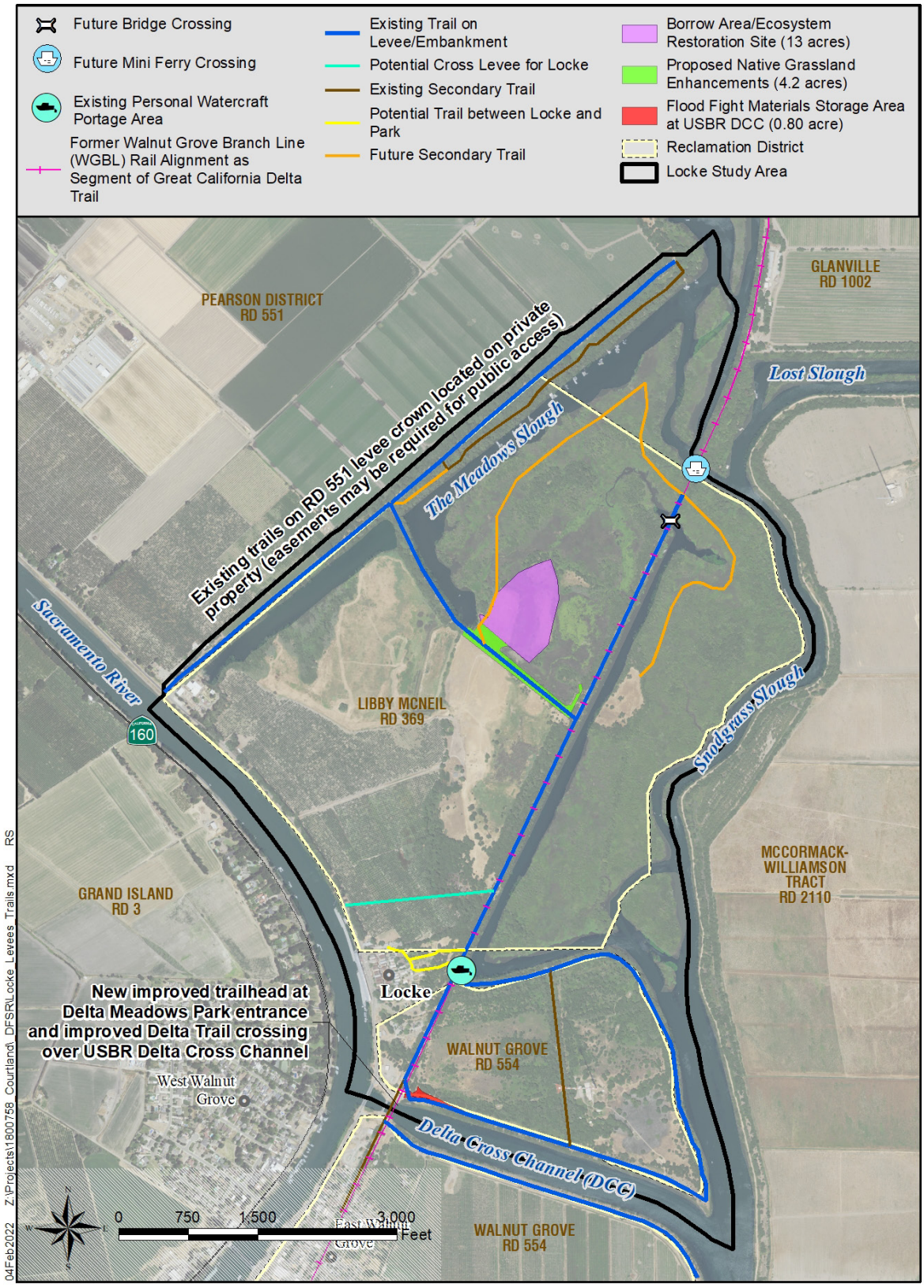

Figure 5-13. Ecosystem Restoration and Recreational/Educational Enhancement Opportunities Adjoining Delta Meadows State Parks Property and USBR Delta Cross Channel

The levee crown from the Locke boathouse and Locke Boarding House Museum to the north towards RD 551 is extra wide along the top of the levee to the Libby, McNeil & Libby Cannery property. This has developed into an informal parking area for local anglers. Parking in this area could be formalized and an additional trailhead into Delta meadows could also be created, with interpretive signage detailing the rich agricultural history of Locke and the larger study area.

The Delta Meadows State Park is popular with non-motorized boaters. Kayakers frequent this area because wildlife are attracted to the dense riparian and wetland vegetation and it offers a glimpse into how much of the Delta may have appeared prior to European settlement. This area also offers boaters proximity to birdwatching opportunities at the Cosumnes River Preserve, Snodgrass Slough, or to points farther upstream or downstream. By improving access in the study area (in concert with improvements in the adjacent East Walnut Grove study area), boaters could use the East Walnut Grove Marina, Locke, or Delta Meadows as a starting point for boating all the way to Stone Lakes National Wildlife Refuge, where existing parking and trailheads are in place. Additionally, facilitating access for pedestrians at Delta Meadows, in conjunction with adjacent trail improvements would provide visibility and revenue for maintenance at this underserved State Park.

Historic District Access

Parking for trail users or visitors to Locke's historic district could be constructed on lands already in public ownership, just to the north of the Delta Cross Channel on either USBR property or on Delta Meadows State Park Property. Locke is the largest and most intact surviving example of a historic rural Chinese-American community in the United States, including more than 50 commercial and residential buildings. Locke is the only such community remaining in the Sacramento-San Joaquin River Delta, which was a particularly important area of rural Chinese settlement. Most of the town's original buildings are still standing and there are also many businesses operating in Locke's historic buildings, where visitors can purchase art and traditional herbs, visit the Dai Loy Museum, enjoy Chinese food, receive traditional Chinese medicine treatments, and peruse the Chinese Cultural Shop offerings. *See* Figure 2-9 in Section 2.1.8 which identifies the location and extent of the Locke Historic District and associated structures located within the Locke study area, including the former Walnut Grove Branch Line (WGBL) rail alignment that is largely owned by public entities (state, federal and Reclamation District 813) between Freeport and Walnut Grove. Additional details of the Locke Historic District and associated historic buildings can also be reviewed in Appendix C – Cultural Resources Records Search Results for Locke, California.

Great California Delta Trail Segments and Connection Trails

Improvements to perimeter levees around the study area could include installation of an all-weather surface along the existing crown road, parking, and signage. A trail leading around the perimeter of the study area could be usable for local residents and out-of-Delta visitors. The existing railroad bridge over the Delta Cross Channel, located on private property, could be re-

opened to the public, which would create a direct connection between the historic districts of Locke and East Walnut Grove without requiring visitors to walk or ride along the heavily trafficked and narrow River Road. In addition to reopening the former rail crossing over the Delta Cross Channel, the former WGBL coexisting on existing levee crowns in RDs 369, 554, and 1002 could become early segments of the Great California Delta Trail in the Central Delta as identified in the DPC's Great California Delta Trail Master Plan of January 2022. https://delta.ca.gov/recreation-and-tourism/

In addition to improving the trail systems on these existing, adjoining RD levee systems, improving the trailhead system at Delta Meadows could also enhance the opportunity of having Delta Meadows, Locke, and Walnut Grove becoming a larger recreational activity hub in the Central Delta as also identified in the DPC's Great California Delta Trail Master Plan of January 2022.

Additionally, with the installation of a foot/bike bridge or small mini-ferry that could be solar powered, and battery-assist at the location of the now defunct and removed railroad turnstile bridge across Meadows Slough, pedestrians or cyclists could potentially travel from East Walnut Grove, over the Delta Cross Channel, along the improved railroad embankment levees adjacent to Locke (within RDs 554 and 369), and then connect to other Delta Legacy Communities, to the adjacent Delta Meadows State Park (with facility improvements in partnership with State Parks), north into RDs 1002 and 813 to Stone Lakes National Wildlife Refuge, and finally to Freeport and Old Sacramento. Figure 5-12 and Figure 5-13 collectively provide an initial identification of both ecosystem restoration and recreational/educational enhancement multi-benefit opportunities within the immediate study and for segments of the RD 369, 554 and RD 1002 levee crowns along the former WGBL that could become early segments of the Great California Trail in the Central Delta. The trail segments could easily connect with the Stone Lakes National Wildlife Refuge area in the North Delta adjacent to the Delta Legacy Communities of Hood and Freeport, with the largest obstacle crossing Snodgrass Slough north at Delta Meadows just southwest of RD 1002. These ecosystem and recreational multi-benefit opportunities must be balanced with maintaining the quality of life for residents and businesses of the Locke community and require further refinement and discussion with landowners, neighboring RDs including RDs 554, 551 and 1002, stakeholders, including the Locke Foundation and the Locke Management Association.

Locke and the adjoining Delta Meadows area has much to share with visitors, as detailed on the Story Map for the community, accessible here: Locke Story Map - Sacramento County Small Communities Flood Risk Reduction Program.[4]

[4] Locke Story Map - Sacramento County Small Communities Flood Risk Reduction Program: https://sacramentocounty.maps.arcgis.com/apps/MapJournal/index.html?appid=277f1bd2979b4cc2adb068ec234daa33

6. Identification and Trade-Off Analysis of Structural-Based Flood Risk Reduction Management Actions

This Section uses the structural elements and non-structural measures previously described in Section 5 to develop and prioritize Management Actions (MAs) based on risk reduction and responsiveness to planning objectives, as well as constraints regarding funding, implementation, and capital costs. MAs were developed by combining one or more flood risk reduction elements. These MAs are recommended to be implemented in a successive fashion as funding is collectively identified and secured. This Section also provides the capital costs associated with each MA, as well as a trade-off analysis using the planning objectives identified above in Section 4.1.

The structural elements and non-structural measures identified in Section 5 were prioritized into seven MAs based on the most efficient approaches to reducing risk and achieving the previously identified objectives of:

- Reducing risk to life
- Reducing risk to property damage
- Reducing probability of levee failure
- Limitation of high insurance premiums
- Improved preparedness and response
- Enhancing resiliency and reliability of through-Delta water conveyance
- Prioritizing environmental stewardship and multi-benefit projects

As previously discussed, risk reduction is defined as the product of the probability of levee failure and the consequences of failure. The consequences of levee failure are defined in this study in terms of life loss and property damage. Of the seven MAs, those which resulted in the greatest risk reduction by reducing the probability of levee failure of the weakest levee segments and reducing the consequences of levee failure through reduced life loss and property damage were given priority. However, funding, implementation, and capital cost are also considered during the prioritization process.

6.1 Identification of Flood Risk Reduction Management Actions

The seven MAs are summarized below. These MAs are compared against the no action, future without project condition to quantify how well each MA addresses the objectives of this study using the planning objectives identified above in Section 4.1.

6.1.1 No Action, Future Without Project

Future without project conditions represent the current level of flood protection within the study area, does not incorporate any structural or non-structural flood risk reduction elements, and incorporates expected changes to the study area from climate change, sea level rise, and future land uses.

Without any changes to the flood management system or implementation of non-structural measures:

- The study area remains at a high risk of flooding. As previously discussed, according to ongoing and previous studies conducted by DWR and the DSC DLIS, it is estimated that the community of Locke has an estimated 29- to 50-year level of flood protection.
- There is a high risk of life loss for the densely populated community of Locke. In the event of a levee failure along the left bank of the Sacramento River fronting the community, significant life loss is likely as a result of high floodwater depths and velocities which would leave little time to evacuate.
- There is also a high risk of property damage for the community of Locke and the larger study area. A levee breach along the left bank of the Sacramento River upstream from the community could result in flood depths in the community of Locke upwards and exceeding 10 feet These flood depths could result in damages to the community and the larger study area on the order of $55M. With the current level of flood protection noted above, this equates to an EAD annualized value of nearly $363,000.
- The community remains susceptible to high NFIP annual premium increases, which could result in a net reduction of insured homes, further increasing flood risk.
- Levees within the Delta remain at risk of failure, which could significantly impact the agricultural economy within and adjacent to the community of Locke and the conveyance of water to SWP and CVP water contractors south of the Delta.

6.1.2 Management Action 1: Repair and Strengthen-in-Place Delta Meadows Cross Slough Non-SPFC Levee Northeast of Locke (portion of NULE Segment 1054 in RD 369)

As previously discussed, the Delta Meadows Cross Slough right bank levee (portion of NULE Segment 1054 in RD 369) which adjoins the RD 551 Delta Meadows Slough levee with the Snodgrass Slough right bank levee (also in RD 369) is estimated to have a moderate to high likelihood of failure as documented in the NULE GAR and confirmed with CPT geotechnical explorations and soil samples collected in 2019. Of the levees within the Locke study area, the Delta Meadows Cross Slough right bank levee has the highest probability of levee failure as a result of vulnerabilities to underseepage, through seepage, and slope stability. Although not modeled as part of the Delta Flood ESP for RD 369, a breach along the Meadows Cross Slough levee could result in property damage in the community of Locke and the larger study area as a result of deep flooding. Life loss is also a possibility as a result of a levee breach on the Delta Meadows Cross Slough levee. Since flood risk is defined in terms of probability of levee failure and risk of life loss and property damage, flood risk is greatest within the study area for this levee segment. When considering capital cost, implementation, and funding, repair, and strengthen-in-place of the Delta Meadows Cross Slough levee in RD 369 this levee segment was selected as the most efficient, no regrets means of reducing this flood risk. Remedial alternatives for MA 1 are described in Sections 5.1.1.2 and 5.2.1.

6.1.3 Management Action 2: Repair and Strengthen-in-Place Snodgrass Slough Non-SPFC Levee Northeast of Locke (portion of NULE Segment 1054 in RD 369) and Portion of RD 554 Railroad Embankment

The Snodgrass Slough right bank levee in RD 369, which extends southwest for approximately 0.6 mile from the south side of the Delta Meadows Cross Slough levee is estimated to have a moderate to high likelihood of failure due to vulnerabilities to underseepage, through seepage, and slope stability as documented in the NULE GAR and confirmed with CPT geotechnical explorations and soil samples collected in 2019. Although not modeled as part of the Delta Flood ESP for RD 369, a breach along the Snodgrass Slough right bank levee could result in property damage in the community of Locke and the larger study area as a result of deep flooding. Life loss is also a possibility as a result of a levee breach on the Snodgrass Slough levee. A breach on the former railroad embankment which adjoins the Snodgrass Slough right bank levee (and extends southwest approximately 0.20 mile towards high ground near the northwest entrance to the Delta Cross Channel) also has the potential to result in life loss and property damage in Locke and the larger study area. As a result, repairing and strengthening the Snodgrass Slough levee in RD 369 and the most northerly 0.20 mile of railroad embankment in RD 554 was selected as the next most efficient means of reducing flood risk to the community of Locke and the larger study area. Remedial alternatives for MA 2 are described in Sections 5.1.1.2 and 5.2.1.

6.1.4 Management Action 3: Repair and Strengthen-in-Place Sacramento River SPFC Levee West of Locke (NULE Segment 121 in RD 369 and a Portion of NULE Segment 127 in RD 554)

As previously discussed, the risk of life loss is of greatest concern within the community of Locke if a levee breach were to occur along the left bank of the Sacramento River, either upstream (NULE Segment 121 in RD 369) or downstream (NULE Segment 127 in RD 554) of the community. A levee breach near or within the community of Locke would likely result in high floodwater velocities, leaving little or no time to evacuate. A levee breach along these segments of levee could also result in significant property damage in the community and in RDs 369 and 554 as a result of deep flooding. However, these segments of SPFC levee are estimated to have a lower likelihood of failure as documented in the NULE GAR. As a result, repair and strengthen-in-place of the roughly 0.93 mile of levee along the left bank of the Sacramento River (NULE Segment 121, 0.8 mile, and a 0.13 mile portion of NULE Segment 127 downstream of Locke) was prioritized as MA 3. MA 3 would improve the resiliency and reliability of through-Delta water conveyance by improving 3 percent of the non-urban SPFC levees between Freeport and the Delta Cross Channel (total of 37 miles), and 2 percent of the SPFC levees which comprise the freshwater corridor within the North Delta (total of 62 miles). Remedial alternatives for MA 3 are described in Section 5.1.1.1. This MA may also require addressing a potential freeboard deficiency of the RD 369 levee immediately upstream and adjoining the community of Locke. The levee at this location is deemed to be the controlling reach of flow conveyance capacity for the Sacramento River between Steamboat and Georgiana Sloughs as documented in the DWR Sacramento River Basin Channel Capacity Atlas, dated December 2016.

6.1.5 Management Action 4: Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee North of Locke (portion of NULE Segment 1040-A in RD 551)

The portion of the RD 551 Delta Meadows Slough levee common to the RD 369 and RD 551 boundaries which extends eastwards approximately 0.6-mile from the confluence with the Sacramento River is estimated to have a lower likelihood of failure due to vulnerabilities to underseepage and slope stability. The levee segment is the south cross levee boundary of RD 551 and is normally dry. This levee segment would only experience water of significant depth following the rare event of a levee failure occurring upstream in the RD 551 Pearson District along the Sacramento River left bank SPFC levee. Such levee breach would also have to result in flooding the entire RD 551 Pearson District to flood elevations of 18 to 19 ft. NAVD88 if a relief cut was not implemented in RD 551. If a relief cut was implemented in RD 551 the maximum flood depth along this reach of RD 551 would not likely exceed elevation 16 ft. NAVD88. The crown elevations of NULE Segment 1040-A vary between 23 and 26 ft. NAVD88, resulting in freeboard levels of 7 to 10 ft. along this segment that also has waterside slopes that appear to be flatter than 4:1 HV (horizontal to vertical). Life loss is not likely to be a concern with this levee segment (1040-A) as the entire RD 551 basin is quite large and would require several days to fill

up prior to having any significant water stage on this levee segment which would allow time to evacuate the downstream community of Locke. However, property damage in Locke and the larger study area are a possibility should a levee breach occur along this segment of levee. Repair and strengthen-in-place of the 0.6-mile portion of the Delta Meadows Slough levee in RD 551 is selected as MA 4. Remedial alternatives for MA 4 are described in Sections 5.1.1.3 and 5.2.1.

6.1.6 Management Action 5: Secure 100-Year FEMA Certification, with Potential Cross Levee North of Locke Paired with Perimeter Levee Improvements South of the Potential Cross Levee

As described in Section 5.1.2.2, repair and strengthen-in-place of the 0.75 mile of levees in RDs 369 and 554 in conjunction with a potential 0.30-mile cross levee north of Locke would greatly reduce the probability of levee failure to the community of Locke. FEMA certification of said levee system including and south of a potential cross levee ensures 100-year flood protection for the community of Locke and helps to limit the small number of high NFIP insurance premiums currently held in within the community of Locke. However, FEMA certification of this levee system may be cost-prohibitive without support from through- and south-of-Delta water conveyance interests associated with the CVP and SWP and/or with other potential eco-system and recreational enhancements offered in nearby Delta Meadows. As a result, securing 100-year FEMA certification for this levee system was prioritized as MA 5. FEMA certification would be performed once the levee system is remediated and improved to current FEMA criteria for erosion, through seepage, underseepage, slope stability, and freeboard. All design criteria, O&M requirements, and documentation requirements included in 44 CFR §65.10 would also need to be addressed to secure 100-year FEMA certification.

6.1.7 Management Action 6: Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System

As described in Section 5.1.2.3, repairing and strengthening-in-place of the 2.93 miles of levees primarily in RD 369 but also within RD 554 and RD 551 would greatly reduce the probability of levee failures along the entire left bank of the Sacramento River, along Snodgrass Slough and the former Walnut Grove Branch line (WGBL) rail embankment to the east, and upstream flood waters originating from within RD 551 to the north. Improvements to these levee segments would protect lives and property within the community of Locke and within RD 369, including portions of RD 554 north of the Cross Channel and east of the former WGBL. FEMA certification of said perimeter levee system ensures 100-year flood protection for the community of Locke and the balance of the RD 369 basin contained within the bounds of these levees, reduces high insurance premiums in the study area and enhances the resiliency and the reliability of through-Delta water conveyance by improving nearly 3 percent of the SPFC levees located between Freeport and the Delta Cross Channel (total of 37 miles) and nearly 2 percent of the total SPFC levees (total of 62 miles) which comprise the freshwater corridor in the North Delta. FEMA certification of this levee system may be cost-prohibitive without support from through- and south-of-Delta water conveyance interests associated with the CVP and SWP. As a result,

securing 100-year FEMA certification for this levee system was prioritized as MA 6. FEMA certification would be performed once the levee system is remediated and improved to current FEMA criteria for erosion, through seepage, underseepage, slope stability, and freeboard. All design criteria, O&M requirements, and documentation requirements included in 44 CFR §65.10 would also need to be addressed to secure 100-year FEMA certification.

See Appendix K for further details in support of the multi-benefit opportunities identified by the Sacramento County Delta Legacy Communities associated with reducing flood risks combined with improving SWP water conveyance through the Delta.

6.1.8 Management Action 7: Sacramento River Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke with a Potential Cross Levee north of Locke

MA 7 combines the repairs and improvements associated with MA 3 (repairing and strengthening-in-place the 0.93 miles of SPFC levee along the left bank of the Sacramento River) with MA 5 (FEMA certification of the levee system consisting of a cross levee north of Locke and perimeter improvements south of said cross levee). Combining these flood risk reduction elements, which comprise MA 7, reduces life loss and property damage in the community of Locke and the larger study area, improves the resiliency and reliability of through-Delta water conveyance, as previously described in Sections 6.1.4 and 6.1.7, ensures 100-year flood protection for the community of Locke, and helps to limit high NFIP insurance premiums. As previously discussed, FEMA certification of the levee system and repairing and improving the levee along the left bank of the Sacramento River may be cost-prohibitive without support from through- and south-of-Delta water conveyance interests associated with the CVP and SWP. As a result, the flood risk reduction elements described herein were prioritized as MA 7. FEMA certification would be performed once the levee system is remediated and improved to FEMA criteria for erosion, through seepage, underseepage, slope stability, and freeboard. All design criteria, O&M requirements, and documentation requirements included in 44 CFR §65.10 would also need to be addressed to secure 100-year FEMA certification.

See 9.Appendix K for further details in support of the multi-benefit opportunities identified by the Sacramento County Delta Legacy Communities associated with reducing flood risks combined with improving SWP water conveyance through the Delta.

6.2 Capital Costs

Cost estimates were developed for each of the structural elements identified in Section 5.1. Where possible, these cost estimates were developed in concert with previous estimates prepared by DWR. Table 6-1 provides a range of capital cost estimates by levee reach using the previously identified remediation alternatives. These estimates are used as the basis to develop the range of costs for each of the repair and strengthen-in-place structural elements. Costs presented in this Section are intended to be Class 4 (Feasibility Level) estimates as defined by

the Association for Advancement of Cost Engineering International, and additional geotechnical explorations and analysis are recommended to further refine these cost estimates. Costs for all approaches are escalated to a cost basis of July 2020 using the 20 cities average from the Engineering News-Record Construction Cost Index. Further description of the development of the capital costs can be found in Appendix F.

Table 6-1. Repair and Strengthen-in-Place Cost Estimates by Levee Reach for Perimeter Levees of Locke Study Area

Levee Segment Location	Reach	Start Station	End Station	Length (ft)[1]	Remediation Alternative 1	Remediation Alternative 1 Cost Estimate	Remediation Alternative 2	Remediation Alternative 2 Cost Estimate
SPFC Left Bank Sacramento River - RD 369	121-A	2515+48	2556+52	4,100	75-ft.-deep cutoff wall	$29,372,000	65-ft.-wide, 9-ft.-tall combination seepage and stability berm	$13,544,000
SPFC Left Bank Sacramento River - RD 554	127-A	2506+08	2515+48	900	15-ft.-deep cutoff wall	$3,042,000	15-ft.-wide, 8-ft.-tall, drained stability berm	$1,180,000
SPFC Subtotal Locke Study Area				5,000		$32,414,000		$14,724,000
Delta Meadows Slough Levee (portion of NULE Segment 1040) – RD 551	1040-A	1000+00	1032+00	3,200	65-ft.-deep cutoff wall	$16,846,000	135-ft.-wide, 15-ft.-tall combination seepage and stability berm	$14,525,000
Delta Meadows Cross Slough Right Bank Cross Levee (portion of NULE Segment 1054) – RD 369	1054-A	1000+00	1015+00	1,500	25-ft.-deep cutoff wall 65-ft.-wide RSP	$4,294,000	55-ft.-wide seepage berm 65-ft.-wide RSP	$4,174,000
	1054-B	1015+00	1032+00	1,700	15-ft.-deep cutoff wall 100-ft.-wide RSP (1,000 feet)	$6,082,000	15-ft.-wide, 8-ft. tall, drained stability berm 100-ft.-wide RSP (1,000 feet)	$2,710,000
Snodgrass Slough Right Bank Levee (portion of NULE Segment	1054-C	1144+42	1175+11	3,100	35-ft.-deep cutoff wall 110-ft.-wide RSP (500 ft.)	$10,676,000	90-ft.-wide, 9-ft.-tall combination seepage and stability berm 110-ft.-wide RSP (500 ft.)	$9,331,000

Levee Segment Location	Reach	Start Station	End Station	Length (ft)[1]	Remediation Alternative 1	Remediation Alternative 1 Cost Estimate	Remediation Alternative 2	Remediation Alternative 2 Cost Estimate
1054) – RD 369 and 554								
Locke South Railroad Embankment – RD 554	LKSRR-A	0+00	14+35	1,400	20-ft.-deep cutoff wall	$4,167,000	80-ft.-wide, 9-ft.-tall combination seepage and stability berm	$3,721,000
Non-SPFC Subtotal for Locke Study Area				10,900		$42,065,000		$34,461,000
Perimeter Totals for Locke Study Area				15,900		$74,479,000		$49,185,000

Note: [1]Reach lengths rounded to the nearest 100 feet

6.2.1 Repair and Strengthen-in-Place Delta Meadows Cross Slough Non-SPFC Levee East of Locke (Management Action 1)

The range of cost estimates to repair and strengthen-in-place the 0.6-mile Delta Meadows Cross Slough levee were developed using the costs provided for reaches 1054-A and 1054-B in Table 6-1. The cost estimate for this element ranges from $6,884,000 (assuming berms are implemented for each reach) to $10,376,000 (assuming cutoff walls are implemented for each reach).

In comparison, as detailed in the 2014 RFMP, DWR estimated a total cost of $4,835,000 to perform fix-in-place levee repairs to this levee segment, which equates to $5,640,000 when escalated to July 2020 dollars.

6.2.2 Repair and Strengthen-in-Place Snodgrass Slough Non-SPFC Levee (portion of NULE Segment 1054 in RD 369) and Portion of RD 554 Former Railroad Embankment Southeast of Locke (Management Action 2)

The range of cost estimates to repair and strengthen-in-place the 0.6-mile Snodgrass Slough levee and the most northerly 0.20 mile of the adjoining railroad embankment was developed using the costs for reaches 1054-C and LKSRR-A. The cost estimate for this element ranges from $12,069,000 (assuming berms are implemented for each reach) to $13,742,000 (assuming cutoff walls are implemented for each reach). Repair and improvement of the Snodgrass Slough levee ranges from $8,572,000 to $9,917,000 and the estimated cost to repair the adjoining railroad embankment ranges in cost from $2,738,000 to $3,066,000, with berms being the cheaper option for both levee segments.

In comparison, as detailed in the 2014 RFMP, DWR estimated a total cost of $4,835,000 to perform fix-in-place levee repairs to the Snodgrass Slough levee, which equates to $5,640,000 when escalated to July 2020 dollars. Repairs and improvements to the adjoining railroad embankment were not investigated as part of the 2014 RFMP.

6.2.3 Repair and Strengthen-in-Place Sacramento River SPFC Levee West of Locke (NULE Segment 121 in RD 369 and a Portion of NULE Segment 127 in RD 554) (Management Action 3)

The range of cost estimates to repair and strengthen-in-place the 0.93 miles of levee along the left bank of the Sacramento River (entire 0.80 mile of NULE Segment 121 and 0.13 mile of NULE Segment 127 downstream of Locke) was developed using the costs provided for reaches 121-A and 127-A in Table 6-1. The cost estimate for this element ranges from $14,406,000 (assuming berms are implemented for each reach) to $31,593,000 (assuming cutoff walls are implemented for each reach). However, it is expected that a cutoff wall would be implemented along each levee reach to reduce physical impacts associated with a stability or combination

seepage and stability berm that would displace structures within the community that are located on and/or directly adjacent to the landward toe of the existing levee system.

6.2.4 Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee North of Locke (portion of NULE Segment 1040 in RD 551) (Management Action 4)

The range of cost estimates to repair and improve the 0.60 miles of levee along the right bank of Delta Meadows Slough located within RD 551 was developed using the costs provided for reach 1040-A in Table 6-1. The cost to repair this segment of levee ranges from $14,525,000 (135-ft.-wide, 15-ft.-tall combination seepage and stability berm) to $16,846,000 (65-ft.-deep cutoff wall).

In comparison, as detailed in the 2011 Remedial Alternatives and Cost Estimates Report (RACER) for the North NULE study area, DWR estimated a total cost of $17,509,000 to remediate the entirety of NULE Segment 1040 (1.4 miles), which equates to $22,083,000 in July 2020 dollars (URS, 2011b). With an estimated length of 0.60 mile, DWR's estimated cost to remediate the right bank of Delta Meadows Slough in RD 551 is $9,464,000.

6.2.5 Secure 100-Year FEMA Certification with Potential Cross Levee North of Locke in RD 369 Paired with Perimeter Levee Improvements South of the Proposed Cross Levee (Management Action 5)

The cost of securing 100-year FEMA certification for the levee system described in Section 5.1.2.2 is the summation of all the costs associated with: (1) repairing and strengthening a total of 0.75 mile of SPFC and non-SPFC levees along the left bank of the Sacramento River (NULE Segment 121 in RD 369 and a portion of NULE Segment 127 in RD 554), along the right bank of Snodgrass Slough (portion of NULE Segment 1054 in RD 369), and improving the adjoining railroad embankment to current FEMA standards identified above in Sections 6.2.2 and 6.2.3 and collectively identified above in Table 6-1; (2) construction of the cross levee as detailed in Section 5.1.2.1; (3) addressing any reaches that contain an immediate freeboard issue (none) or long-term settlement issues (unknown) as noted above in Section 5.1.2.2; (4) correcting all encroachments (closures, pipelines, and structures) within and/or adjacent to the entirety of the perimeter levee system that pose a threat to the structural and/or operational integrity of the levee system pursuant to 44 CFR §65.10, as noted above in Section 5.1.2.2; (5) conducting the applicable interior drainage studies and operational plans as noted above in Section 5.1.2.2; and (6) updating applicable operation and maintenance plans following all repairs and improvements and modifications to ensure the levees are operated and maintained by RDs 369 and 554 in accordance with FEMA, USACE, and CVFPB standards. For cost estimating purposes, FEMA certification items (3) through (6) noted herein and described in more detail within Section 5.1.2.2, are estimated at 5 percent of the total combined cost of items (1) and (2) herein associated with repairing and strengthening the levee system and constructing a new cross levee. The estimated cost to secure 100-year FEMA certification for this levee system ranges from

$15,735,000 (assuming berms are implemented to repair the entire perimeter levee system) to $22,490,000 (assuming cutoff walls are implemented to repair the entire perimeter levee system) (Table 6-2).

Table 6-2. Estimated Range of Costs for 100-Year FEMA Certification of Levee System Paired with Potential 0.30-mile-long Cross Levee Just North of Locke - Management Action 5

Cost Component	Estimated Cost
Remediation Alternative 1 (Cutoff Walls) Implemented for Levee System	
1. Repair and Strengthen-in-Place 0.75 miles of SPFC and Non-SPFC Levee System in RDs 369 and 554 South of Potential Cross Levee: Remediation Alternative 1 (Cutoff Walls)	$17,359,000
2. Construction of Potential 0.30-mile-long Cross Levee North of Locke in RD 369	$4,060,000
3. FEMA Certification (5 percent of items 1-2 above)	$1,071,000
Total	**$22,490,000**
Remediation Alternative 2 (Berms) Implemented for Levee System	
1. Repair and Strengthen-in-Place 0.75 miles of SPFC and Non-SPFC Levee System in RDs 369 and 554 South of Potential Cross Levee: Remediation Alternative 2 (Berms)	$10,926,000
2. Construction of Potential 0.30-mile-long Cross Levee North of Locke in RD 369	$4,060,000
3. FEMA Certification (5 percent of items 1-2 above)	$749,000
Total	**$15,735,000**

6.2.6 Secure 100-Year FEMA Certification: Entire RD 369 Perimeter Levee System (including Small Non-SPFC Levee Segments of RDs 551 and 554) (Management Action 6)

The cost of securing 100-year FEMA certification for the community of Locke and the entire perimeter levee system of RD 369 is the summation of all the costs associated with: (1) repairing and strengthening the 2.93 miles of SPFC and non-SPFC levees along the left bank of the Sacramento River (the entirety of NULE Segment 121, RD 369, and the northerly 700-foot-portion of NULE Segment 127 in RD 554), along the right bank of Delta Meadows Slough (portion of NULE Segment 1040 in RD 551), along the right bank of Meadows Slough and Snodgrass Slough (portion of NULE Segment 1054 in RD 369), and along the former railroad embankment, which extends from the south side of the Snodgrass Slough right bank levee towards the northwest entrance to the Delta Cross Channel, to current FEMA standards identified above in Sections 6.2.1 through 6.2.3 and collectively identified above in Table 6-1; (2) addressing any reaches that may contain a freeboard issue (Sacramento River left [east] bank levee upstream and adjacent to the community of Locke) or long-term settlement issues (unknown) as noted above in Section 5.1.2.2; (3) correcting all encroachments (closures, pipelines, and structures) within and/or adjacent to the entirety of the perimeter levee system that

pose a threat to the structural and/or operational integrity of the levee system pursuant to 44 CFR §65.10, as noted above in Section 5.1.2.2; (4) conducting the applicable interior drainage studies and operational plans as noted above in Section 5.1.2.2; and (5) updating applicable operation and maintenance plans following all repairs and improvements and modifications to ensure the entirety of the perimeter levee system is operated and maintained by RDs 369, 554, and 551 in accordance with FEMA, USACE, and CVFPB standards. For cost estimating purposes, FEMA certification items (3) through (5) noted herein and described in more detail within Section 5.1.2.2, are estimated at 5 percent of the total cost of item (1) herein associated with repairing and strengthening the levee system. The estimated cost to secure 100-year FEMA certification for this levee system ranges from $50,276,000 (assuming berms are implemented to repair the entire perimeter levee system) to $76,185,000 (assuming cutoff walls are implemented to repair the entire perimeter levee system) (Table 6-3).

Table 6-3. Estimated Range of Costs for 100-Year FEMA Certification of entire RD 369 Perimeter Levee System (including Short Non-SPFC Levee Segments of RDs 551 and 554) - Management Action 6

Cost Component	Estimated Cost
Remediation Alternative 1 (Cutoff Walls) Implemented for Entire RD 369 Perimeter Levee System	
1. Repair and Strengthen-in-Place Entire RD 369 Perimeter Levee System: Remediation Alternative 1 (Cutoff Walls)	$72,557,000
2. FEMA Certification (5 percent of item 1 above)	$3,628,000
Total	**$76,185,000**
Remediation Alternative 2 (Berms) Implemented for Entire RD 369 Perimeter Entire Levee System	
1. Repair and Strengthen-in-Place Entire RD 369 Perimeter Levee System: Remediation Alternative 2 (Berms)	$47,882,000
2. FEMA Certification (5 percent of item 1 above)	$2,394,000
Total	**$50,276,000**

6.2.7 Sacramento River Left (east) Bank SPFC Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke with a Potential Cross Levee north of Locke (Management Action 7)

The cost of MA 7 is the summation of costs associated with MA 5 described in Section 6.2.5 above, plus the cost of repairing and strengthening the northerly 0.60 miles of SPFC levee along the left bank of the Sacramento River associated with MA 3. The estimated cost for MA 7 ranges from $25,794,000 (assuming berms are implemented to repair and strengthen the levees) to $44,304,000 (assuming cutoff walls are implemented to repair and strengthen the levees) (Table 6-4).

Table 6-4. Estimated Range of Costs for Management Action 7

Cost Component	Estimated Cost
Remediation Alternative 1 (Cutoff Walls) Implemented for Levee System	
1. Repair and Strengthen-in-Place Levee System: Remediation Alternative 1 (Cutoff Walls)	$39,173,000
2. Construction of a Cross Levee North of Locke	$4,060,000
3. FEMA Certification for Community of Locke Only (5% of item 1 above, for remediations only south of Cross Levee; and 5% of item 2 above, for Cross Levee)	$1,071,000
Total	**$44,304,000**
Remediation Alternative 2 (Berms) Implemented for Levee System	
1. Repair and Strengthen-in-Place Levee System: Remediation Alternative 2 (Berms)	$20,985,000
2. Construction of a Cross Levee North of Locke	$4,060,000
3. FEMA Certification (5% of item 1 above, for remediations only south of Cross Levee; and 5% of item 2 above, for Cross Levee)	$749,000
Total	**$25,794,000**

6.2.8 Capital Cost Summary

A summary of capital costs for MAs 1 through 7 are provided in Table 6-5 below.

Table 6-5. Estimated Range of Costs for Management Actions 1-7 including FEMA Certification for the Community of Locke

Management Action (MA)	Cutoff Walls	Berms	Cross Levee	RSP	FEMA Certification	Total
1: Repair and Strengthen-in-Place Delta Meadows Cross Slough Non-SPFC Levee (portion of NULE Segment 1054 in RD 369)	$7,652,000	$4,160,000	--	$2,724,000	--	$6,884,000 - $10,376,000
2: Repair and Strengthen-in-Place Snodgrass Slough Non-SPFC Levee (portion of NULE Segment 1054 in RD 369) and Portion of RD 554 Former Railroad Embankment	$12,983,000	$11,310,000	--	$759,000	--	$12,069,000 - $13,742,000
3: Repair and Strengthen-in-Place, 0.93-miles of Sacramento River SPFC Levee (NULE Segment 121 in RD 369 and a Portion of NULE Segment 127 in RD 554)	$31,593,000	$14,406,000	--	--	--	$14,406,000 - $31,593,000
4: Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee (portion of NULE Segment 1040 in RD 551)	$16,846,000	$14,525,000	--	--	--	$14,525,000 - $16,846,000
5: Secure 100-Year FEMA Certification, South Portion RD 369 Perimeter Levee System Paired with a Potential Cross Levee North of Locke in RD 369	$16,600,000	$10,167,000	$4,060,000	$759,000	$749,000 - $1,071,000	$15,735,000 - $22,490,000
6: Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System, including Small Segments of Non-SPFC Levee in RDs 551 and 554 (Summation of MAs 1 to 4)	$69,075,000	$44,400,000	--	$3,482,000	$2,394,000 - $3,628,000	$50,276,000 - $76,185,000
					Total Cost per Mile for MA 6	**$17M-$26M**
7: Sacramento River SPFC Levee Improvements (0.93 miles) Paired with Securing 100-Year FEMA Certification for the Community of Locke with a Potential Cross Levee	$38,414,000	$20,226,00	$4,060,000	$759,000	$749,000 - $1,071,000	$25,794,000 - $44,304,000

6.3 Trade-Off Analysis of Flood Risk Reduction Management Actions

MAs 1 to 7 were compared in a trade-off analysis against the study goal of obtaining 100-year flood protection for the Locke study area and against the objectives described in Section 4. Other considerations, such as agricultural sustainability, local support, cost, cultural resources, ecosystem, and consistency with existing Delta regulations and policies were also used to compare each of the MAs.

6.3.1 Planning Objectives

6.3.1.1 Reducing Risk to Life

A breach almost anywhere in the small study area of Locke could contain high instantaneous floodwater velocities and depths of imminent danger within the community that would most likely result in life loss in Locke. All MAs 1-7, (with the exception of MA 4 related to improvements on the RD 551 Delta Meadows Slough dry cross levee 0.70 miles north of Locke) would all result in measurable reductions in potential life loss. Flooding in the community of Locke originating from a levee failure of the RD 551 Delta Meadows Slough dry cross levee would not likely be an instantaneous flooding event triggering the loss of lives in Locke. Substantial notice and warning would occur to the community of Locke in the event the entire upstream RD 551 basin including Courtland was subject to inundation, potentially triggering the evacuation in Locke. The large RD 551 – Pearson District basin would take several days to fill prior to triggering a high-water condition against the normally dry RD 551 Delta Meadows Slough levee prior to a potential breach occurring and posing a threat to the downstream community of Locke. During stakeholder outreach meetings it was conveyed the community's greatest concern for levee failures and life loss was not from the SPFC levee reaches along the Sacramento River, but from the non-SPFC levee reaches, namely the Delta Meadows Cross Slough levee northeast of Locke, followed by the Snodgrass Slough levee and former WGBL railroad embankments east and southeast of Locke. Thus, there is value in reducing the risks to life loss by implementing improvements to the noted non-SPFC levee reaches easterly of Locke, namely MAs 1 and 2.

6.3.1.2 Reducing Risk to Property Damage

As previously discussed, EAD represents the annualized expected damages through the consideration of potential flooding conditions and is one of the primary drivers for flood management funding within the Delta, and the greater area within the CVFPP planning area. EAD includes potential flood damages to structures, structure contents, land improvements, adjoining crops, regional infrastructure, and vehicles. Reduction in EAD is a common metric used to evaluate flood risk reduction measures and is used in this feasibility study to evaluate how well each MA meets the objective of reducing risk to property damage. Further details on

the EAD analysis performed as part of this study are provided in Appendix E-1 – Expected Annual Damages Technical Memorandum, prepared by HDR Inc., dated August 31, 2021.

As shown previously in Table 3-7, baseline (or without project) EAD for the community of Locke under existing and future conditions (with climate change adjustments) is approximately $363,000 and $1.5M, respectively. Existing without project conditions represent the current level of flood protection within the study area and does not incorporate any new structural or any new proposed non-structural flood risk reduction elements. Future without project conditions represent the current level of flood protection within the study area, does not incorporate any structural or non-structural flood risk reduction elements, and incorporates expected changes to the study area from climate change, sea level rise, and future land uses.

Table 6-6 and Table 6-7 below provide the estimated net reduction in EAD to the Locke study area as a result of implementing MAs 5, 6, and 7 under existing and future conditions, respectively. Net, incremental EAD reduction values for MAs 1 through 4 were not incrementally calculated in Appendix E as standalone measures, but MA 6 is representative of collectively implementing MAs 1 through 4. The net reduction in EAD values were formulated by subtracting the estimated EAD value for the noted inventories in the small project study area, which were estimated assuming a fractional, partial, or full improvement, from the baseline (or without project) EAD. The pay-back period in years (excluding interest) and corresponding benefit-cost ratios are then calculated using the estimated cost of each MA evaluated.

Overall, the greatest reduction in EAD for the Locke study area is provided by MA 6 (FEMA certification of the entire RD 369 perimeter levee system). As shown in Table 6-6, implementing MA 6 would result in a net reduction in EAD for the study area of $353,000 under existing conditions. On an annualized basis, this represents an annualized EAD of $10,000 for the entire study area, inclusive of the community of Locke. However under existing conditions, at a cost of up to $76M, the flood risk reduction payback period is over 200-years (excluding interest), and there is a very low benefit-cost ratio of 0.1 without the consideration of multiple benefits.

The next greatest incremental reduction in EAD is provided by either MA 5 (securing FEMA certification for the community of Locke with a potential cross levee) or MA 7 (MA 5 plus SPFC levee improvements along the left bank of the Sacramento River). Both MAs are estimated to result in a net reduction in EAD to the study area of $335,000, which represents an annualized EAD for the Locke study area of $28,000. The two MAs provide the same net reduction in EAD since improvements along the left bank of the Sacramento River and would not result in additional incremental reduction in EAD to Locke as the non-SPFC levees northeast of Locke would remain unimproved within the study area. At an estimated cost of up to $22.5M, the flood risk reduction payback period for MA 5 under existing conditions is 67 years with a low cost-benefit ratio of 0.4. The flood risk reduction payback period for MA 7 is nearly double that under existing conditions at 132 years and a lower benefit-cost ratio of 0.2 with the additional cost of improving the SPFC levee along the left bank of the Sacramento River north of the proposed cross levee.

The discussion above also applies under future conditions as shown in Table 6-7. As shown in Table 6-7, the effects of climate change and sea level rise result in both an increase in the baseline EAD for the Locke study area ($1.5M increased from $363,000 under existing conditions), and a greater benefit from each of the MAs as seen by the higher net reductions in EAD. Under future conditions the payback periods and corresponding benefit-cost ratios for MA 5 are much more favorable as indicated in Table 6-7 with a back period of less than 16 years and a more favorable benefit-cost ratio of 1.7.

In general, when considering the estimated capital cost to construct or implement each MA, securing 100-year FEMA certification for the community of Locke with a potential cross levee (MA 5) provides the largest incremental value to the community of Locke and the larger study area. With the implementation of MA 5 (with an estimated cost of $22.5M), the total net reduction in EAD for the Locke study area is estimated at $335,000 under existing conditions and $1.4M under future conditions. Notably, as shown in Table 6-6 and Table 6-7, securing 100-year FEMA certification for the entire RD 369 perimeter levee system (MA 6) provides similar value to the community of Locke as certifying said cross levee system. However, at an estimated cost of over $76M, the flood risk reduction payback period under future conditions is over 50 years, and there is a relatively much smaller benefit cost ratio of only 0.5 without the consideration of multi-benefits.

Table 6-6. Locke Study Area EAD Values for Existing Conditions Consistent with the 2022 CVFPP Update

Scenarios for Select Structural-Based Management Actions (MAs)	Estimated Cost[1]	SAC 51 EAD With Full FEMA Certification Improvements[(4)]	Total Net EAD Reduction to Locke Study Area	Flood Risk Reduction Pay Back Period in Years (excluding interest)	Benefit-Cost Ratio[2]
Baseline EAD, SAC 51 (Locke): **$363,000**[(1)]					
Secure 100-Year FEMA Certification, South Portion RD 369 Perimeter Levee System Paired with a Potential Cross Levee North of Locke in RD 369 (**MA 5** without benefits to Ag/Crop Areas) [(4)]	$15,735,000 - $22,490,000	$27,600 = ($10,200[(a)] - $500[(b)]+$17,900[c)]) *(accounts for no benefits to adjoining Ag/Crop Areas)*	$363,000 - $28,000 = $335,000*	$22,490,000/$335,000 = 67.1 years (max.)	0.4 (min.)
Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System, including Small Segments of Non-SPFC Levee in RDs 551 and 554 (**MA 6** with benefits to adjoining Ag/Crop Areas) [(4)]	$50,276,000 - $76,185,000	$10,000	$363,000 - $10,000 = $353,000	$76,185,000/$353,000 = 216 years (max.)	0.1 (min.)
Sacramento River SPFC Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke with a Potential Cross Levee (**MA 7** without benefits to Ag/Crop Areas) [(4)]	$25,794,000 - $44,304,000	$27,600 = ($10,200[(a)] - $500[(b)]+$17,900[c)]) *(accounts for no benefits to adjoining Ag/Crop Areas)*	$363,000 - $28,000 = $335,000**	$44,304,000/$335,000 = 132 years (max.)	0.2 (min.)

Notes:

Levee Performance Data Curve for EAD Values from Appendix E – Table 5: [(1)] Baseline w/o Improvements; [(2)] Fractional Improvements; [(3)] Partial Improvements; [(4)] Full FEMA Cert. Improvements

EAD Values: [(a)] Total EAD under Full Improvement; [(b)] EAD Associated with Crops under Full Improvement; [(c)] EAD Associated with Crops under Without Project

[1] A range of estimated costs (low-high) are generally provided for each management action concurrent with the costs summarized in Table 6-56-5

[2] Benefit-Cost Ratio assuming a capital recovery factor of 0.037 (n=50 years, i=2.75%)

[*] Net reduction in EAD to the Locke study area is representative of a full improvement to SAC 51 with the addition of expected annual damages associated with: 1) crops outside and north of the cross-levee system and, 2) a portion of River Road north of the cross-levee system along the left bank of the Sacramento River (whose value was not quantified as part of this analysis)

[**] Net reduction in EAD to the Locke study area is representative of a full improvement to SAC 51 with the addition of expected annual damages associated with: 1) crops outside and north of the cross-levee system

Table 6-7: Locke Study Area EAD Values for Future Conditions with Climate Change Adjustments Consistent with the 2017 CVFPP Update

Scenarios for Select Structural-Based Management Actions (MAs)	Estimated Cost	SAC 51 EAD With Full FEMA Certification Improvements[4]	Total Net EAD Reduction to Locke Study Area	Flood Risk Reduction Pay Back Period in Years (excluding interest)	Benefit-Cost Ratio
Future conditions Baseline EAD, SAC 51 (Locke): **$1,533,000**[1]					
Secure 100-Year FEMA Certification, South Portion RD 369 Perimeter Levee System Paired with a Potential Cross Levee North of Locke in RD 369 (**MA 5** w/o benefits to Ag/Crop Areas)[4]	$15,735,000 - $22,490,000	$105,500 = ($39,900[a] - $1,700[b]+$67,300[c]) *(accounts for no benefits to adjoining Ag/Crop Areas)*	$1,533,000 - $106,000 = $1,428,000*	$22,490,000/$1,427,000 = 15.8 years (max.)	1.7 (min.)
Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System, including Small Segments of Non-SPFC Levee in RDs 551 and 554 (**MA 6** with benefits to adjoining Ag/Crop Areas)[4]	$50,276,000 - $76,185,000	$40,000	$1,533,000 - $40,000 = $1,493,000	$76,185,000/$1,493,000 = 51.0 years (max.)	0.5 (min.)
Sacramento River SPFC Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke with Potential Cross Levee (**MA 7** w/o benefits to Ag/Crop Areas)[4]	$25,794,000 - $44,304,000	$105,500 = ($39,900[a] - $1,700[b]+$67,300[c]) *(accounts for no benefits to adjoining Ag/Crop Areas)*	$1,533,000 - $106,000 = $1,428,000**	$44,304,000/$1,427,000 = 31.0 years (max.)	0.9 (min.)

Notes:

Levee Performance Data Curve for EAD Values from Appendix E – Table 6: [1] Future Baseline w/o Improvements; [2] Future Fractional Improvements; [3] Future Partial Improvements; [4] Future Full FEMA Cert. Improvements

EAD Values: [a] Total EAD under Full Improvement; [b] EAD Associated with Crops under Full Improvement; [c] EAD Associated with Crops under Without Project

[1] A range of estimated costs (low-high) are generally provided for each management action concurrent with the costs summarized in Table 6-56-5

[2] Assuming a capital recovery factor of 0.037 (n=50 years, i=2.75%)

* Net reduction in EAD to the Locke study area is representative of a full improvement to SAC 51 with the addition of expected annual damages associated with: 1) crops outside and north of the cross-levee system and, 2) a portion of River Road north of the cross-levee system along the left bank of the Sacramento River (whose value was not quantified as part of this analysis)

** Net reduction in EAD to the Locke study area is representative of a full improvement to SAC 51 with the addition of expected annual damages associated with: 1) crops outside and north of the cross-levee system

6.3.1.3 Reducing Probability of Levee Failure

Management Action 1 results in a moderate to high reduction in the probability of levee failure through the repair and improvement of the Delta Meadows Cross Slough levee (portion of NULE Segment 1054 extending southeast to the Snodgrass Slough levee portion of NULE Segment 1054). Repair of this portion of NULE Segment 1054 in RD 369 would likely eliminate the probability of an instantaneous levee failure since this levee segment is estimated to have a moderate to high likelihood of failure due to underseepage, through seepage, and slope stability vulnerabilities.

Similarly, **Management Action 2** also results in a moderate to high reduction in the probability of levee failure through the repair and improvement of the Snodgrass Slough levee (portion of NULE Segment 1054 extending southwest towards Locke from the Meadows Cross Slough levee). Repair of this portion of NULE Segment 1054 in RD 369 would likely eliminate the probability of an instantaneous levee failure since this levee segment is estimated to have a moderate to high likelihood of failure due to underseepage, through seepage, and slope stability vulnerabilities.

Management Action 3 strengthens and improves the SPFC levee segments along the left bank of the Sacramento River within the Locke study area, including the levee immediately fronting the community of Locke. Strengthening these SPFC levee segments would likely eliminate the potential of a levee failure, both immediately adjacent to the community and along the entirety of the levee segments in the project study area.

Management Action 4 results in a low to moderate reduction in the probability of levee failure through the repair and improvement of the most westerly 0.60-miles of the RD 551 Delta Meadows Slough levee (NULE Segment 1040-A) which is normally dry and has never experienced flood waters against it. Repair of this portion of NULE Segment 1040-A would likely eliminate the probability of an instantaneous levee failure since this levee segment has a low to moderate likelihood of failure due to underseepage and slope stability vulnerabilities.

Management Action 5 strengthens and improves the perimeter levee system south of the proposed cross levee including the SPFC levees along the left bank of the Sacramento River (portion of NULE Segments 121 and 127 in RDs 369 and 554), a portion of the Snodgrass Slough right bank levee (portion of NULE Segment 1054 in RD 369), and the RD 554 railroad embankment which extends from the south side of the Snodgrass Slough right bank levee to the northwest entrance to the Delta Cross Channel. The Snodgrass Slough levee is estimated by DWR to have a moderate to high likelihood of failure, while levees along the left bank of the Sacramento River are estimated to have a low likelihood of failure. As a result, MA 6 results in a moderate reduction in the probability of levee failure.

Management Action 6 strengthens and improves the entire perimeter levee system within RD 369, including the Delta Meadows Cross Slough levee and the Snodgrass Slough levee (portion of NULE Segment 1054 in RD 369), which are estimated by DWR to have a moderate to high

likelihood of failure. Consequently, MA 6 results in the highest reduction in the probability of levee failure of all MAs under consideration.

Management Action 7 results in a moderate reduction in the probability of levee failure by combining the flood risk reduction elements described as part of MAs 3 and 5.

6.3.1.4 Reduction of High Insurance Premiums

Those MAs which result in 100-year FEMA certification could result in a net reduction in NFIP insurance premiums. MAs 5, 6, and 7 are the only solutions which result in 100-year FEMA certification. However, implementation of the structural elements and non-structural measures as part of MAs 1 to 4 in concert with a community- or risk-based insurance program, could also result in a net reduction in NFIP flood insurance premiums for the community.

6.3.1.5 Improved Preparedness and Response

Improved flood preparedness and response is largely provided by non-structural measures previously described above in Section 5.2, including ongoing implementation and annual review of the Flood Emergency Safety Plans (ESPs) for the north Delta area collectively developed by Sacramento County OES and all of the RDs in the north Delta including RD 369. Preparedness and response also includes utilization of Sacramento County's OES Decision Support Tool to assist with flood warning, and flood fight activities leading into and including flood response activities in the Sacramento County Delta Region. Advancing and formalizing potential relief cuts under the County's current and future Local Hazard Mitigation Plan (LHMP) efforts, particularly for potential upstream relief cuts within RD 551 could very well possibly eliminate the need for any improvements along the normally dry levee segment of RD 551 NULE segment 1040-A (Management Action 4).

6.3.1.6 Enhancing Resiliency and Reliability of Through-Delta Water Conveyance

MAs 3, 6, and 7 would provide the greatest enhancement of the resiliency and reliability of through-Delta water conveyance by improving the entire SPFC levee system located along the Sacramento River within the study area, which equates to 3 percent of the SPFC levees located between Freeport and the Delta Cross Channel and 2 percent of the total SPFC levees along the freshwater corridor in the Delta. MA 5, which improves a portion of the SPFC levees within the study area, also enhances the resiliency and reliability of through-Delta water conveyance to a lesser degree. MAs 1,2 and 4 do not directly improve through-Delta water conveyance.

6.3.1.7 Environmental Stewardship and Multi-Benefits

Since the entire suite of MAs involve improvements to perimeter or internal levees in the study area, or the construction of a potential new cross levee, all of the enhancement concepts would be feasible to implement in whole, or part, during levee repair work, including: (1) enhancing existing riparian habitat along Snodgrass Slough and Meadows Slough and seasonal wetland

(wet meadows), (2) enhancing the combination of wildlife habitat and recreation opportunities within the Delta Meadows State Park and the nearby USBR Cross Channel, adjacent to the communities of Locke and East Walnut Grove, and (3) SRA habitat creation or enhancement.

Under all MAs, a recreation component could be implemented in whole, or in part, during construction of the cross levee or during improvements to the Delta Meadows Cross Slough Levee or any perimeter levee improvement, as the top of each levee segment of levee crown can easily facilitate a network of multi-use trails if properly planned. Trail usage along a small (Locke only) or large (wider study area) loop could include signage and interpretive information for users regarding the rich history of the area and could also connect across the Delta Cross Channel, linking the Locke and East Walnut Grove historic districts. However, a larger loop trail is most likely if MA 6 is implemented, since this is the only option that includes a cross levee, and a smaller loop trail could be more cost-effective than a larger loop, that would require modifications to the crown of multiple levee segments in the study area. A perimeter trail, particularly along the former Walnut Grove Branch Line (WGBL) as identified in the Delta Protection Commission's Great California Delta Trail Master Plan of January 20, 2022, could offer a connection to other Delta Legacy Communities, north to Stone Lakes National Wildlife Refuge, through Delta Meadows State Park (with facility improvements in partnership with State Parks), and to points farther north and east, to connect with other recreational areas with existing parking and trailheads such as the Cosumnes River Preserve and the Stone Lakes National Wildlife Refuge. The DPC's Great Delta Master Plan also suggests that the Locke, Walnut Grove and Delta Meadows areas could collectively serve has a major activity hub and supporting trailhead for the Great Delta Trail in the Central Delta. This is particularly true if the former WGBL rail alignment, largely owned by the State, the USA and other public entities could be repurposed from rails to a multi-use trail system between Walnut Grove and Freeport, and potentially other Delta Legacy communities such as Hood and Courtland, and possibly as far south as Isleton and Brannan Island State recreation Area.

Improvements to recreational access in the Locke study area would also complement the DPC's Vision for Locke, as detailed in their Economic Sustainability Plan. These elements are currently developed only to a conceptual level, but support development of a Delta Meadows River trail, a connection of the trail to the historic district with public parking at the north end of downtown Locke and near the USBR Cross Channel as well. Restoration of waterfront and downtown historic structures, and further development of a community garden in existing open space to the east of Locke, and the development of additional commercial and overnight amenity uses all could be of significant value to the community of Locke.

6.3.2 Other Considerations

6.3.2.1 Agricultural Sustainability

Under MAs 2 to 5, agricultural sustainability could be affected if the repair and strengthen-in-place *via* cutoff walls (Remediation Alternative 1) are not implemented, since the proposed

seepage, stability, or combination berms (proposed as Remediation Alternative 2) could range from 15 feet to 135 feet in width, resulting in displacement of productive permanent pear orchards. The estimated displacement of acreage associated with implementing cutoff walls versus stability or combination berms as part of MAs 1 to 6 is summarized below in Table 6-8. Under MA 1, implementing seepage or stability berms on the Delta Meadows Cross Slough levee could potentially displace an estimated 3 acres of permanent crops. Implementing stability or combination berms on the SPFC levees fronting the community of Locke (MA 3) would displace an estimated 13 acres of permanent crops (though it is assumed that a cutoff wall would be implemented on these levee reaches to reduce physical impacts associated with a stability or combination berm that would displace structures within the community). Under MAs 2, 4, 5, and 7 an estimated 20 acres of permanent crops would be displaced if berms are implemented to remediate the levee reaches associated with each MA. Implementing berms and a cross levee for MA 6 is estimated to result in the greatest displacement of permanent crops at nearly 55 acres. As shown in Table 6-8, these impacts are reduced when implementing cutoff walls for each of the proposed MAs.

6.3.2.2 Local Support

Those MAs which result in the least impacts to agricultural sustainability garner the most local support. Consequently, under MAs 1 to 7, local support is given to vertical remediations (cutoff walls) over horizontal remediations (seepage, stability, or combination berms) since a cutoff wall would be installed entirely within the existing levee prism and would not result in a net reduction in agricultural land. RD 369 and Locke also prefer repairing and improving-in-place the existing levee systems over introducing a potential cross levee system north of the Locke community within RD 369.

6.3.2.3 Cost

MA 1 (repairing and strengthening the Delta Meadows Cross Slough levee) and MA 2 (repairing and strengthening the Snodgrass Slough levee and a portion of the railroad embankment) are the lowest cost solutions to reducing flood risk in the study area at nearly $10.4M and $13.7M, respectively. MA 3 (repairing and strengthening the SPFC levees fronting the community of Locke), MA 4 (repairing and strengthening the Delta Meadows Slough levee), and MA 5 (securing 100-year FEMA certification with a cross levee and perimeter levee improvements), are the next lowest cost solutions ranging between $14.5M and $31.6M. MA 7 (Sacramento River levee improvements paired with FEMA certification for the community of Locke) is the second highest cost solution to reduce flood risk in the study area at $44.3M The highest cost solution to reduce flood risk in the study area, with an estimated cost of $50 to $76M, is MA 6, which repairs and strengthens the entire RD 369 perimeter levee system to secure 100-year FEMA certification for the community of Locke and RD 369.

Table 6-8. Estimated Displaced Agricultural Acreage when Implementing Management Actions 1-7

Management Action (MA)	Estimated Displaced Agricultural Acreage: Remediation Alternative 1 (Cutoff Walls)	Estimated Displaced Agricultural Acreage: Remediation Alternative 2 (Berms)
MA 1: Repair and Strengthen-in-Place Delta Meadows Cross Slough Non-SPFC Levee East of Locke (portion of NULE Segment 1054 in RD 369)	2	3
MA 2: Repair and Strengthen-in-Place Snodgrass Slough Non-SPFC Levee Northeast of Locke (portion of NULE Segment 1054 in RD 369) and Portion of RD 554 Railroad Embankment	3	18
MA 3: Repair and Strengthen-in-Place Sacramento River SPFC Levee West of Locke (NULE Segment 121 Primarily in RD 369 and a Portion of NULE Segment 127 in RD 554)	3	13
MA 4: Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee North of Locke (portion of NULE Segment 1040-A in RD 551)	2	19
MA 5: Secure 100-Year FEMA Certification, with Potential Cross Levee North of Locke Paired with Perimeter Levee Improvements South of the Potential Cross Levee	7	17
MA 6: Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System	10	53
MA 7: Sacramento River Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke Utilizing a Potential Cross Levee North of Locke	12	22

6.3.2.4 Cultural Resource Considerations

Under all of the MAs, cultural resources could be affected, since installation of a cutoff wall and/or placement of riprap can disturb previously unknown archeological resources and repair/strengthen-in-place remediations (including a seepage, stability, or combination berm up to 65 ft. wide) may require grading or foundational work. However, built-environmental resources, such as historic buildings, on adjacent land would not be permanently affected. Additionally, under MAs 5 and 7, cultural resources could be affected by construction of the foundation of a potential cross levee.

6.3.2.5 Ecosystem Considerations

Under MAs 1, 2, 4, and 5, biological resources could be affected since substantial existing riparian habitat exists on the Delta Meadows Slough and Snodgrass Slough levees.

Implementation of MA 3 along the landside of the Sacramento River east levee would likely result in fewer biological resource impacts, since repairs would be focused within the existing levee prism and riprap would be placed on the existing levee, which is fairly clear of vegetation except for some large trees. It is likely these repairs could be implemented if appropriate work window restrictions, monitoring, and species and habitat avoidance and mitigation measures are in place. However, under MAs 5 and 7, a small amount of open space would be affected by construction of a cross levee (up to 20-ft.-wide at the levee crown and as much as 110-ft.-wide at the base of the levee) and any clearing or maintenance of necessary adjacent easements. Biological resources in this area could be affected if any sensitive habitat along the alignment cannot be avoided. Although the area in the vicinity of the cross levee is in agricultural production, farmed areas do provide important habitat for certain species. The extensive habitat along Snodgrass Slough would likely preclude any waterside repairs or remediation. However, cutoff walls or landside repairs are more likely than water side repairs and improvements.

The restoration activities possible in the study area would be consistent with Delta Plan Strategy 4.2 “Restore Habitat”, Strategy 4.4 “Prevent Introduction of and Management of nonnative Species Impacts”, and Strategy 5.2 “Plan to Protect the Delta’s Lands and Communities”. These actions would provide benefits to the following species: Sacramento splittail and Delta smelt, western pond turtle, multiple waterbird guilds (waders, dabblers, and divers), tricolored blackbird, other songbird species. The actions described at a conceptual level, above, would also provide critical regional habitat connectivity between Cosumnes River Preserve, Delta Meadows, McCormack Williamson Tract restoration, and Stone Lakes National Wildlife Refuge.

6.3.2.6 Consistency with Existing Delta Regulations and Policies

As mentioned previously, there are several agencies with regulatory, flood management, and/or land use authority over projects in the Delta, including the Sacramento County Delta Legacy Community of Courtland, that is located in the Primary Zone of the Delta. Due to the large number of broad policies and goals contained in the many DPC, DSC, and Conservancy planning documents applicable to the study area, an exhaustive matrix comparing the various proposed flood management elements against the many broad goals and policies of Delta agencies is contained in Appendix G.

Generally, all of the proposed MAs indirectly support the various Delta agencies plans and policies regarding sustainability and viability of the Delta agricultural economy, preservation of the Legacy Community’s unique history and sense of place, and opportunities for public recreation and ecosystem enhancement (where feasible). The only MA components that could conflict with existing regulations could be those that propose seepage/stability berms if their final configuration would affect a substantial acreage of important farmland of regional and statewide significance within the study area. Although most restrictions regarding agricultural land conversion address conversion to urban uses, the concept of taking agricultural land out of production due to flood management facilities would need to be explored further before implementation of any MA.

Historically, levee repairs can induce population growth and encourage development within the floodplain. Although levee repairs are proposed under all the various MAs, development within the Delta is constrained by the Delta Plan and SPA ordinances which limit new residential, commercial, and industrial development within the Primary Zone of the Delta. As such, future floodplain development within the study area is not expected to be substantial. By protecting Locke and adjacent working agricultural lands with better flood protection, and providing multi-benefit opportunities, when possible, Locke can reasonably thrive as a community within the confines of existing regulations.

6.3.3 Trade-Off Analysis Summary

A summary of the trade-off analysis is provided in Table 6-9 below.

Table 6-9. Trade-Off Analysis Summary

Management Action	Flood Risk Reduction				Limitation of High Insurance Premiums	Estimated Displacement of Agricultural Acreage (Cutoff Walls/Berms)	Enhancing Resiliency and Reliability of through-Delta Water Conveyance	Local Support	Multi-Benefit, Eco-System and Recreation Enhancements	Cost
	Reducing Risk to Life	Reducing Risk to Property Damage	Reduced Probability of Levee Failure	Net Reduction in EAD to Locke Study Area (Existing Conditions/ Future Conditions)						
1	High	High	Medium-High	N/A	No	2/3	No	High	High	High
2	Low	High	Medium-High	N/A	No	3/18	No	High	High	High
3	High	High	Low	N/A	No	3/13	Yes	High	Medium	High
4	Low-Medium	High	Moderate	N/A	No	2/19	No	High	High	High
5	High	High	High	$335,000 – $1,428,000	Yes	7/17	Yes	Medium	High	High
6	High	High	Moderate	$353,000 - $1,493,000	Yes	10/53	Yes	High	Low	High
7	High	High	High	$335,000 – $1,428,000	Yes	12/22	Yes	Medium	High	High

7. Recommendations

Section 7 details the suite of MAs recommended for implementation. Stakeholder and public input on these MAs are also provided, along with other non-structural measures that are recommended for implementation. Following these recommendations, right-of-way, and easements considerations, as well as considerations for operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) are discussed, as well as regulatory requirements, financial feasibility, and stakeholder support.

7.1 Recommended Suite of Structural-Based Management Actions

Of the seven MAs previously identified, MAs 1 to 4 are recommended for timely, near-term implementation. This includes:

- **Management Action 1**: Repair and Strengthen-in-Place Delta Meadows Cross Slough Non-SPFC Levee East of Locke (portion of NULE Segment 1054 in RD 369)
- **Management Action 2**: Repair and Strengthen-in-Place Snodgrass Slough Non-SPFC Levee Southeast of Locke (portion of NULE Segment 1054 in RD 369)
- **Management Action 3**: Repair and Strengthen-in-Place Sacramento River SPFC Levee Adjacent to and Northwest of Locke (NULE Segment 121 Primarily in RD 369 and a Portion of NULE Segment 127 in RD 554)
- **Management Action 4**: Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee North of Locke (portion of NULE Segment 1040 in RD 551)

Three additional management actions for long-term consideration:

- **Management Action 5**: Secure 100-Year FEMA Certification, with Potential Cross Levee North of Locke Paired with Perimeter Levee Improvements is identified as an alternative to MAs 1 to 4.
- **Management Action 6:** Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System surrounding the Locke study area is identified as an alternative to MAs 1 to 5.
- **Management Action 7:** Sacramento River Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke utilizing a potential cross levee is identified as an alternative to MAs 5 and 6.

Long-term MAs include the long-term goal of securing a 100-year level of flood protection for the entire study area by repairing and improving both the SPFC levee along the Sacramento River and the non-SPFC levees along Snodgrass and Delta Meadows Sloughs (Multi-Benefit **MA 6**).

As previously discussed, repairing and improving the SPFC levee along the left, east bank of the Lower Sacramento River (identified in MAs 3, 6, and 7) would also improve the resiliency and reliability of the through-Delta water conveyance system upstream of the Delta Cross Channel. Provided the community can also garner support from in-Delta and South of Delta water export interested parties, including but not limited to, the DCA, DWR, CVP, Metropolitan Water, and State Water Contractors, it is recommended that MAs 3, 6, or 7 be implemented over time to improve and modernize the perimeter levee systems that also serve to improve the resiliency and reliability of the through-Delta conveyance system as it currently exists today and into the future with conveyance of water through the Delta upstream of the Delta Cross Channel.

See Appendix K for further details in support of the multi-benefit opportunities identified by Sacramento County and the County's Delta Legacy Communities associated with reducing flood risks combined with improving SWP water conveyance through the Delta.

It is also recommended that any of the structural-based MAs identified above be coupled with the noted suite of non-structural measures identified and prioritized in Section 7.3 below. The conceptual designs and estimated costs for this suite of MAs are provided below.

7.1.1 Management Action 1: Repair and Strengthen-in-Place Delta Meadows Cross Slough Non-SPFC Levee East of Locke (portion of NULE Segment 1054 in RD 369)

As described in Section 5.1.1.2, Table 5-2, remedial alternatives to repair and strengthen the Delta Meadows Cross Slough levee include cutoff walls ranging between 15 to 25 feet deep, and berms (stability or combination seepage and stability berms) ranging between 15 to 65 feet wide. Each remedial alternative is also paired with RSP ranging between 65 to 100 feet wide. Cutoff walls were selected as the recommended remedial alternative to repair and improve the northwesterly 0.3 mile of the Delta Meadows Cross Slough levee, with berms implemented for the remaining 0.3 mile. Conceptual cross sections for these remediations are provided in Section 5, Figure 5-1, Figure 5-3, and Figure 5-5.

7.1.2 Management Action 2: Repair and Strengthen-in-Place Snodgrass Slough Non-SPFC Levee Northeast of Locke (portion of NULE Segment 1054 in RD 369)

As described in Section 5.1.1.2, Table 5-2, remedial alternatives to repair and strengthen the Snodgrass Slough levee include a 35-foot-deep cutoff wall or a 90-foot-wide, 9-foot-tall combination seepage and stability berm. Both remedial alternatives are paired with 110-foot-wide RSP for a total of 500 feet Cutoff walls were selected as the recommended remedial alternative to repair and strengthen the Snodgrass Slough levee in an effort to reduce impacts to riparian vegetation. Conceptual cross sections for these remediations are provided in Section 5, Figure 5-1 and Figure 5-5.

7.1.3 Management Action 3: Repair and Strengthen-in-Place Sacramento River SPFC Levee Adjoining and Northwest of Locke (NULE Segment 121 in RD 369 and a Portion of NULE Segment 127 in RD 554)

As described in Section 5.1.1.1, Table 5-1, remedial alternatives to repair and strengthen the SPFC levees along the left bank of the Sacramento River includes cutoff walls ranging between 15 to 75 feet deep, and berms (stability or combination seepage and stability berms) ranging between 15 to 65 feet wide. Cutoff walls were selected as the recommended remedial alternative to repair and strengthen the SPFC levees in an effort to reduce physical impacts that would displace structures within the community and the existing pear orchard north, and upstream of Locke. A conceptual cross section for this remediation is provided in Section 5, Figure 5-1.

7.1.4 Management Action 4: Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee North of Locke (portion of NULE Segment 1040 in RD 551)

As described in Section 5.1.1.3, remedial alternatives to repair and strengthen the Delta Meadows Slough levee includes a 65-foot-deep cutoff wall or a 135-foot-wide, 15-foot-tall combination seepage and stability berm. Cutoff walls were selected as the recommended remedial alternative to repair and strengthen the Delta Meadows Slough levee in an effort to reduce physical impacts that would displace prime farmland. A conceptual cross section for this remediation is provided in Section 5, Figure 5-1.

7.1.5 Management Action 5: Secure 100-Year FEMA Certification, with Potential Cross Levee North of Locke Paired with Perimeter Levee Improvements South of the Potential Cross Levee

Remedial alternatives to construct a new cross levee and repair and strengthen the RD 369 perimeter levee system south of said cross levee are described in Sections 5.1.2.1 and 5.1.2.2.

7.1.6 Management Action 6: Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System

Remedial alternatives to repair and strengthen the entire RD 369 perimeter levee system are described in Section 5.1.2.2 as well as in MAs 1 to 4.

7.1.7 Management Action 7: Sacramento River Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke with a Potential Cross Levee North of Locke

As described in Section 5.1.1.1, Table 5-1, remedial alternatives to repair and strengthen the SPFC levees along the left bank of the Sacramento River includes cutoff walls ranging between

15 to 75 feet deep, and berms (stability or combination seepage and stability berms) ranging between 15 to 65 feet wide. Cutoff walls were selected as the recommended remedial alternative to repair and strengthen the SPFC levees in an effort to reduce physical impacts that would displace structures within the community and the existing pear orchard north, and upstream of Locke. A conceptual cross section for this remediation is provided in Section 5, Figure 5-1.

Remedial alternatives to construct a new potential cross levee and repair and strengthen the RD 369 perimeter levee system south of said cross levee are described in Sections 5.1.2.1 and 5.1.2.2.

7.2 Stakeholder and Public Input on Structural-Based Management Actions and Non-Structural Flood Risk Reduction Measures

The recommended suite of seven MAs was informed by stakeholder and public feedback received following preparation of the draft FSR in November 2020. Stakeholders and the public expressed support for repairing the weakest link in the perimeter levee system of the Locke study area (MA 1) and securing 100-year FEMA certification for the entire perimeter levee system and entire study area including agricultural lands north and northeast of Locke (MA 6). The idea of utilizing a potential cross levee (MA 5) was not well received and was viewed as a last resort. No formal input was provided for MAs 2 to 4, other than improving the entire perimeter levee system to meet current engineering FEMA accreditation standards.

7.3 Community Preferred Structural-Based Management Actions

From the recommended suite of structural-based MAs, a suite of community preferred structural-based MAs was developed based on the stakeholder and public input described above in Section 7.2. This suite of structural-based MAs includes MAs 1-3 for near term implementation, and MA 6 (improving the entire project area perimeter levee system to current engineering FEMA accreditation standards) for long-term implementation. MA 7 serves as a potential compromise between implementing all of MA 6, by eliminating MA 1 and significant portions of MA 2 along the former WGBL that would be north of any potential cross levee system north of Locke within RD 369. Separate cost estimates below have been provided for the implementation of MAs 5, 6, with MA 7 as a potential compromise to MA 6. Capital costs for these MAs are described further in Section 6.2 as summarized previously in Table 6-5. MA 5 represents the least costly suite of structural-based Management Actions for implementation with a potential cross levee north of Locke; whereas MA 6 Represents the highest cost that would be incurred for implementing the community preferred structural based Management Actions considered for entire study area of Locke. The range of these costs for the least costly suite through the highest suite of structural based MAs 5-7 are provided below in Table 7-1. The noted costs are likely worse-case cost estimates based upon the limited amount of available levee geotechnical data and accompanying levee survey data that is needed to properly prepare remediation designs to improve the existing levee system(s) to current FEMA engineering accreditation standards.

Table 7-1: Key Structural-Based Management Actions Considered and Associated Costs

Management Action	Estimated Cost
MA 5: Secure 100-Year FEMA Certification, with a Potential Cross Levee North of Locke (Not Community Preferred) Paired with Perimeter Levee Improvements South of a Potential Cross Levee	$15,739,000 – $22,490,000 Minimum Cost for Study Area of Locke
MA 6: Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System (Community Preferred)	$50,276,000 - $76,185,000 Maximum Cost for Study Area of Locke
MA 7: Sacramento River Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke as Potential Alternative to MA 5	$25,794,000 - $44,304,000

7.4 Non-Structural Measures Recommended for Implementation

Out of the full suite of 15 non-structural measures described in detail in Appendix H, and further discussed in Section 5.2, the following non-structural measures are recommended to be carried forward to reduce flood risks within the Locke study area:

1. Vegetation Removal and Levee Crown Maintenance
2. Improved Governance Between Neighboring LMAs/RDs
3. Voluntary Elevation of Structures
4. Wet or Dry Floodproofing
5. Flood Emergency Safety Plans
6. Sacramento County OES Decision Support Tool
7. Local Hazard Mitigation Plan and Relief Cuts
8. Alternatives to FEMA National Flood Insurance Program (NFIP) – Private, Community-Based Flood Insurance
9. NFIP Flood Insurance Enhancements *via* AFOTF
10. Mokelumne River Conveyance Improvements & Staten Island Overflow Area
11. Improve FEMA CRS score for Sacramento County/Isleton
12. Land Use Regulations and Limitations
13. SWIFs & Periodic Inspections with USACE
14. Public Education/Public Awareness

The only non-structural measure previously identified but not carried forward is acquisitions and relocations. Relocating entire communities within the Delta, particularly the national historic Delta Legacy Community of Locke, is inconsistent with the goals and objectives of both the Delta Plan and the Sacramento-San Joaquin Delta National Heritage Area designation.

The recommended suite of the key non-structural measures and timeline status are summarized below. Of these, a portion are currently ongoing within the Locke study area, with the remaining recommended for implementation in the near term and long-term as summarized in Table 7-2. Associated recommendations and costs, as applicable, are summarized below.

Table 7-2. Recommended Timeline for Implementation of Other Non-Structural Measures

Non-Structural Measure	Ongoing	Recommended: Near Term (1-6 years)	Recommended: Long Term (> 6 years)
Vegetation Removal and Levee Crown Maintenance		X	X
Improved Governance between Neighboring LMAs/RDs & Community		X	X
Voluntary Structural Elevation		X	X
Wet or Dry Floodproofing		X	X
Flood Emergency Safety Plans	X	X	X
Sacramento County OES Decision Support Tool	X	X	X
Local Hazard Mitigation Plan and Relief Cuts		X	X
Alternatives to NFIP – Community and Flood-Risk Based Insurance Program		X	X
NFIP Flood Insurance Enhancements *via* AFOTF		X	X
Mokelumne River Conveyance Improvements/Flood Easements			X
Improve FEMA CRS Score for Sacramento County	X	X	
SWIFs & Periodic Inspections with USACE		X	X
Public Education and Awareness	X	X	X

7.4.1 Deferred Vegetation Removal and Levee Crown Maintenance (portions of Meadows Cross Slough Levee, Snodgrass Slough Levee, and Delta Meadows Slough levee)

Please refer to Section 5.2.1 for a more detailed description of this non-structural measure which includes deferred vegetation removal and levee crown maintenance for select portions of the non-SPFC levees in the Locke study area. Vegetation removal and levee crown maintenance is proposed along the Delta Meadows Cross Slough right bank levee (portion of NULE Segment 1054, RD 369), as well as along select portions of the Snodgrass Slough right bank levee (portion of NULE Segment 1054, RD 369) and the Delta Meadows Slough levee (portion of NULE Segment 1040, RD 551), primarily in support of providing improved access for flood fight activities.

7.4.2 Improved Governance between Neighboring LMAs/RDs and Community

Please refer to Section 5.2.2 for a more detailed description of this non-structural measure that is a long-term non-structural measure that could be beneficial to not only the community of Locke and RD 369 but also the adjacent Reclamation Districts RD 554-Walnut Grove and RD 551-Pearson District.

To improve economies of scale, there is the potential for RD 369 – Libby McNeil to join forces (personnel, consultants, and equipment) with RD 554 – Walnut Grove or other adjacent RDs (RD 551 – Pearson District) to streamline costs and collaborate on reducing flood risks. RDs 369 and 554 have reportedly joined forces with other neighboring Districts in developing a NOI to file a SWIF application with the CVFPB and the USACE. The SWIF assesses deficiencies and prioritizes levee repairs along the left bank of the Sacramento River, including the SPFC levee segments that provide protection to the communities of Courtland, Locke, and East Walnut Grove.

7.4.3 Voluntary Elevation of Structures

It is recommended that voluntary raising of structures, on a case-by-case basis, be carried forward as a non-structural solution for reducing flood risks within the Locke study area only outside of the Locke National Historic District identified in Figure 2-9. The County should also encourage residential and business owners to participate in the voluntary raising of structures by offering potential cost-sharing incentives (50 percent or greater cost share reductions) available through Federal and state cost-sharing programs.

As described previously, there are a total of 71 structures in the Locke study area, including the portion of RD 554 located north of the Delta Cross Channel. As previously presented in Table 5-4 in Section 5.2.3, this represents a cost of at least $12M to elevate all of the structures within the study area of Locke. Note that this cost could be greater when assuming commercial, industrial, and public buildings may be more costly to elevate than single family residential structures.

The cost to raise all structures to these heights may be feasible with federal and state participation but may not be desirable for this particular historic Delta Legacy Community. However, elevating structures in the no-historic district of Locke is encouraged on a case-by-case basis wherever feasible with Federal and state assistance. This non-structural measure would need to be voluntary for residential structures as expressed during public outreach meetings. This measure is recommended for implementation, on a case-by-case basis, in the long term for only areas located outside the historic district of Locke.

7.4.4 Wet or Dry Floodproofing

Please refer to Section 5.2.4 for a more detailed description of this non-structural measure that would be voluntary in nature for individual homeowners and business owners, similar to voluntary elevation of structures. Similar to elevating structures, wet or dry floodproofing would be done a case-by-case-basis and could be implemented during the short- and long-term.

7.4.5 Improved Emergency Response – Flood Emergency Safety Plans and County OES Decision Support Tool

As the ESPs are intended to be guiding documents to save lives and reduce potential flood damages if a flood emergency were to occur, it is imperative that they are updated as needed with the best available and most up-to-date information. In particular, updates to the ESPs may include detailed relief cut locations for each RD – *see* Section 7.4.6 below for more information. Coordination on the plan update began in September 2020 and the final plan update is scheduled for completion before the end of 2021.

It is recommended that the Delta Flood ESP for Hood be updated every 5 years and/or as needed.

7.4.6 Local Hazard Mitigation Plan and Relief Cuts

Sacramento County began public outreach to update the 2016 LHMP in 2020. The next 5-year update to the LHMP was planned to be complete by the end of 2021. As part of this update, Sacramento County has the opportunity to reevaluate the impacts of flooding and levee failure to the people and assets of the Sacramento County planning area, including RDs 369, 551,and 554, and to establish updated goals and prioritize projects to reduce these impacts on people and property within RDs 369, 551, and 554. It is recommended that Sacramento County continue to update the LHMP every 5 years.

Relief cuts properly executed in the study area could result in a reduction in flood depths in excess of 4 feet if the RDs are willing, as previously noted, the updated LHMP is the most likely vehicle to formalize relief cuts. As discussed above, Sacramento County RDs will be updating their ESPs and are looking at incorporating a relief cut if feasible. A planned relief cut for RD 551 upstream of Locke could possibly negate the need for any significant levee improvements along NULE Segment 1040-A (MA 4 - with a current worse-case range of remediation costs between $14,525,000 and $16,846,000).

7.4.7 Alternatives to NFIP – Community and Flood-Risk Based Insurance Program

Please refer to Section 5.2.7 for a more detailed description of this non-structural measure of a community-based flood insurance program that has been recommended for implementation for the short- and long-term as a viable supplement and/or alternative to FEMA's current NFIP.

Locke and other Delta Legacy Communities might choose to implement a community-based flood insurance program through the establishment of an HOA or a GHAD. A GHAD is a state-level public agency for the purpose of providing prevention, rapid response, and funding to address hazardous geologic conditions. They were established in 1979 by the Beverly Act to allow local residents to develop self-funding mechanisms that address the long-term abatement and maintenance of structures that protect real property from geologic hazards.

The City of Isleton has already taken the initial steps in June to July of 2021 to formalize a path for property owners within its city limits to aggregate their resources and establish a community-based flood insurance program that can be used to augment and/or replace the current set of NFIP policies held within the City of Isleton. The County is also encouraging the unincorporated North Delta Legacy of Locke to consider alternatives to the current NFIP, including a community-based flood insurance program that could be administered with or without developing a GHAD (for further details *see* Appendix J, prepared by Kathleen Schaefer, P.E., CFM, former FEMA regional administrator of NFIP).

7.4.8 NFIP Flood Insurance Enhancements via AFOTF

Please refer to Section 5.2.9 for a more detailed description of this non-structural measure that is an ongoing, long-term non-structural measure that could be beneficial to all unincorporated, agriculturally-based areas within Sacramento County including the community of Locke.

7.4.9 Improve FEMA CRS Score for Sacramento County

Please refer to Section 5.2.11 for a more detailed description of this non-structural measure that is an ongoing, long-term non-structural measure that has been beneficial to all unincorporated areas within Sacramento County including the community of Locke.

Sacramento County, *via* its floodplain administrator program, is a very active participant of the NFIP, and through its County-wide Flood Protection Ordinance the County strives to reduce flood risks throughout the unincorporated areas of Sacramento County while also attempting to reduce NFIP premium policy rates. Through different flood mitigation activities outlined within the NFIP, Sacramento County has been able to reduce flood insurance through the FEMA CRS. The County currently has the opportunity to improve their CRS score to achieve the highest possible Class 1 designation by implementing and participating in EAPs and associated Table Top Exercises for nearby, upstream dams/reservoirs (namely Folsom Reservoir, and possibly others) that could have a sizeable impact on flooding portions of Sacramento County if said reservoir(s) were to fail and cause flooding. This last jump from a CRS Class 2 to Class l designation would result in the last available 5 percent decrease (from 40% to 45%) in NFIP premiums and would place Sacramento County as the second highest ranked CRS community in the entire Country behind Placer County.

7.4.10 Public Education and Awareness

Please refer to Section 5.2.12 and Appendix H for a more detailed description of this non-structural measure that includes three ongoing public education and awareness programs for the Delta Legacy Communities. The noted public education/awareness programs are administered by: (1) the DPC *via* their Delta Flood Preparedness Week hosted each fall season prior to the beginning of each flood season; (2) the Sacramento County Program for Public Information increases flood awareness through informational materials (such as the Storm Ready Booklets) and multiple levels of outreach, ranging from radio spots to specific stakeholder engagement; and (3) the DWR Flood Risk Notification Program that includes sending annual notices in advance of the flood season to every property owner who is located behind a SPFC levee within the Delta. The individual notices include the property owner's address and informs the owners their property may be exposed to potential flood risk from the failure of the levee system. DWR also suggests each property owner visit DWR's Flood Risk Notification[1] and enter their address to get the most up-to-date information on State-federal levees in their area.

These programs all act as an ongoing, long-term conduit of flood risk information and coordination directly with the community members of Locke and other nearby Delta Legacy Communities protected by a combination of SPFC and non-SPFC levees.

7.5 Right-of-Way and Easement Considerations/Recommendations

Local preference and planning guidelines in the Delta encourage retention of agricultural lands as much as possible; and the Delta Plan encourages preservation of agricultural land and uses versus displacement for commercial or residential uses. The structural-based MA components that could conflict with existing, regional regulations of preserving agricultural lands in the Delta could be those that include seepage/stability berms as noted above in Section 6.3.2.1. Table 6-8 in Section 6.3.2.1 provides a summary of each structural-based MA and the corresponding acreage of agricultural lands that may be displaced with either a seepage/stability or combination berms.

If the final configuration of structural-based MAs would displace or affect a substantial acreage of important farmland of regional and statewide significance within the study area it may be deemed inconsistent with the Delta Plan and policies as administered by the DSC and DPC. It should be noted any major construction activity within the Delta would be considered a "Covered Action" under the Delta Reform Act of 2009 and the CEQA lead agency would be required to submit a written certification of consistency with detailed findings as to whether the covered action is consistent with the Delta Plan. Any person who claims that a proposed "Covered Action" is inconsistent with the Delta Plan may appeal a certification of consistency to the Council. (Calif. Water Code, § 85225.10).

[1] https://water.ca.gov/myfloodrisk

It should be noted that most landowners in the study area adjoining the existing SPFC and non-SPFC levee systems actually own fee-title land under the levee prism and up to the ordinary high-water mark on the water-side of the levee to maintain their riparian water rights to the Sacramento River and adjoining sloughs. The State and the Sacramento-San Joaquin drainage district retain easements for the SPFC levees and Caltrans and Sacramento County also retain easements in most locations (*vs*. fee title) where highway and or roadway are overlain on the top of the levee crowns.

Right-of-way (ROW) acquisition quantities were estimated for the multitude of structural-based MAs (*see* Appendix F). In addition to determining costs for acquiring fee title or dedicated easements for various MAs, estimates were also developed for any temporary roadways to divert traffic. ROW was estimated based on review of aerial photography of existing land use and visual ground-truthing to confirm some of the different agricultural uses. ROW acquisition costs as summarized below in Table 7-3 only accounts for the required alignment and doesn't include purchase of full parcels.

The impact of known utilities to be relocated is considered minimal to the larger scope of the project. Unidentified utility relocations are assumed part of the allowance for unlisted items costs. Costs do not include removal and relocation of any existing structure on the landside of the levee, including but not limited to pump stations, residences, etc. The impact of utility crossings on the stability of the levee foundation, embankments, and refinements to associated costs for mitigation and/or relocation of these crossings will need to be considered during the project design phase.

Table 7-3: Permanent Right-of-Way Cost Estimates per Acre and Structure

Permanent Right-of Way (fee title) and Structures	Unit	Cost
Permanent Right-of Way (fee title) - Seasonal Agricultural Field/ Row Crops	AC	$25,000
Permanent Right-of Way (fee title) - Orchard/ Vineyard	AC	$40,000
Permanent Right-of Way (fee title) - Commercial/ Industrial	AC	$240,000
Permanent Right-of Way (fee title) - Residential	AC	$180,000
Residential structures	Ea.	$250,000
Other structures	Ea.	$75,000

7.6 OMRR&R Considerations

O&M is the traditional term used to describe the routine activities necessary for a functioning flood management system. OMRR&R is a more recently developed term used to describe and include the comprehensive set of non-routine activities that realistically need to occur for the system, and also includes rehabilitation, repair, and replacement.

There is limited legal authority defining the terms repair, replacement, and rehabilitation. However, some guidance can be found in 33 CFR 208.10, and USACE ER 110-2-401. The guidance in these legal authorities in addition to regular practice of the State and LMAs, and the expectations of USACE with regard to OMRR&R throughout the years, seems to indicate that the obligation to perform routine O&M did not significantly expand with the explicit requirement to include the terms repair, replacement, and rehabilitation in new assurance agreements. Promulgated in 1944, the requirements of 33 CRF 208.10 form the foundational requirements for O&M prescribed by the Secretary of the Army that non-federal sponsors give assurances to comply with, and in turn are transferred in entirety from the CVFPB to LMAs through local assurance agreements. These requirements are further stated in Standard Operating Manuals for SPFC facilities which also explicitly include certain "repair" and "replacement" obligations required from the non-federal sponsor.

LMAs are not only faced with insufficient funding to conduct the activities needed to maintain and operate SPFC facilities, but they are also working under conditions, design standards, and environmental regulations that have changed since the flood infrastructure was constructed. These changes have complicated OMRR&R and affected the ability to perform necessary activities needed to ensure a fully functioning flood system. Historically, this was not a major issue because federal programs, including PL 84-99 administered by USACE, were relied on to fund necessary repairs associated with damages from significant flood events. However, federal funding is becoming more difficult to obtain and eligibility requirements for post-event assistance through PL 84-99 are becoming increasingly more difficult to meet.

As part of the 2017 CVFPP Update, DWR prepared an OMRR&R cost estimate to account for more stringent USACE O&M standards, additional USACE RR&R responsibilities, increasing mitigation costs, and correcting original system design deficiencies. In the technical memorandum, the State communicates that although the State may provide non-routine investment in levee improvements, repairs, and rehabilitation when necessary and when funding is available, the responsibility for maintenance lies with LMAs. To support the continued increase in O&M and additional burden of RR&R responsibilities, an assessment will likely be necessary.

OMRR&R costs in the Locke study area will increase in connection with the implementation and OMRR&R of a potential new cross levee north of Locke (MAs 5 and 7). This is a MA that will not likely be pursued by RD 369 unless there is large support and financial assistance from the community beneficiaries, namely the residences and business owners of the Locke community. The community will need to conduct a benefit assessment for not only the implementation and construction of the cross levee but also for the long-term OMRR&R. The community beneficiaries of said cross levee may not be the likely candidate to perform the OMRR&R, but they need to be prepared to compensate RD 369 (or another applicable O&M entity) for any incremental cost of OMRR&R over and above what RD 369 may incur without the added presence of a cross levee.

No new substantial OMRR&R cost are anticipated by RD 369 with the implementation of MAs 1 to 4 and MA 6 associated with repairing and strengthening-in-place various portions of the RD 369 perimeter levee system.

7.7 Regulatory Requirements

Environmental requirements associated with implementation of the preferred MA would include preparation of a CEQA/NEPA document, permits, endangered species consultations, Tribal consultation, and cultural resource assessments and consultations.

The level of CEQA/NEPA documentation required for the preferred structural-based MAs is dependent on many factors, including the project extent and severity of associated environmental impacts including biological and cultural resources, and air quality and greenhouse gas emissions. Under CEQA, if all impacts can be avoided or mitigated for, then a Mitigated Negative Declaration would suffice for the project. However, in areas where extensive habitat or air quality impacts are unavoidable, then an EIR would need to be prepared. More extensive CEQA documentation would result in a higher cost for analysis and preparation. The required level of NEPA documentation generally follows CEQA, but in certain instances, a less extensive analysis may be appropriate, depending on the lead federal agency.

Permits such as Clean Water Act Section 404 and 401 permits, approvals under the federal Endangered Species Act and California Endangered Species Act, and a Streambed Alteration Agreement from CDFW (Section 1600 permit) will be needed, depending on what levee elevation is affected (is work below Mean High Water or Ordinary High Water) and if upland work is conducted in sensitive areas. Prior to beginning the regulatory process for implementation of a proposed element, the following studies would be needed: a wetland delineation of the study area in accordance with the 1987 USACE Wetland Delineation Manual and Sacramento District standards and focused habitat classification and assessments to determine the potential impacts of the project on special-status species. Conducting the delineation and focused surveys incurs a cost as may any avoidance or minimization measures that may need to be incorporated into project design. Additionally, mitigation for unavoidable effects to sensitive vegetation and wildlife would likely incur a cost associated with on-site or off-site mitigation.

RDs 369 and 554 currently conduct some maintenance activities (repairs affecting up to 100 ft. of levee) under a Routine Maintenance Agreement (RMA) with CDFW. The RMA covers maintenance activities for 5 years from the date of issuance, but can often be extended indefinitely, with periodic “touch-up” biological surveys. Depending on project activities, this agreement may be used or a separate 1600 may be required from CDFW. There are several CDFW staff familiar with project activities common to Delta levees maintenance and repairs covered under the Subventions program, and this helps with timely project permitting and implementation. Due to the presence of several threatened and endangered aquatic species in the

Delta it should be noted that most all waterside work on the levees in the Delta is largely limited to the short 90-day disturbance period of August 1 through October 31.

As described previously, a total of 13 resources were identified during the records search and from information provided by Sacramento County. The majority of these have not been formally evaluated for their eligibility for listing in either the NRHP or CRHR. Many of the identified resources are along the Sacramento River levee and within the community of Locke, and therefore near to elements of the proposed MAs, including remediation of levees along the Sacramento River and the cross levee north of Locke. Further evaluation of these resources, including cultural and historic resources, would need to be conducted to inform final project design and implementation. *See* Appendix C for additional information on cultural resources within the study area.

In addition to complying with environmental regulations, any geotechnical investigations, and subsequent modifications on or within 15 feet landward of any SPFC levee system will require a USACE Section 408 permit approval initiated by the local sponsor through the CVFPB. The sponsor's application, must be developed by the local LMA or RD prior to submittal to the CVFPB. Upon receipt by the CVFPB it can take 90 to 120 days to receive approval and a mandatory endorsement by the CVFPB prior to their submittal to the USACE. Upon receipt of the Section 408 application by the USACE it can take at times up to 18 months or more to issue the Section 408 approval. Thus, it may take up to two years for the local sponsor to gain Section 408 approval after submitting an application to the CVFPB.

7.8 Federal, State and Local Funding Sources and Financial Strategies

The potential federal, state, and local funding sources for the flood risk reduction MAs and non-structural measures identified for the Delta Legacy of Locke identified below in Sections 7.8.1 through 7.8.3 are largely excerpted and updated from the suite of funding sources previously identified in the 2014 Lower Sacramento/Delta North RFMP and the 2017 CVFPP Update. One new additional key federal funding source is FEMA's Building Resilient Infrastructure and Communities (BRIC) program that can channel competitive funds to the small Delta Legacy Communities through Cal OES for both structural and non-structural flood risk reduction measures.

Section 7.8.4 also provides a new potential financial strategy identified in May of 2018 by the DPC's Assessment District Feasibility Study and Delta Levees Financing Options. The noted study conceptually identifies feasible funding mechanisms to assess SWP/CVP conveyance fees and potential Delta flood prevention fees associated with improving the outdated Delta levee systems that provide state-wide and regional benefits beyond the Delta Legacy Communities and adjoining agricultural interests.

7.8.1 Federal Funding Sources

The process for garnering federal funding for flood risk reduction projects requires that a federal interest in the project be identified. Federal interest has generally been identified and evaluated within feasibility studies prepared by the USACE, which evaluate various criteria and generally emphasize the flood damage-reduction benefits typically associated with larger urban area projects. Unfortunately, the small communities and rural areas generally lack the necessary flood risk reduction benefits alone to justify a significant federal interest, unless there are sizeable multi-objectives/benefits that can also be attached to the smaller benefits normally associated with small, rural communities that exist in the North Delta. One sizeable multi-benefit component that has been identified in most all of the Sacramento County Delta Legacy communities is repairing and strengthening-in-place the SPFC levee system along the Sacramento River for the entirety of the community's study area (Locke's structural-based Management Actions 3 and 6) will also improve the reliability and resiliency of the through-Delta conveyance of SWP and CVP water through the Delta. Given the constrains of the current approach for evaluating and garnering federal investment for stand-alone flood risk reduction projects, coupled with constrained federal budgets, it may be difficult to secure significant federal investment in the region through the USACE. Furthermore, the evaluation, project identification and appropriation process for USACE projects can be protracted, expensive and can lead to higher project costs that may, in some cases, not be in the best economic interest of local project proponents.

Greater opportunities for federal funding may exist via FEMA's emerging BRIC program that can channel competitive funds to small communities through Cal OES. FEMA's BRIC program supports flood risk reduction programs and projects for small, rural communities with smaller, local cost-sharing requirements, particularly for disadvantaged communities. It also enables large multi-benefit infrastructure projects that could possibly be combined with reducing flood risks in the noted North Delta Legacy Communities, including the benefit of improving the long-term reliability and resiliency of through-Delta conveyance of SWP and CVP water through the Delta adjoining the communities. This is particularly applicable for the federal- and state-authorized SPFC levee system in the North Delta adjoining the chain of six Delta Communities, namely Hood, Courtland, Locke, Walnut Grove (East and West) directly adjacent to the Sacramento River SPFC levee system, and the City of Isleton adjacent to the Georgiana Slough SPFC levee system.

Table 7-4 provides a summary of potential federal funding sources to fund both structural-based management improvements and non-structural flood risk reduction measures. The table outlines the general uses of the funding source and the attributes and applicability of the mechanism for flood management.

Table 7-4: Potential Federal Funding Programs

Agency	Program Name (Acronym)	Program Summary	Status	Who is Eligible to Apply	Cost Share Range
FEMA	Building Resilient Infrastructure and Communities (BRIC)	The BRIC program supports hazard mitigation projects, reducing the risks faced from disasters and natural hazards. (Approximately $919M available for local projects spread across entire nation for fiscal year 2021)	Relatively New	Federally Recognized Native American Tribes, State governments; City or township governments, County governments via Cal OES	Varies 75%-90% Highest for small disadvantaged communities (DACs)
FEMA	Flood Mitigation Assistance (FMA)	The FMA grant program provides funding to reduce or eliminate the risk of repetitive flood damage to buildings and structures insurable under the National Flood Insurance Program (NFIP).	Ongoing	Federally Recognized Native American Tribes, State governments; City or township governments, County governments via Cal OES	Varies 75%-100%
FEMA	Pre-Disaster Mitigation (PDM)	The PDM Grant Program is designed to implement a sustained pre-disaster natural hazard mitigation program to reduce overall risk from future hazard events, while also reducing reliance on Federal funding from future disasters.	Ongoing	Federally Recognized Native American Tribes, State governments; City or township governments, County governments via Cal OES	75% 90% for small disadvantaged communities (DACs)
USACE/ State	USACE/CVFPB Feasibility Studies (USACE FS)	A feasibility report is developed to identify the recommended plan: project scope, economic benefit, and an accurate cost and schedule baseline identified with potential project risks.	Ongoing	CVFPB with a local Sponsor	50% USACE, 50% State and Locals Split
USACE/ State	USACE/CVFPB Civil Works Projects (USACE CW)	Upon completion of a USACE feasibility study a Chief's Report is provided to congress. If the Chief's Report is authorized by Congress a local agency can advance a project with the USACE upon securing federal appropriations.	Ongoing	CVFPB with a local Sponsor, 25%	35% Split between CVFPB and local Sponsor
USACE	Sacramento River Bank Protection Project (SRBPP)	The Sacramento River Bank Protection Project is a long-term flood risk management project designed to enhance public safety and help protect property along the Sacramento River and its tributaries.	Phasing Out	Project Levees authorized in the SRFCP	0%

7.8.2 State Funding Sources

In the near term, the State plans to utilize the remaining Proposition 1E bonds authorized to fund projects consistent with the CVFPP last adopted in July 2017 and being updated at 5-year intervals with the next update scheduled for 2022. Within the latest 2017 CVFPP updates, the State identified remaining Proposition 1E and 84 bond funds were not sufficient to meet all of the flood protection goals and identified an ongoing need for flood risk reduction within the Central Valley. Additional bond authorizations and greater utilization of State general funds will be needed to meet the goals identified in the CVFPP, particularly for the SCFRRP flood risk reduction components. The SCFFRP component measures for the entire CVFPP study area were estimated between $1.5B to $1.9B in the 2017 CVFPP update for the Sacramento Basin alone compared to only $310M to $370M for the San Joaquin Basin. The State Legislature will need to play a significant role, with respect to how State and local funding can be generated particularly within the Delta region, as it considers legislation associated with planned updates to the CVFPP and the associated financing/funding plan recommendations.

Below is an abbreviated excerpt from Section 3.13.1 of California's Flood Future Report of November 2013[2] that suggests levee improvements in the Delta should be orchestrated with improving the conveyance of SWP and CVP water through the Delta to areas south of the Delta where water demands are significantly greater than available water supplies south of the Delta.

> "The Sacramento-San Joaquin Delta provides a major source of water supply to more than 60 percent of California residents and is a vital source of water supply for agriculture. The Delta is a unique place defined by its ecological value as the transitional ecosystem from fresh to salt water and by its extensive levee system *(including SPFC levees in the north Delta and several non-SPFC levees in the central and south Delta that convey water to the SWP and CVP pumps in the south Delta)*. The Delta consists of approximately 70 major islands and tracts encompassing approximately 700,000 acres located behind levees. Virtually all assets and attributes of the Delta are dependent upon this large levee system. The levees reduce flood risk to land areas near and below sea level and provide for a network of channels that direct movement of *(SWP and CVP)* water across the Delta. The State of California has significant interest in the benefits provided by Delta levees, which have been legislated in the California Water Code (§ 12981, for example).
>
> The Delta is unique, not only as a levee system but also as an influence on existing DWR flood management programs within the Delta. The Delta is a prime example of why Integrated Water Management (IWM) is important in California. Due to its location, importance for much of California's water supply, deteriorating ecosystem conditions, questions about levee integrity and feasibility for improvements, and other issues, flood management cannot be considered in isolation of other resource needs. The importance of the Delta and its levees to the State has been included

[2] 2013 California's Flood Future: Recommendations for Managing the State's Flood Risk – Statewide Flood Management Planning Program – Flood SAFE California - Nov. 2013 https://cawaterlibrary.net/wp-content/uploads/2017/05/California_Flood_Future.pdf

> many times in legislation and codes. In addition, multiple Federal and State processes are underway to solve a variety of resource management problems in the Delta, and several include consideration of levee improvements or other flood management actions. These plans, *including the DCA's current efforts that consider a single-purpose isolated conveyance facility* and the Delta Stewardship Council (DSC) Delta Plan, *may* alter Delta conditions and will influence the future of IWM in the Delta. Implementation of these programs would alter ecosystem conditions and water infrastructure, which would influence Delta flood risk; therefore, flood management in the Delta needs to be considered as part of these larger planning efforts."

Given the above perspective within California's Flood Future Report there should be a larger financial interest in reducing flood risks in Delta by the USACE, USBR, FEMA, DWR, CVFPB, and Delta water users south of the Delta. This holds true particularly for improving the SPFC levees in the subject north Delta Legacy Community study areas adjoining the SWP and CVP freshwater conveyance corridor along the Sacramento River upstream of the Delta Cross channel, and portions of both Snodgrass and Georgiana Sloughs immediately downstream of the Delta Cross Channel.

Other policy efforts that could potentially generate future State funding include the recommendations presented within the current Governor's Water Resiliency Portfolio Water Action Plan. These recommendations include providing support and expanding funding for Integrated Water Management Planning and Projects, creating incentives for multi-benefit projects, providing assistance to disadvantaged communities, and prioritizing funding to reduce flood risk and improve flood response. In addition to recommendations that could direct State funding to the region, the former Governor's Water Action Plan also identified recommendations that could make it easier to generate local funding including removing barriers to local and regional funding for water projects. One of the key concepts in the Water Action Plan called for the development of a water financing strategy that leverages various sources of water-related project funding and proposes options for eliminating funding barriers, including barriers to co-funding multi-benefit projects.

Table 7-5 provides a summary of potential State funding sources applicable to Delta Legacy Communities protected by SPFC levees. The State funding programs can fund both structural-based management improvements and non-structural flood risk reduction measures. The table outlines the general uses of the funding source and the attributes and applicability of the mechanism for flood management.

Table 7-5: Potential State Funding Programs

Agency	Program Name (Acronym)	Program Summary	Status	Who is Eligible to Apply	Cost Share Range
State DWR	Delta Special Projects	Cost share grant program for levee maintaining agencies in the Delta to rehabilitate non-SPFC and eligible SPFC levees.	Ongoing	LMA's within the Primary and Secondary Zones of the Legal Delta and limited areas within the Suisun Marsh.	75 to 95% Up to 100% for Habitat Projects
State DWR	Delta Levees Subventions	Cost share program for the maintenance and rehabilitation of non-SPFC and eligible SPFC levees in the Delta.	Ongoing	LMA's within the Primary and Secondary Zones of the Legal Delta.	Up to 75%
State DWR	Flood System Repair Projects (FSRP)	Evaluate (feasibility), design, and construct repairs of non-urban SPFC Facility (levees, channels, structures, etc.) deficiencies	Phasing Out	Eligible applications are local public agencies or Joint Powers Authority	50 to 90%
State DWR	Small Community Flood Risk Reduction Program (SCFRRP)	Projects to reduce flood risk in small, rural, and agricultural communities in the Central Valley. Funds support non-routine O&M, O&M plan updates, evaluations, feasibility studies, design, and construction of proactive repairs to flood control facilities of the SPFC and appurtenant non-SPFC levees.	Current	Local agencies: evaluate SPFC facilities must protect small and rural communities in the Central Valley designated by the CVFPP to have a High or Moderate-High Flood Threat Level.	50 to 90%
State-California Natural Resource Agency	California River Parkways Program	The Proposition 50 California River Parkways Grant Program in the Resources Agency is a competitive grant program for river parkways projects.	Ongoing	Public Agencies and California Nonprofit Organizations	50 to 90%
State DWR	Proposition 68	Proposition 68 authorizes $4.1 billion for state and local parks, natural resources protection, climate adaptation, water quality, and flood protection.	Ongoing	Public agencies, non-profit organizations, public utilities, Native American Tribes, and mutual water companies	50% Up to 100% for DACs
State DWR	Flood Maintenance Assistance Program	Program that provides State funds for eligible maintenance activities to Local Maintaining Agencies and Maintenance Areas.	Ongoing	Local Maintaining Agencies	50 to 75%
State IRWM	Integrated Regional Water Management (IRWM)	Grant funds for development and revisions of IRWM Plans, and implementation of projects in IRWM Plans. Goals of Projects: to assist local public agencies to meet long- term water management needs of the State.	Ongoing	Applicant must be a local public agency or nonprofit representing an accepted IRWM Region. Other IRWM partners may access funds if their projects are identified in the Applicable IRWM Plan	Up to 75%

7.8.3 Local Cost Share Financing and Assessment Strategies

The cities, counties, LMAs and the regional flood management agencies have played a significant part in funding the local share of flood management improvements and operations and maintenance. Funding by local agencies within the region is largely limited due to constitutional and statutory constraints to the way local governments can fund and finance capital improvements and services. As noted previously, Attachment I to California's Flood Future Report provides a detailed description of funding mechanisms available to local agencies to fund flood management improvements. In general, revenues for flood management within the North Delta are generated mostly by RDs or LMAs from property-based taxes, fees, and assessments. In California, a local agency's ability to provide ongoing services and invest in its infrastructure is limited by voter-approved initiatives, such as Proposition 13 (1978) (limiting property tax increases) and Proposition 218 (1996) (requiring voter approval for new assessments) as previously discussed above in Constraints Sections 3.3.1 and 3.3.2.

Limited Availability of Local Funding Sources

Presently the RDs and LMAs in the North Delta largely assess O&M and repair of the levee systems on an agricultural acreage basis, and do not necessarily assess on a land improvement basis that accounts for residential, commercial, or industrial structures. The acreage-based only assessment approach is in large part due to the assessment constrictions presented by Proposition 218 as further discussed above in Section 3.3.2. An exception to the acreage-only assessment in the North Delta is RD 563 - Tyler Island who experienced flooding in 1986 and has had subsequent flood fights in 2007 and 2017. RD 563 (encompassing a portion of the East Walnut Grove study area) successfully executed a Proposition 218 benefit assessment in the early 2010's. Following their detailed Proposition 218 benefit assessment study RD 563 now assesses anywhere from $45 to $65/year for agricultural acreage, $550 to $600/year for residential structures, and anywhere from $1,000 to $1,500/year for commercial/industrial groupings of multiple structures, all dependent upon the benefit received from maintenance, repair and improving the levee system designed to eliminate or reduce variable flood depths within RD 563. To improve the local cost-sharing participation by the Delta Legacy Communities for smaller community-specific flood risk reduction measures such as a flood fight berm, a ring levee, or a cutoff levee system for the community of Locke within RD 369, it is recommended that the community of Locke assess themselves on a combined acreage- and structural-benefit basis, similar to RD 563. A benefit assessment study to support improvements that only benefit the community and not the balance of the larger study area (RDs 369 and 554) will be likely be required; and it may be advisable for the community to consider the development of a GHAD that could also incorporate a community-based flood insurance program. The community-based flood insurance program coupled with the suggested structural-improvement assessment approach can further enhance the community's ability to buy-down known flood risks (*see* Appendix J regarding a community-based flood insurance program for the Delta Legacy Communities in Sacramento County coupled with a community benefit

assessment to generate local cost-share funds and assist with financing flood risk reduction measures).

Table 7-6 provides a summary of the local funding methods used by many agencies in California and the region to fund flood management improvements and services. The table describes the general uses of the funding source and the attributes and applicability of the mechanism for flood management. Included within these sources, many LMAs and RDs within the Delta, such as RDs 554 and 563 where the community of East Walnut Grove is located, fund ongoing O&M and repairs of levees via the Delta Levee Subventions program and/or the Delta Levees Special Projects, both of which are administered by DWR. These programs are reimbursement based administered by DWR and have minimum deductible cost per levee mile, and can include substantial local, up-front cost-share cashflow requirements. Thus, it is important to the communities within the existing RDs to know that they may need to assist with said RD levee improvements that provide direct and/or indirect flood risk reduction benefits to the community.

Table 7-6: Potential Local Funding Programs and Assessment Strategies

Potential Local Funding Programs and Assessment Strategies						Pros, Cons, and Notes		
Item	**Use**	**Voter Approval**	**Bonds Allowed**	**Long/ Short Term**	**Entity**	**Pro**	**Con**	**Notes**
Geological Hazard Abatement Districts (GHAD)	O&M/ Capital Improvements	50% of Property Assessed	Yes	Long-Term	Independent District / Community	Broad scope of works, locally autonomous, Simple Majority Approval, Ongoing Funding Source. Some CEQA exemptions	Must prepare Plan of Control. Creates new responsible independent entity (similar to JPA), Prop 218 applies with respect to assessments levied.	Alternative to RD. Can fund reserves & Community-Based Insurance Program
Various Water Code Sections	O&M/ Capital Improvements	50% by Property Assessed	No	Long-Term	RDs & Community	Simple Majority Approval, Ongoing Funding Source	Applicability of Prop 218 - Must Show Benefit	Can fund maintenance or capital works. Can be used to finance improvements.
Benefit Assessment District Act of 1982	O&M/ Capital Improvements	50% of Property Assessed	No	Long-Term	Flexible	Simple Majority Approval, Ongoing Funding Source	Must Show Benefit Improvements/Services must be within the Boundary	Could provide some reimb. of Advance Funding
Municipal Imprvmt. District Act of 1913/1915	Capital Improvements	50% of Property Assessed	Yes	Long-Term	Flexible	Simple Majority Approval, Ongoing Funding Source	Must Show Benefit Improvements/Services must be within the Boundary	Could provide some reimb. of Advance Funding
Community Facilities Districts	O&M/ Capital Improvements	2/3's (See Note)	Yes	Long-Term	Flexible	Benefit not Needed, Flexible in Forming District, Improvements located anywhere	2/3 Approval Difficult to Obtain	Voting requirements change depending on presence of registered voters within boundary.
Advance Funding	Planning & Capital Improvements	NA	NA	Short-Term	N/A	Can cover upfront planning and operations costs	Limited/Uncertain Availability	Could be subject to reimb. from various sources over time.

7.8.4 Potential Financial Strategy Identified by Delta Protection Commission (DPC) for Delta Levee improvements – May 2018

In May of 2018 the DPC[3] conducted a study that identified a potential financial strategy, inclusive of potential mechanisms to have out-of-Delta beneficiaries such as the SWP/CVP water contractors pay for levee maintenance and improvements that enhance the reliability and resiliency of the Delta levee system(s) that help convey freshwater through the Delta.

Below are excerpted acknowledgments and conclusions of the Delta Flood Risk Management Assessment District Feasibility Study conducted by consultants to the DPC in May of 2018.

The noted financial strategy acknowledges that "*only local landowners pay directly for levee improvements and maintenance by assessments or taxes paid on their property. Other beneficiaries of Delta levees are not explicitly recognized, and only pay indirectly for levee benefits to the extent that their taxes contribute to the General Fund. To move to a beneficiary-pays approach, the State would need to estimate the different public and private benefits and collect fees or taxes from the beneficiaries where administratively feasible. As a result, some beneficiaries that currently receive private benefits but do not directly pay for levees could be required to pay. These include water suppliers and users, as well as owners and users of cross-Delta infrastructure.*"

The study conducted by the DPC "*demonstrates that no single financing mechanism is likely to generate sufficient revenues to pay for the Delta's flood risk management needs consistent with the beneficiary-pays principle. In addition, none is consistent with the recommendation in the Delta Plan to establish a Delta Flood Risk Management Assessment District*." The DPC's "*study illustrates the complex challenges of developing revenue-raising approaches within California's existing web of legal and regulatory constraints on fees, taxes, and assessments. These challenges include identifying the beneficiaries, determining the economic values of their benefits, and finding the best set of financial mechanisms that can collect revenues. The new mechanisms identified*" ……"*were evaluated at a high level, sufficient to draw broad conclusions about feasibility, but lacking sufficient details to be considered more than conceptual at this point. Additional challenges lie ahead if the State moves forward with further development and evaluation - these include determining the levee improvements needed and associated costs, the benefits derived from such improvements, the time frame of the investments and revenue stream needed to pay for those investments, how to disburse revenues in a manner that ensures those that paid receive benefits commensurate with their level of contribution, and the appropriate government agencies to implement the various financial mechanisms.*"

Although the principle of "beneficiary-pays" has long been discussed as a basis for paying for water infrastructure "……, "the State has not adopted policies or principles for an alternative to bond funding for Delta levees." The DPC's study "describes the concept of a beneficiary-pays

[3] Delta Protection Commission (DPC). May 17, 2018. Delta Flood Risk Management Assessment District Feasibility Study and Delta Levee Financing Options. Available at: https://delta.ca.gov/levees/

funding system, with a focus on legal constraints and cost allocation issues, and identifies feasible financial mechanisms for further study."

Figure 7-1, excerpted from the DPC's levee financing feasibility study, shows the current financing approach with the existing mechanisms as they apply to the main categories of beneficiaries. Figure 7-2, also excerpted from the same feasibility study, shows how a beneficiary-pays system could add one of three new fees to the current financing approach to cover more beneficiaries directly. The DPC's study indicates *"further quantitative analysis and deliberation among stakeholders will be needed to determine the most appropriate portfolio of mechanisms and how they should be implemented"*.

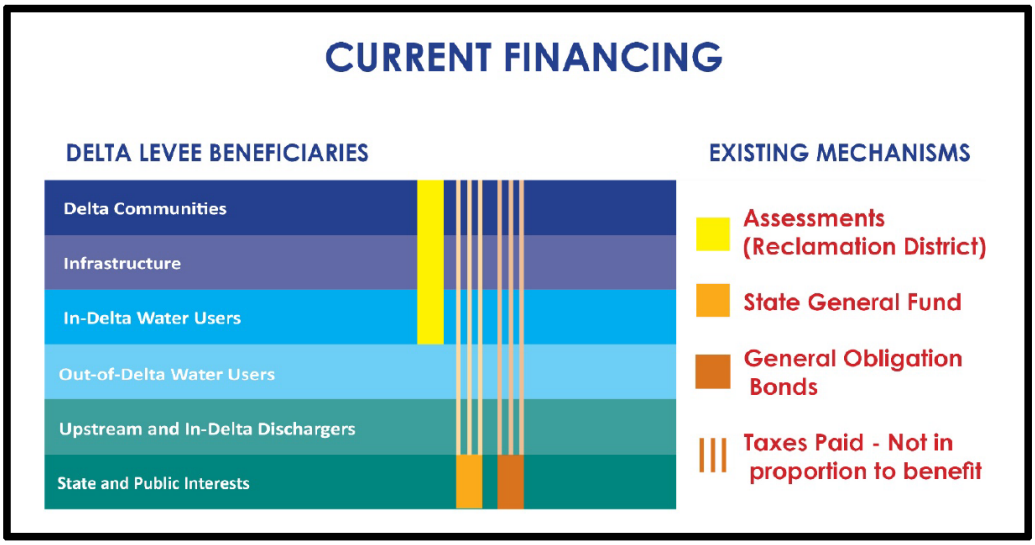

Figure 7-1: Current Financing Strategy for Delta Levee Improvements with Existing Mechanisms

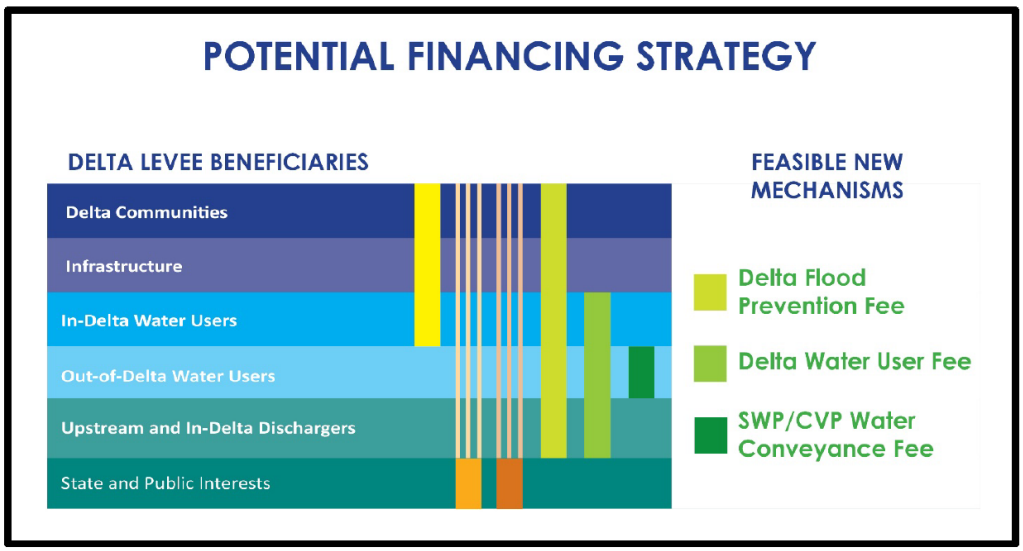

Figure 7-2. Potential Financing Strategy for Delta Levee Improvements with Feasible new Mechanisms

The DPC's study *"does not recommend implementation of any of the preferred mechanisms. Rather, based on the assessment of the mechanisms to be determined to be the most favorable to implement a beneficiary-pays-based approach to funding levee work, it identifies the issues which would need further analysis to move forward with implementation."*

As part of the financing sources currently identified by DWR and the CVFPB for the SPFC and adjoining non-SPFC levees protecting the DWR SCFRRP Delta Legacy Communities in the north Delta, the potential financial strategy utilizing the new mechanisms should be seriously considered for further evaluation in the stakeholder process established to develop levee mechanisms pursuant to the recommendations in the CVFPP 2017 Update and subsequent updates. Regardless, adopting any of the new mechanisms will require further discussion and agreement among the key stakeholders, including the SWP/CVP water contractors who will continue to benefit and rely upon the existing levee infrastructure along the freshwater conveyance corridor, with or without an improved conveyance facility as currently contemplated and proposed by the DCA.

7.9 Financial Feasibility and Local Cost Share Requirements for Key Management Actions

7.9.1 Financial Feasibility Summary Utilizing EAD Evaluations

The net reductions in EAD and financial feasibility values (in pay-back periods) for most of the key recommended short-term and long-term structural-based management actions are described above in Section 6.3.1.2. The evaluations, inventory values, and methodology are presented in Appendix E.

The summary of the EAD results indicating net reductions in EAD values and the return period(s) of investment (in years) for various structural based management actions are summarized in Table 6-6 for existing conditions without climate change adjustments, and Table 6-7 for future conditions that include adjustments for climate change.

The EAD values in Table 6-6 under existing conditions indicates there is a net reduction in EAD values in the amount of $335,000 to $353,000 that could result from Management Action 5, 6, and 7. With estimated costs ranging from $15M-$22M (MA 5) to upwards of $76M (MA 6), the payback periods range from 67 years to over 200 years. The challenge with implementing Management Actions 5, 6 or 7 with longer payback periods is the benefit area(s) coming up with the local cost-share components from not only RD 369, but also from the limited amount of citizens and businesses residing in the community of Locke who will benefit from said repairs or improvements.

7.9.2 Local Cost Share Financing and Assessment Strategies

Implementing any of the above management actions, including the flood risk reduction measure of a potential cross levee north of Locke (MA 5), could still require a local cost share of at least 5 to 10 percent for the community of Locke that has been identified as a qualifying DAC. This still could be a large challenge for Locke that has a median household income estimated at $47,400 or less per DWR's DAC mapping tool, particularly if said management actions do not provide a direct benefit to the balance of the larger 240-acre agricultural area within the study area protected by the collective SPFC and non-SPFC levees. The community of Locke itself only encompasses 37 acres south of the agricultural area, netting a total of only 277 acres within the study area that are fully encompassed and protected by the collection of SPFC and non-SPFC levees. Assessments can only be levied where there is direct benefit received from anyone of the proposed management actions.

For management actions benefiting the area within the bounds of the SPFC and non-SPFC levee system at an estimated 277 acres, there still is a challenge with developing the required local cost-share to participate in the noted federal and State grant programs identified above in Sections 7.8.1 and 7.8.2. Assuming that 80 percent of a local cost-share could be financed with the other 20 percent acquired in accumulated proceeds from an assessment, only one to two percent of the total cost of each management action will be required from RD 369 and the community of Locke, or some combination thereof for those management actions which reduce flood risk for the entire 277-acre area protected by an improved or modified levee system. As described above in Section 7.8.3, this local cost share could be generated through a conventional acreage-based assessment deployed by RD 369 and RD 554 as well as a structural benefit basis, similar to what RD 563 accomplished on Tyler Island in the early 2010's with their Proposition 218 benefit assessment to fund substantial levee repairs/improvements.

As shown below in Table 7-7, a simple conventional agricultural assessment of $40 per acre over the 240 agricultural acreage and $80 per acre within the 37-acre developed community of Locke collectively located within the bounds of the SPFC and non-SPFC levee systems largely in RD 369 could generate up to $12,560 per year. Assessing residential, commercial, and industrial structures within SAC 51 (the entire Locke study area, with most all structures located within the 27-acre community of Locke) at $400 per residential structure and $600 per commercial or industrial structure (to be refined in more detailed during a benefit assessment study), could generate $32,600 per year. With these assessments totaling just over $45,000 per year, it would take an estimated 6.3 years to acquire cash to secure local cost share financing for MA 5 (securing 100-year FEMA certification for the community of Locke with a potential cross levee), and another 25 years to pay back the financed amount. MA 4 (repairing and strengthening the nearly 1.0 miles of levee along the left bank of the Sacramento River) would require 7 years to acquire cash to secure local cost share financing, with an estimated 10 years for MA 7. It could take up to 24 years to pay back the financed amount for MA 4, and up to 39 years to pay back the financed amount for MA 7. The estimated debt pay back periods for MA 6 is nearly double that of MA 7. Additionally, these payback periods could be doubled if a 10 percent cost share

requirement is needed instead of the nominal 5 percent local cost-share scenario that is presented in Table 7-7.

Thus, there needs to be a long-range financial plan developed by the community of Locke and the greater North Delta interests on how they can seek additional funds to partner with other benefiting agencies, particularly for the multi-benefit MAs 4 and 7, but also for improving all of the collective Locke study area SPFC and non-SPFC levee segments if it is ultimately desired to have the entire study area meet current engineering standards such as FEMA's 100-year levee accreditation standards.

Table 7-7: Conceptual Financial Analysis of Locke Local Cost-Share Assessments and Local Pay-Back Periods for Select Management Actions

		Management Action (MA)			
		Repair and Strengthen-in-Place, 0.93-miles of Sacramento River SPFC Levee (**MA 3**)	Secure 100-Year FEMA Certification, South Portion RD 369 Perimeter Levee System Paired with a Potential Cross Levee (**MA 5**)	Secure 100-Year FEMA Certification for Entire RD 369 (**MA 6**)	Sacramento River SPFC Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke with Potential Cross Levee (**MA 7**)
Estimated Cost (Low)		$14,406,000	$15,735,000	$50,276,000	$25,794,000
Estimated Cost (High)		$31,593,000	$22,490,000	$76,185,000	$44,304,000
Net Reduction in EAD to Locke Study Area, Existing Conditions		N/A	$335,000	$353,000	$335,000
Net Reduction in EAD to Locke Study Area, Future Conditions		N/A	$1,428,000	$1,493,000	$1,428,000
Flood Risk Reduction Payback Period (in Years: Future – Existing Conditions)		N/A	15.8 to 67.1 years	51.0 to 215.8 years	31.0 to 132.3 years
Local Responsibility (Lead **Assessed**/Support)		**RD 369/ Community of Locke**	**Community of Locke/ RD 369**	**RD 369/ Community of Locke**	**RD 369/ Community of Locke**
5% Local Cost Share Scenario	5% of Total Cost	$1,580,000	$1,125,000	$3,809,000	$2,215,000
	80% Local Financed (4% Total Cost of MA)	$1,264,000	$900,000	$3,047,200	$1,772,000
	20% Local Cash Needed (1% Total Cost of MA)	$316,000	$225,000	$761,800	$443,000
Acreage Assessment[1]		$12,560	$2,960	$12,560	$12,560
Residential Assessment[2]		$16,400	$16,400	$16,400	$16,400

	Management Action (MA)			
	Repair and Strengthen-in-Place, 0.93-miles of Sacramento River SPFC Levee (**MA 3**)	Secure 100-Year FEMA Certification, South Portion RD 369 Perimeter Levee System Paired with a Potential Cross Levee (**MA 5**)	Secure 100-Year FEMA Certification for Entire RD 369 (**MA 6**)	Sacramento River SPFC Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke with Potential Cross Levee (**MA 7**)
Commercial/Industrial Assessment[3]	$16,200	$16,200	$16,200	$16,200
Total Annual Assessments	$45,160	$35,560	$45,160	$45,160
Number of Years to Acquire Cash to Secure local Cost-Share Financing	7.0 years	6.3 years	16.9 years	9.8 years
Number of Years to Pay Back Financed Amount	28.0 years	25.3 years	67.5 years	39.2 years
Total Payback Years	35.0 years	31.6 years	84.3 years	49.0 years

Notes: The assessed values indicated below are very preliminary in nature per acre and/or per the various structures. A full benefit assessment study will be needed to determine actual assessment values. Changing the acre-assessed values and and/or the structure benefit-assessed values will obviously impact the estimated pay back periods presented herein.

[1] Acreage assessment assessed at $40/acre for ag-based Locke study area north of potential cross levee (240 acres), and $80/acre for community of Locke (37 non-ag acres protected by a potential cross levee system)

[2] Residential assessment utilizes the total number of residential structures (41 located within the community of Locke) from the 2022 CVFPP Update, assessed at $400 per structure

[3] Commercial/industrial assessment utilizes the inventory of structures (23 commercial and 4 industrial all within the community of Locke) from the 2022 CVFPP Update, assessed at $600 per commercial and industrial structures (to be refined later based upon benefit values, that can be partially based upon sq. ft. and elevation of structures, and maximum potential depth of flooding)

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8. Implementation Recommendations

8.1 Implementation Schedule including Roles and Responsibilities

The community of Locke, acting through Sacramento County with support primarily from RD 369, but also from RDs 554 and 551, has the opportunity to significantly reduce flood risks to Locke and its larger study area including RD 369-Libby McNeil and small portions of RD 554 north of the DCC. Locke, Sacramento County, and the noted RDs intend to accomplish this by: (1) repairing and strengthening-in-place the greatest known and documented weaknesses in the RD 369 perimeter SPFC and non-SPFC levee system, and (2) potentially constructing a cross levee north of Locke in conjunction with perimeter levee improvements to further protect the community in the event a levee breach occurs in the study area but outside of the community.

As its highest priority (MA 1) the community of Locke would prefer to repair and strengthen the Delta Meadows Cross Slough non-SPFC levee located east of Locke which is estimated to have the highest probability of failure of all levees within the study area. Repairing and strengthening this levee is currently estimated at a cost of $7 to $10M, given the limited amount of geotechnical data and levee cross-section survey/topo data. This action alone may not represent a substantial, incremental reduction in EAD within the study area, but it would substantially reduce the potential for property damage and potentially the potential for life loss if a levee breach were to occur at this location.

The community of Locke would prefer to see MAs 1 through 4, which represent repairing and strengthening-in-place all of the perimeter SPFC and non-SPFC levees in the Locke study area, implemented in the next 10 years. If the perimeter levee system is collectively improved and certified by FEMA (MA 6), at a cost of up to $76M, the estimated net reduction in EAD to the Locke study area under existing conditions is $353,000, and as much as $1,493,000 under future conditions including adjustments for climate change. MAs 2 to 4 as stand-alone actions do not represent a substantial, incremental reduction in EAD within the study area unless the collective levee system is collectively improved to current engineering standards and certified by FEMA.

As a last alternative to MAs 1, 2-4, or 5, the community of Locke would least prefer to see a stand-alone cross levee system consisting of a new cross levee north of Locke along with perimeter levee improvements south of a new cross levee constructed and accredited by FEMA within the next 10 to 15 years (MA 5). At an estimated cost of $22M, this MA will result in a net reduction in EAD of approximately $335,000 under existing conditions. This MA, as suggested by the community and RD 369, could be paired with repairing and strengthening the entire 0.93-mile-long SPFC levee along the left bank of the Sacramento River (MA 7). At a cost of up to $44M, MA 7 would also result in an estimated net reduction in EAD of $335,000 under existing conditions. The benefits of MAs 5 and 7 are greater 50 years into the future with inland climate

change adjustments and sea level rise, representing a total net reduction in EAD of up to $1.4M for the Locke study area.

To achieve the noted reductions in flood risk, the following recommendations include full development of the structural-based MAs, including improving the SPFC levee system to meet current FEMA 100-year engineering accreditation standards, advancing non-structural measures, and developing multi-benefits that will improve the reliability and resiliency of conveying SWP and CVP water in the North Delta upstream of the Delta Cross Channel. They are outlined and planned to secure financial assistance and concurrence with DWR, CVFPB, USACE, and the Delta Conservancy and confirm consistency with Delta Plans administered by the DPC, DSC to reduce known flood risks in the North Delta. The following recommendations can be sequenced or phased in the order as listed below or easily amended based upon variable funding sources. However, it is recommended the first three recommendations take priority for initiating all short-term structural-based MAs, with all other recommendations not tied to any specific phasing or prioritization, with several non-structural measures already partially implemented.

1. The community of Locke, with support from Sacramento County and the RDs, should seek funds *via* community block grants funds or other sources to fund a Proposition 218 election that may be required to raise local cost-share funds for developing the applicable local cost share for flood risk reduction actions that have community-specific benefits over and above those that are more beneficial to the larger RD basins and the Locke study area. The community-specific flood risk MAs that could significantly reduce life loss and potential damages in Locke due to flooding in the community include strengthening-in-place the perimeter non-SPFC levee system (MAs 1,2, and 4) and the SPFC levee along the left bank of the Sacramento River immediately fronting the community (MA 4). These community-specific levee improvements could be implemented concurrently and certified by FEMA (MA 6). Alternatively, a potential cross levee could be considered along with repairs to the perimeter levees to form a levee system that could be certified by FEMA (MA 5). This could be implemented with improvement of nearly all the SPFC levees within the Locke study area (MA 7). Any of these MAs would require planning and financing beyond the current responsibilities and capabilities of RDs 369 and 554. The local cost share of said community-specific flood risk reduction measures could also be partially funded *via* a community-based flood insurance program as another relatively near-term non-structural measure, as noted further below.
2. To implement any of these MAs, geotechnical explorations and levee surveys will be required in advance of preparing preliminary designs and advancing permits and supporting CEQA/NEPA documentation. It is recommended that that the community, with the support of Sacramento County and others, work largely with RD 369 to identify potential funding sources and advance said geotechnical explorations, remediation designs, and environmental documents so these MAS are closer to shovel-ready when funds may become more readily available.

3. The community of Locke should work closely in the near-term with other Delta Legacy Communities in Sacramento County, particularly other DWR SCFRRP participants, including the City of Isleton, to establish a GHAD or HOA to advance a private, community-based flood insurance program that would effectively provide relief from the ever-increasing high NFIP rates. The City of Isleton has taken the initial steps in developing a community-based flood insurance program, and it will be more cost effective (resulting in significantly lower insurance premiums than offered by the NFIP) if there were more nearby communities pooling their resources together and aggregating or spreading their potential flood losses over a larger pool of insureds. The timely development of said GHAD or HOA would not only serve to substantially reduce flood insurance rates, but it could serve as a vehicle to generate local cost-share funds to buy-down flood risks within the community that is currently assessed by RD 369 on an acreage only basis, versus a flood risk value tied to structure improvements and content values. The private, community-based flood insurance program could also fund regional programs or local cost-share requirements to buy-down risks at the regional level, including larger, long-term multi-objective components such as improving the entire SPFC levee reaches not only in the Locke study area but also in the greater North Delta (MAs 3 or 6).
4. In connection with implementing the multiple-benefit project of improving the nearly 1-mile of SPFC levee along the left bank of the Sacramento River (MA 6) it is recommended that community representatives pool their resources together with other participating Delta Legacy Communities in the North Delta. Improving the SPFC levees to current, modern FEMA engineering standards to address seepage, underseepage, and stability will also serve to improve the reliability and resiliency of conveying SWP and CVP water through the North Delta with or without the DCA's current tunnel and intakes proposal. The noted communities and regional stakeholders have been approached by the DCA regarding their Communities Benefits Program, and the Delta Legacy Communities have suggested improving the SPFC levee system, particularly upstream of the Delta Cross Channel is necessary with or without the proposed DCA improvements. It is suggested that the Community of Locke and its neighboring Delta Legacy Communities, particularly in Yolo and Sacramento Counties, work with RFMP representatives, including SAFCA, WSAFCA, CVFPB, and DWR MA 9 to share and ideally implement their preferred alternative of how improving the limited number of SPFC levee miles in the North Delta along the Sacramento River in the North Delta will also improve the reliability and resiliency of conveying SWP and CVP water through the entire Delta.

   (See Appendix K for additional background information related to improving water conveyance through the Delta in tandem with reducing flood risks to the Delta Legacy Communities within Sacramento County.)

   While implementing the near- and long-term structural-based MAs the community of Locke, with assistance from Sacramento County, RD 369, and others can implement the following non-structural measures to further reduce residual flood in the Locke study

area. All the non-structural measures for implementation are described in more detail in Sections 5.2 and 7.3 and within Appendix H. The following non-structural solutions are highly recommended for implementation, some of which are already in the early stages of implementation:

1) Deferred Vegetation Removal and Levee Crown Maintenance on non-SPFC levees
2) Improved Governance Between Neighboring LMAs/RDs
3) Voluntary Elevation of Structures
4) Wet or Dry Floodproofing
5) Flood Emergency Safety Plans
6) Sacramento County OES Decision Support Tool
7) Local Hazard Mitigation Plan and Relief Cuts
8) Alternatives to FEMA National Flood Insurance Program (NFIP) – Private, Community-Based Flood Insurance
9) NFIP Flood Insurance Enhancements *via* AFOTF
10) Mokelumne River Conveyance Improvements & Staten Island Overflow Area
11) Improve FEMA CRS score for Sacramento County/Isleton
12) Land Use Regulations and Limitations
13) SWIFs & Periodic Inspections with USACE
14) Public Education/Public Awareness

8.2 Additional Studies, Reports, Permits, Approvals

8.2.1 DSC Consistency Determination Required with Delta Plan and Qualifying Covered Actions

The Sacramento-San Joaquin Delta Reform Act of 2009 (Delta Reform Act) established a certification process for demonstrating consistency with the Delta Plan. The Delta Reform Act requires any State or local agency proposing to undertake a qualifying action (covered action) must submit to the Delta Stewardship Council (DSC) a written certification of consistency with detailed findings as to whether the covered action is consistent with the Delta Plan (Wat. Code, § 85225). ***The certification of consistency needs to demonstrate the project or covered action is consistent with the Delta Plan's co-equals goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals are to be achieved in a manner that protects and enhances the unique cultural, recreational, natural resources and agricultural values of the Delta as an evolving place.***

As a component of demonstrating consistency of covered actions with the Delta Plan all levee projects must evaluate and where feasible incorporate alternatives, including the use of setback

levees, to increase floodplains and riparian habitats. ***Evaluation of setback levees in the Delta shall be required along the Sacramento River between Freeport and Walnut Grove and other locations as shown in Appendix 8 of the Delta Plan.*** This Delta Plan policy considers construction of new levees or substantially rehabilitate or reconstruction of existing levee systems as covered actions. This policy language relative to expanding floodplains and riparian habitats in levee projects within the Delta was last amended by the DSC and included in the California Code of Regulations in 2019. Thus, prior to undertaking any substantial levee rehabilitation projects located between Freeport and Walnut Grove along the Sacramento River the project proponent, whether it is a local community, RD, LMA, or any other local/state entity, it should consult early with the DSC regarding the applicability of evaluating setback levee alternatives in tandem with substantial levee rehabilitation efforts as considered in this Feasibility Study Report; and then the project proponent should be prepared to file a consistency determination upon completion and adoption of the applicable final CEQA/NEPA documents.

8.2.2 Alignment with DSC's 3x3 Prioritization of State Investments in Delta Levees and Flood Risk Reduction

As previously highlighted in Section 4.1, the Delta Legacy Communities and their cost-share partners investing in substantial levee repairs, improvements, and rehabilitation efforts, including increased OMRR&R expenditures, should be structured as outlined in this feasibility study report, to be most responsive to the DSC's 3x3 Prioritization of State Investments in Delta Levees and Risk Reduction. The 3x3 prioritization table for levee investments is presented in Section 4 and is highlighted below in Table 8-1. The 3x3 table is highlighted below in seven of the nine cells indicating that most structural-based management actions and non-structural measures proposed for implementation for the community of Locke are most responsive to the DSC's Prioritization of State Investments in Delta levees and risk reduction. Locke's Management Actions 3 and 7, consisting of the multi-benefit project of repairing and strengthening-in-place 1.0 miles of the SPFC levee between the Delta Cross Channel on the south and RD 551 to the north also has the added benefit of improving the resiliency and reliability of the fresh water conveyance corridor aqueduct that conveys SWP and CVP water through the Delta.

See Appendix K for further details in support of the multi-benefit opportunities associated with MA 6 identified by the Sacramento County Delta Legacy Communities associated with reducing flood risks combined with improving the reliability and resiliency of SWP water conveyance through the Delta.

Although not fully exhausted through this current feasibility study effort, it is recommended that West walnut Grove and its cost-sharing partners further explore ecosystem conservation opportunities that may protect existing and provide net enhancements to floodplain habitat.

Table 8-1: 3x3 Goals of the DSC for State Investment in Delta Integrated Flood Management.

Goals	Localized Network	Levee Network	Ecosystem Conservation
1	Protect existing urban and adjacent areas by providing 200-year flood protection.	Protect water quality and water supply conveyance in the Delta, especially levees that protect freshwater aqueducts and the primary channels that carry fresh water through the Delta.	Protect existing and provide for a net increase in channel-margin habitat.
2	Protect small communities and critical infrastructure of statewide importance (located outside of urban areas).	Protect floodwater conveyance in and through the Delta to a level consistent with the SPFC for project levees.	Protect existing and provide for net enhancement of the floodplain habitat.
3	Protect agriculture and local working landscapes.	Protect cultural, historic, aesthetic, and recreational resources (Delta as Place).	Protect existing and provide for net enhancement of wetlands.

8.2.3 Additional Ongoing Studies and Plans

CVFPP and Lower Sacramento-Delta North Regional Flood Management Plan (RFMP) Updates

As recommended above in Section 8.1, the Community of Locke, including RD 369, and the greater collection of Delta Legacy Communities in the north Delta need to be more engaged within the ongoing Lower Sacramento-Delta North Regional Flood Management Plan (RFMP) planning efforts that will feed into subsequent CVFPP updates beyond 2022. To secure funding from regional, state, and federal interests to reduce Locke's flood risks the community representatives and Sacramento County floodplain administrators need to be included and be a part of the Lower Sacramento-Delta North RFMP planning efforts. This is particularly important in light of receiving federal and state funds that could potentially be channeled through the CVFPP and CVFPB for structural-based management actions and/or non-structural measures that could be authorized by the USACE, and provide multi-benefits to not only the community of Locke but to the greater Delta region and statewide interests. As previously stated, improving the SPFC levees to current, modern FEMA engineering standards to address seepage, underseepage, and stability will also serve to improve the reliability and resiliency of conveying SWP and CVP water through the North Delta with or without the DCA's current tunnel and intakes proposal. It is suggested that the community of Locke and its neighboring Delta Legacy Communities, particularly in Yolo and Sacramento Counties, work closely with RFMP representatives, including SAFCA, WSAFCA, CVFPB, and DWR MA 9 to share and ideally implement their preferred alternatives of improving the limited number of SPFC levee miles in the North Delta along the Sacramento River in the North Delta will also improve the reliability and resiliency of conveying SWP and CVP water through the entire Delta. This approach needs to be integrated

into the ongoing planning efforts within the Lower Sacramento-Delta North RFMP, which has and will continue to be a vehicle for implementing projects through the CVFPP's reoccurring 5-year updates that are adopted and implemented by the CVFPB.

Relief Cut Updates via Local Hazard Mitigation Plans (LHMP) and Flood Emergency Safety Plans (ESPs)

As noted above in Section 7.4.6 - Local Hazard Mitigation Plans and Relief Cuts, Sacramento County is in the process of updating its 2016 LHMP and is scheduled for completion in late 2021 or early 2022. As part of this update, Sacramento County has the opportunity to reevaluate the impacts of flooding and levee failure to the people and assets of the Sacramento County planning area, including RDs 369, 551,and 554. The LHMP can establish updated goals and prioritize projects to reduce these impacts with the noted RDs, including the community of Locke.

It is recommended that Sacramento County and the RDs continue to update the LHMP every 5 years, and formalize potential relief cuts for the noted RDs. Formalized relief cuts could potentially reduce the duration and depth of flooding in Locke in the event a levee breach were to occur within or adjacent to the Locke study area, including RDs 369, 551, and 554. Sacramento County and the noted RDs, as a component of the LHMP, will be updating their Flood Emergency Safety Plans (ESPs) and are looking at incorporating relief cuts where ever feasible. A planned relief cut for RD 551 upstream of Locke could possibly negate the need for any significant levee improvements along NULE Segment 1040-A (MA 4 - with a current worse-case range of remediation costs between $14,525,000 and $16,846,000) as noted in Table 6-7.

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Appendix A: Geotechnical Data and Assessment Report

Appendix B: Biological Resources Constraints Assessment for the Community of Locke

Appendix C: Cultural Resources Records Search Results for Locke, California

Appendix D: Ecosystem Multi-Benefit Opportunities for the Sacramento County Delta Legacy Communities Flood Risk Reduction Feasibility Studies

Appendix E-1: Expected Annual Damages (EAD) Analysis for Sacramento County/Isleton Communities - HDR Engineering, August 2021

Appendix E-2: 2022 CVFPP Update to SPFC Levee Fragility Curves; and Hazard Level Categorization for Sacramento County SCFRRP SPFC and non-SPFC Levees Technical Memorandum - AECOM, November 2020, including Addendum of December 2020

Appendix F: Cost Estimate Development for the Flood Risk Reduction Feasibility Study for Delta Legacy Community of Locke, CA

Appendix G: DPC, DSC, and Delta Conservancy Master Comparison Matrix

Appendix H: Identification of Non-Structural Elements for the Communities of Hood, Courtland, Locke, East Walnut Grove, and West Walnut Grove & Ryde Flood Risk Reduction Feasibility Studies

Appendix I: Hydrology and Hydraulics Technical Memorandum for the North Delta Legacy Communities of Hood, Courtland, Locke, Walnut Grove (East), Ryde/Walnut Grove (West), and Isleton

Appendix J: Community Based Flood Insurance Program White Paper – Kathleen Schaefer, March 2022

Appendix K: Multi-Benefit Project Opportunities Identified to Reduce Flood Risks and Improve SWP Water Conveyance Through the Delta by the Sacramento County Delta Legacy Communities

Introduction to Appendix K:

The following PowerPoint Presentation(s) were largely developed November 2020 - April 2021 by the Sacramento County Delta Legacy Communities participating in the DWR SCFRRP grant program focused on reducing flood risks along the Sacramento River Corridor. The Sacramento County Delta Legacy Communities and the Sacramento River Corridor collectively coincide with the freshwater conveyance corridor of SWP and CVP deliveries through the North Delta.

A common theme shared amongst all the Sacramento County Legacy Communities includes improving the entirety of the State Plan of Flood Control (SPFC) levee system to current FEMA engineering accreditation standards along both banks of the Sacramento River also provides the multi-benefit of improving the Delta water conveyance corridor between Freeport and the USBR Delta Cross Channel in Walnut Grove.

PPT slides 2 through 12: Provide a brief explanation of the SCFRRP program and identification of flood risks and vulnerabilities to the Sacramento County Delta Legacy Communities.

Slides 13 – 38: Provide a summary of key structural-based Management Actions (MAs). Cost summaries are also included for levee improvements that would result in: (1) FEMA accreditation for the communities located within the larger RDs: (2) improving the entirety of the RD perimeter levee systems to current FEMA accreditation standards; or (3) just improving the SPFC levee system(s) along the Sacramento River Corridor to current engineering standards.

Slides 39 – 49: Present the Delta Legacy Communities' proposal of improving the levees along Sacramento River conveyance corridor to current FEMA engineering standards that includes the multi-benefit of improving reliability and resiliency of conveying water through the North Delta. The Communities' proposal can possibly serve as a more cost-effective alternative to the DCA's current single-purpose proposal with intakes and tunnels in the North Delta.

Slides 50 – 52: Present the need to collaborate and include multi-beneficiaries in developing and financing levee improvements in the Delta, including identification of funding mechanisms to implement levee improvements that are also beneficial for greater reliability and resiliency of through-Delta water conveyance. (Per California's Flood Futures Recommendations of Nov. 2013, and the DPC's Levee Financing Options Feasibility Study of May 2018.)

Slides 53 - 71: Present the latest cost comparisons, and science behind improving said levee system(s) in the North Delta also has the multi-benefit of improving the reliability and resiliency of conveying SWP and CVP water through the Delta w/ or w/o a modified DCA proposal. The latter slides also suggest improving the levees in the conveyance corridor of the North Delta Region will not result in a stranded investment.