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 (SCFRRP)

Submitted to:
Sacramento County Department of Water Resources

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Locke Story Map - Sacramento County Small Communities Flood Risk Reduction Program

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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
COE	Corps of Engineers
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
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
EIS	Environmental Impact Statement

EOP	Emergency Operations Plan
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
USFWS	U.S. Fish and Wildlife Service
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 (SCFRRP) 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 is to identify a potential suite of structural and non-structural flood risk reduction elements, develop management actions based on these potential elements, develop and prepare implementation costs for each of the management actions, identify a preferred suite of management actions and other non-structural measures based on stakeholder and community input, and to develop 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.

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 from the community of Locke located on the tract of land known as Walnut Grove 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 California Department of Water Resources (DWR) Non-Urban Levee Evaluations (NULE) that were

initiated in 2010-2014.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.

A suite of seven potential management actions 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 management actions included 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 554 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 management actions can be paired with a suite of non-structural management actions, 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 non-structural action items for consideration are summarized below within this Executive Summary and Section 7.3 of this Feasibility Study Report.

The management actions were evaluated qualitatively 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 management actions 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, a recommended suite of management actions was 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).

- **Management Action 2**: Repair and Strengthen-in-Place through Geotechnical Remediation, Snodgrass Slough Levee southeast of Locke (portion of NULE Segment 1054 in RD 369)

- **Management Action 3**: Repair and Strengthen-in-Place through Geotechnical Remediation, Delta Meadows Slough Levee north of Locke (portion of NULE Segment 1040 in RD 551)

- **Management Action 4**: 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

- **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

- **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

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 Management Actions 5 and 6.

Securing FEMA certification for the entire RD 369 perimeter levee system (Management Action 6, which includes Management Actions 1-4) is estimated at $50-$76 million. If Management Action 5 (cross levee paired with perimeter levee improvements south of said cross levee) or Management Action 7 (which effectively combines Management Actions 4 and 5) are implemented in place of Management Actions 6, the total estimated capital costs are $16-$23 million and $26-$44 million, respectively, in 2020 dollars.

Two key management actions (Management Actions 4 and 7) contain state-wide multi-benefits by repairing, raising, and strengthening-in-place the Sacramento River left bank levee within the bounds of the study area between the downstream boundary of RD 551 at Delta Meadows Slough and the upstream boundary of RD 554 near the northwest entrance

to the Delta Cross Channel for a total of nearly 1.0 mile. The same geotechnical remedial actions could concurrently improve the efficiency, resiliency and reliability along the left bank of the freshwater conveyance 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 25 million residences and over 3 million acres of agricultural crops south of the Delta. The noted 1.0 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 1.0 mile stretch of SPFC levees 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 are currently estimated at approximately $14-$32 million (Management Action 4) and $26-$44 million (Management Action 7), which could gain the sizeable interest and cost-sharing contributions of the noted interests and beneficiaries statewide and south of the Delta.

In addition to the key structural-based management actions 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 preferred 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 – North Delta Regional Flood Management Plan (RFMP) region
- Community and flood-risk based insurance program in lieu of or in tandem with the current FEMA NFIP
- 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

- 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

Forthcoming following community input – implementation.

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 the CVFPB and 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. 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 very 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 focuses more on the densely populated portions of land tracts protected by SPFC levees; whereas the Delta five-year plans focus more on the perimeter levee systems protecting the 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 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 State Plan of Flood Control[1] (SPFC) 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 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.

Regarding small communities, SB 5 requires cities, counties and State and local flood management agencies to collaborate to provide cost-effective strategies for reducing flood risk. The bill also called for development of 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, inclusive of 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 Legacy communities include Courtland, Hood, East Walnut Grove, West Walnut Grove/Ryde, Isleton, Clarksburg and Rio Vista.

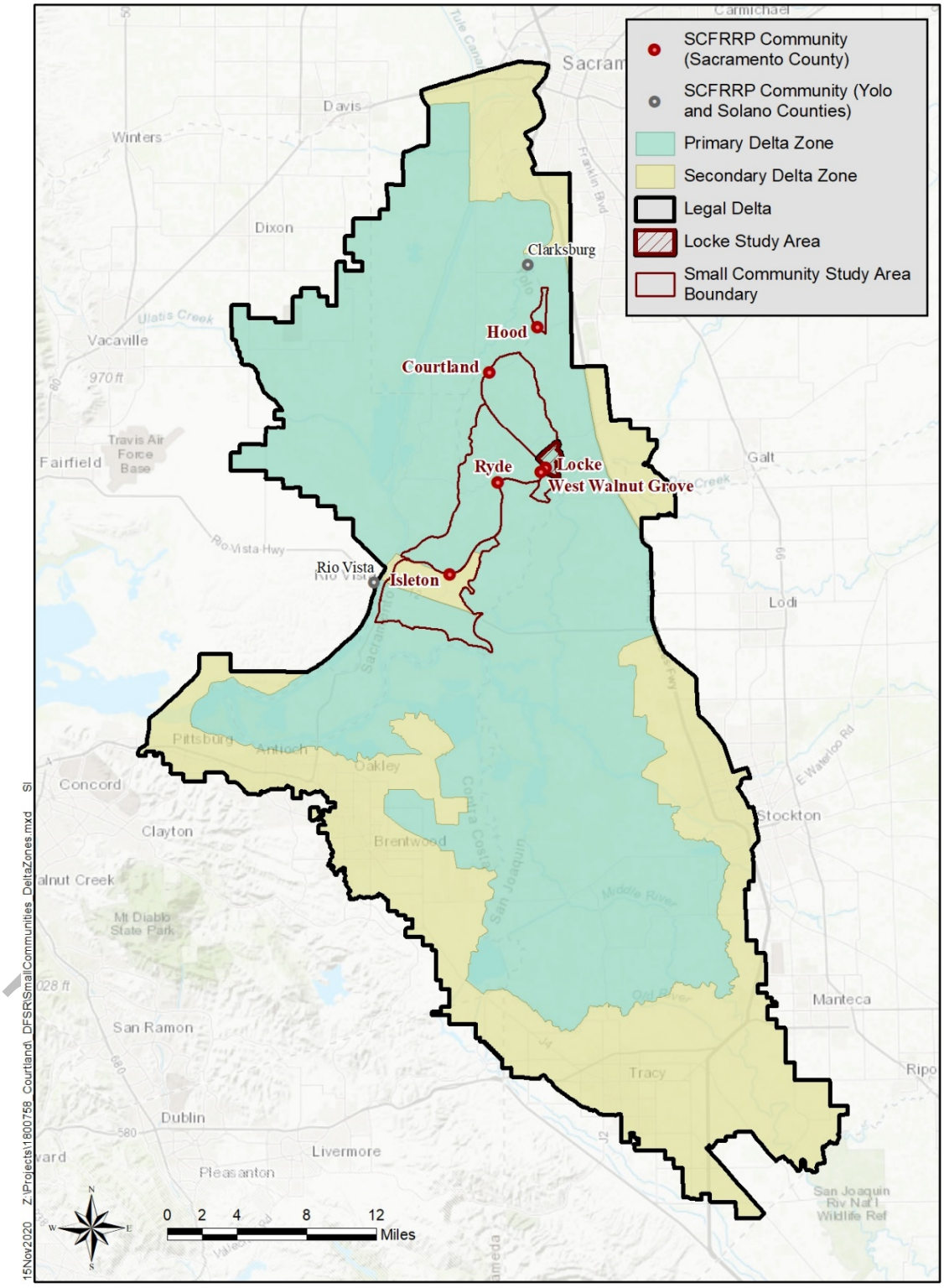

Figure 1-1. Delta Legacy Communities Participating in the Small Communities Flood Risk Reduction Program

1.2 Goals and Scope of the Study

As described in the 2012 and subsequent 2017 CVFPP, 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 percent 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 failure
- 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 SPFC levee system protecting the Locke study area can collectively enhance the resiliency and reliability through-Delta water conveyance upstream of the Delta Cross Channel.

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

While 100-year flood protection is 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 the Delta (as shown in Figure 1-1) there are significant restrictions within the Delta Plan adopted by the Delta Stewardship Council (DSC) do not permit development to occur displacing agricultural land uses. As

result, improvements identified in this study are not expected to induce development and/or result in increased flood risk within the Locke study area.

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 acres of agricultural lands and a population of 25 million.
    - 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 1.0 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 serve as a vital element of the primary through-Delta water conveyance channel in the North Delta.

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.

The levees protecting the community of Locke fall well short of meeting 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]).

Also in 2012, the Biggert-Waters Flood Insurance Reform Act (BW-12) was passed putting into motion substantial annual increases to flood insurance costs until premiums are rated based on the elevation certificate. The unfortunate oversite in this is that the premiums don't recognize that there is a levee system that has stood the test of time. Instead, premiums are rated as if there were no levees present. 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.

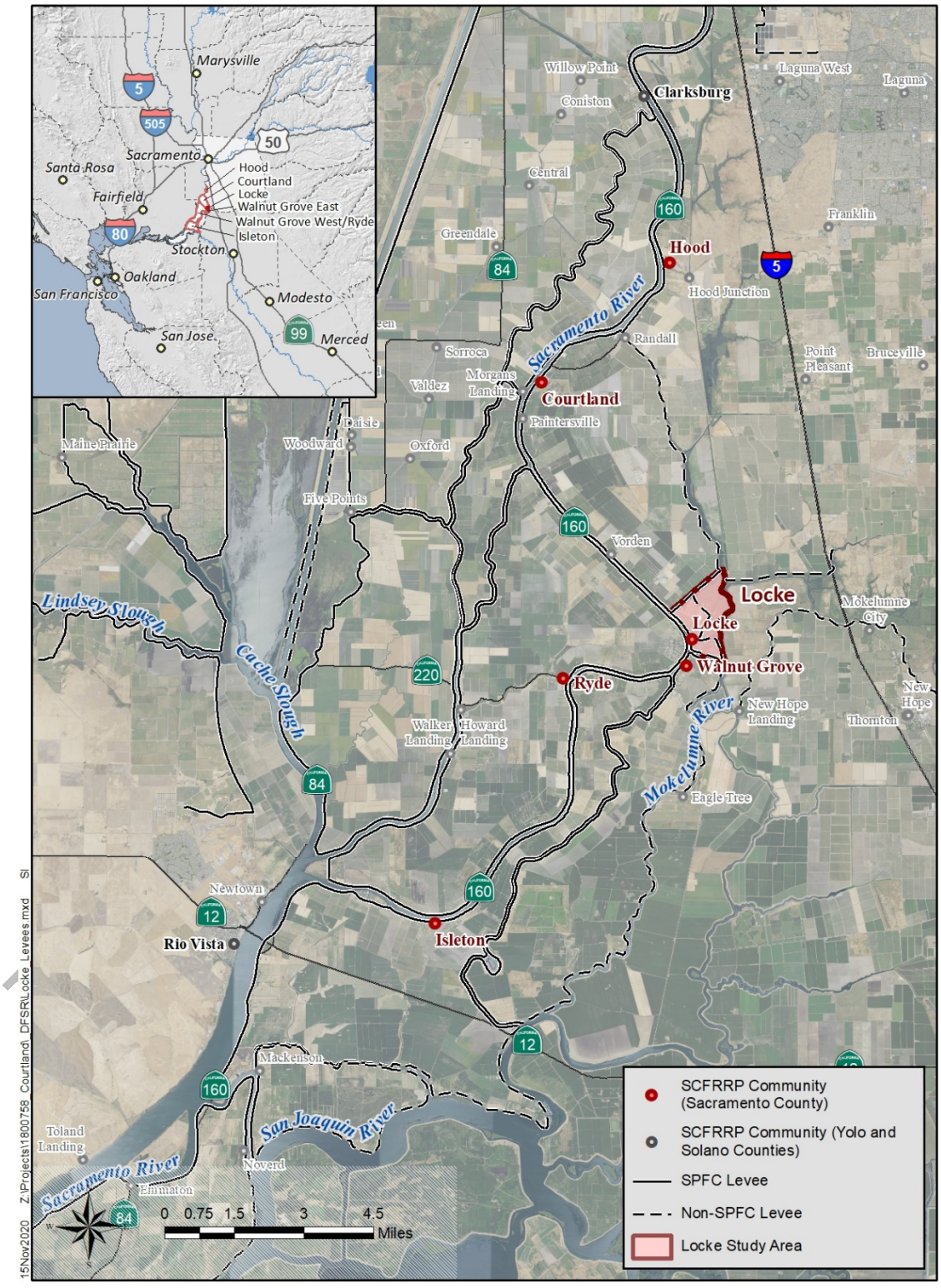

Figure 1-2. Delta Legacy Communities Participating in the SCFRRP.

1.5 Study Area and Location

The study area for this SCFRRP effort includes the community of Locke and the larger 760-acre 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 (ft.) (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 367 – Libby McNeil. Within this system are a total of 1.0 mile of SPFC levees collectively maintained by RD 369 and RD 554 (0.8 miles – RD 369, 0.2 miles – RD 554), 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. 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.

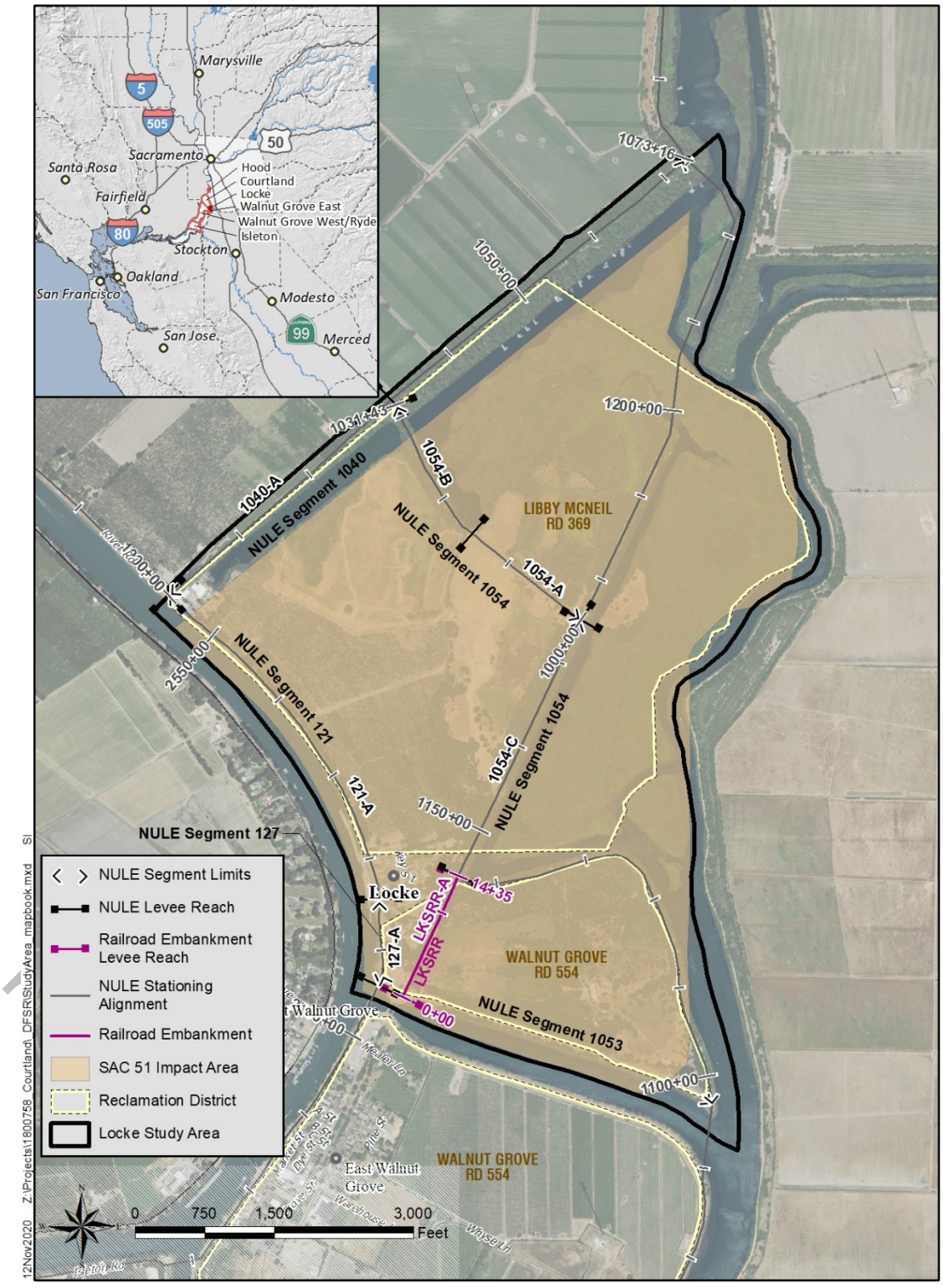

Figure 1-3. Locke Study Area

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 is working 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.

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 the Delta Legacy Community of Locke. Stakeholders include representatives of RD 369; landowners and NFIP policy holders within RD 369, and Sacramento County; the Sacramento County Department of Water Resources, inclusive of the County's floodplain administrator; and 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, inclusive of 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 website http://sacdelta.stormready.org/ (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 include: securing protection from flooding from the east levee that backs up to the Delta Meadows State Park, determining costs to repair levees (with the exception of the Sacramento River levee), 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 management actions and non-structural measures were discussed. The group's highest priority structural management action was 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 levees along the left bank of the Sacramento River due to their 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 the historic protections on the buildings and their 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 the District 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 management actions were developed, the study team again met with the community members to discuss initial findings from geotechnical evaluations as well as evaluate management actions 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.

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 all of the levees in the North Delta, inclusive of 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 $15 million per mile. Provided here is another link to FEMA's fact sheet 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.

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 in November 2020 for their review which was followed by a virtual meeting in December 2020 to discuss the draft Feasibility Study Report 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 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 by summer of 2021. Additional stakeholder input into the preference and prioritization of management actions and accompanying non-structural related measures are provided in Section 7.2.

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 feasibility study has been prepared in close 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.

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 drafted, 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/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.

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)

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. In particular, 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 management actions 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 1-2 ft. 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.

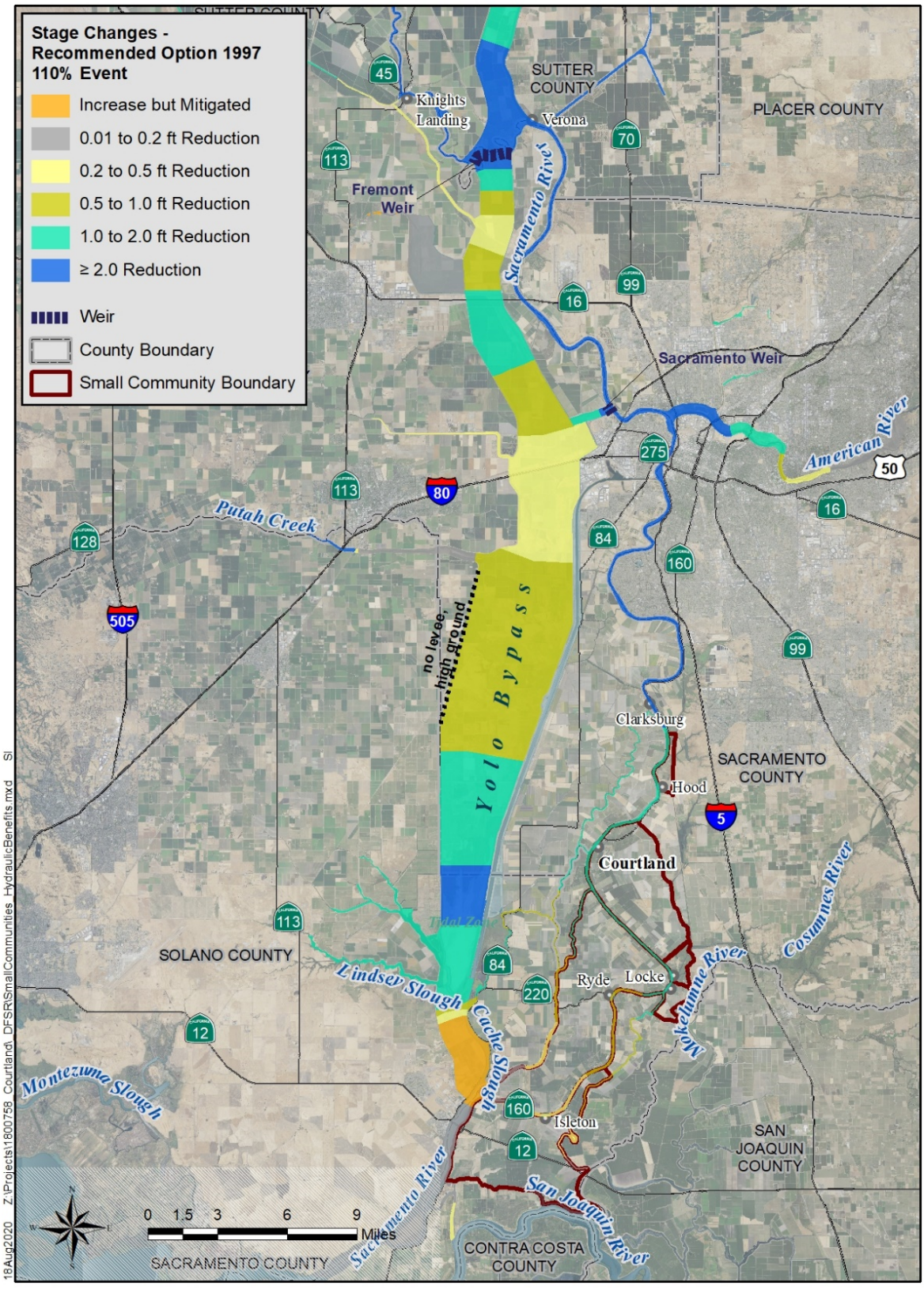

Figure 1-4. Flood Stage Reductions as a Result of the BWFS Expansions and Modifications.

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 current DLIS prioritization (Figure 1-5).

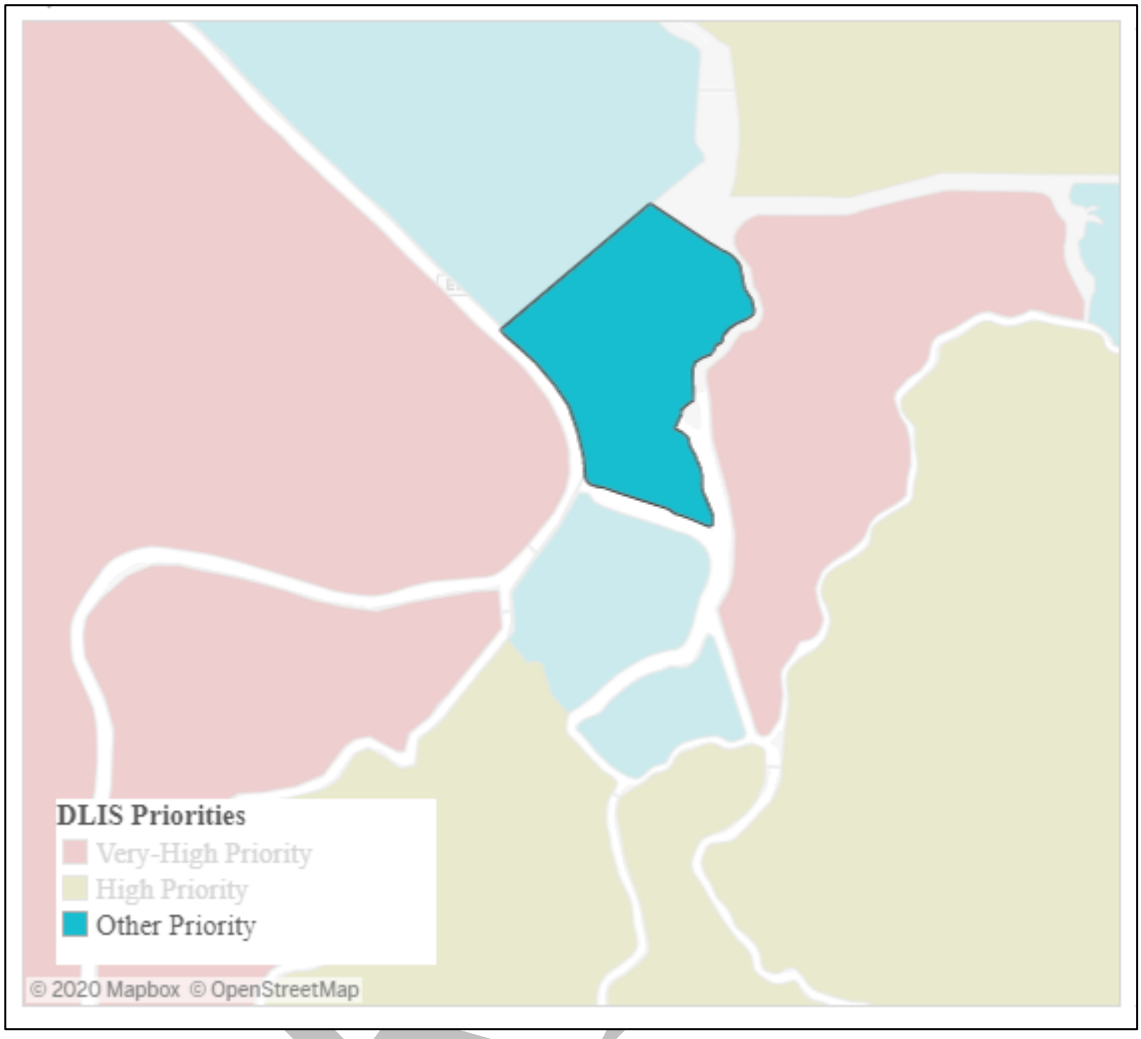

Figure 1-5. DLIS Analysis – Overall Prioritization (Rand Corporation, 2020)

A representation of DLIS analysis (annual probability of flooding due to a hydrologic event) is shown in Figure 1-6. The Locke study area has an annual probability of 0.9 percent to 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.

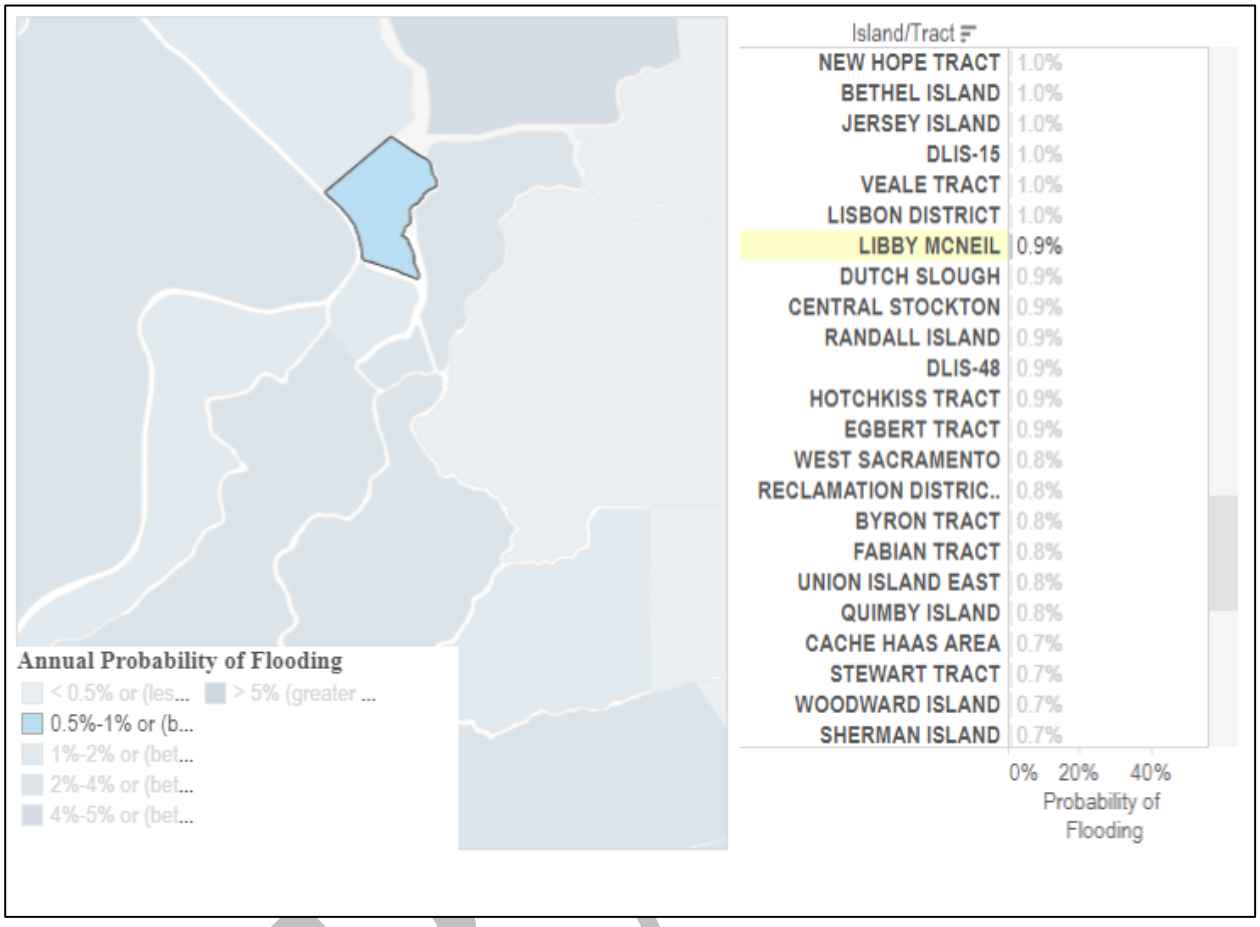

Figure 1-6. DLIS Analysis - Hydrologic Event (Rand Corporation, 2020)

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.

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 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, Topography and Levees. 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 E for additional information).

1.7.7 Levee System-Wide Improvement Framework

As of August 2020, RD 551 and adjoining RDs were in the process of drafting a 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 Central Valley Flood Protection Board (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 left (east) 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 ft. NAVD 88 (Figure 2-1). Top of levee elevations vary from approximately 15 to 30 ft. 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 1.0 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 update to the CVFPP, 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. The levee performance curves for the Locke study area are being updated as a result of geotechnical explorations conducted during the course of this study.

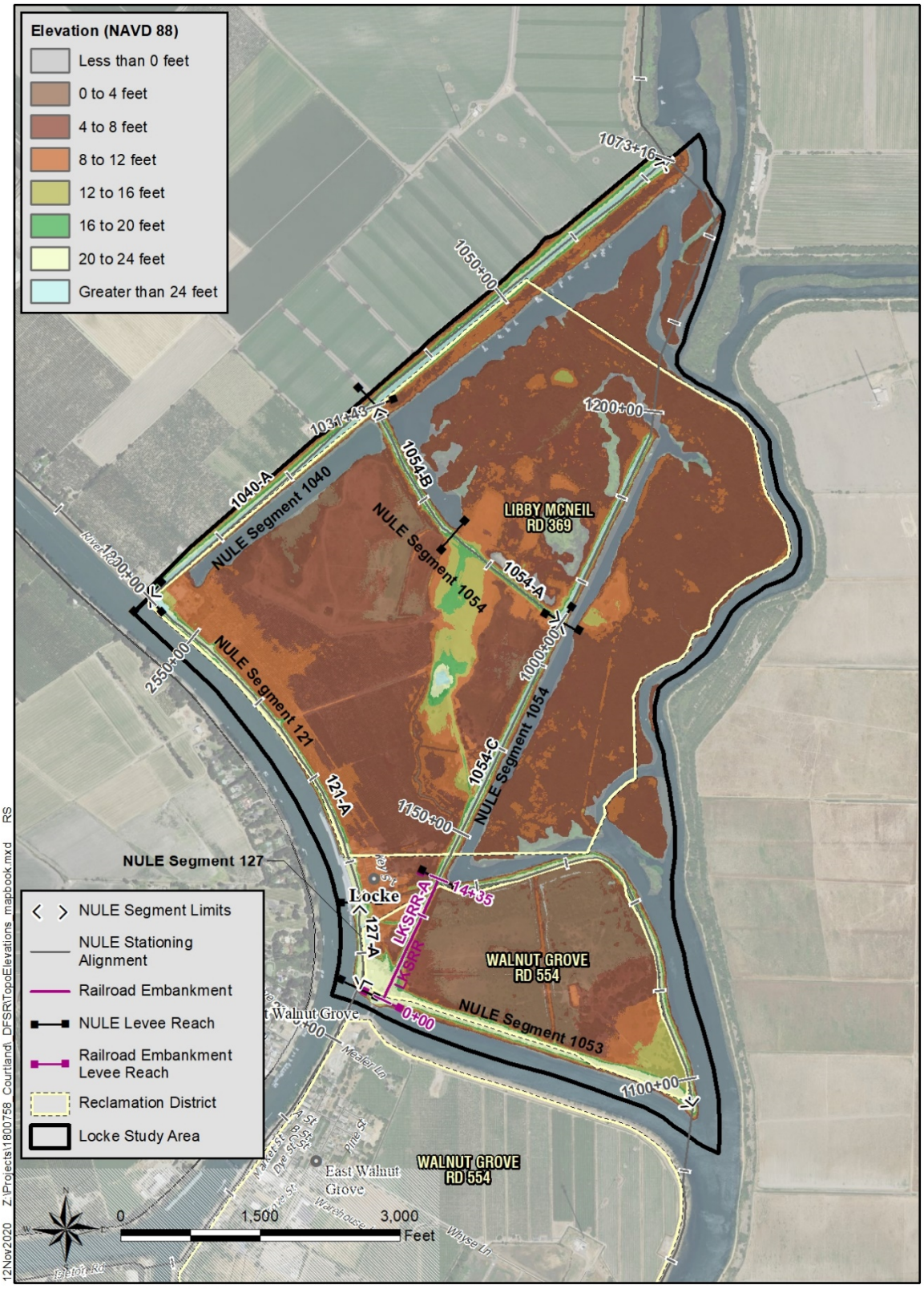

Figure 2-1. Study Area Ground Elevations and Levees.

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 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, and Appendix E, 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 more than $15 million per mile. Click here to read FEMA's fact sheet 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.

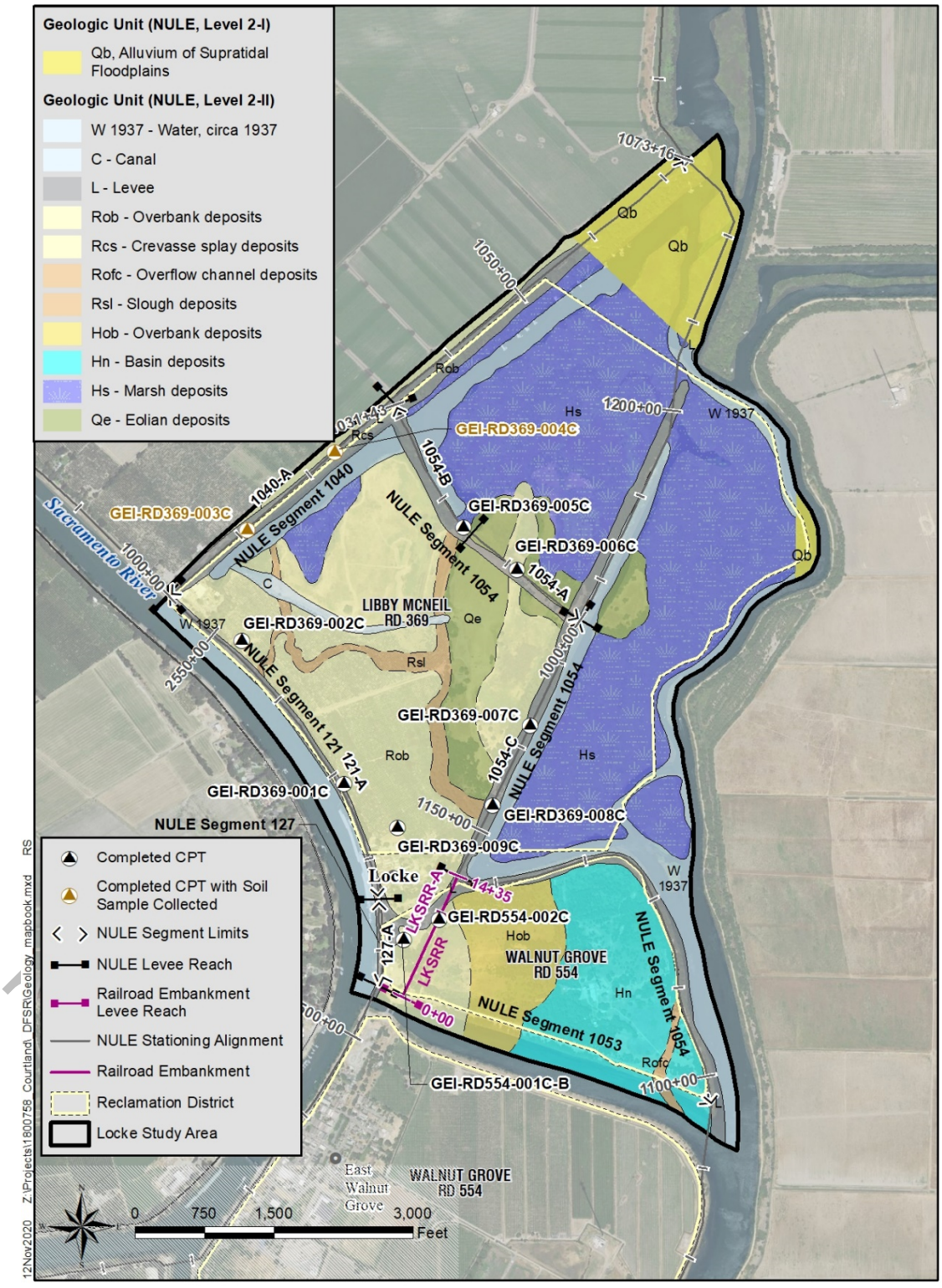

Figure 2-2. Geomorphology within the Study Area.

2.1.3 Population, Communities, and Land Use

According to the 2017 CVFPP and based on 2010 census data, the total population of the SAC 51 impact area (Locke), inclusive of Locke and the larger agricultural area, is 202 (DWR, 2017d). 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.

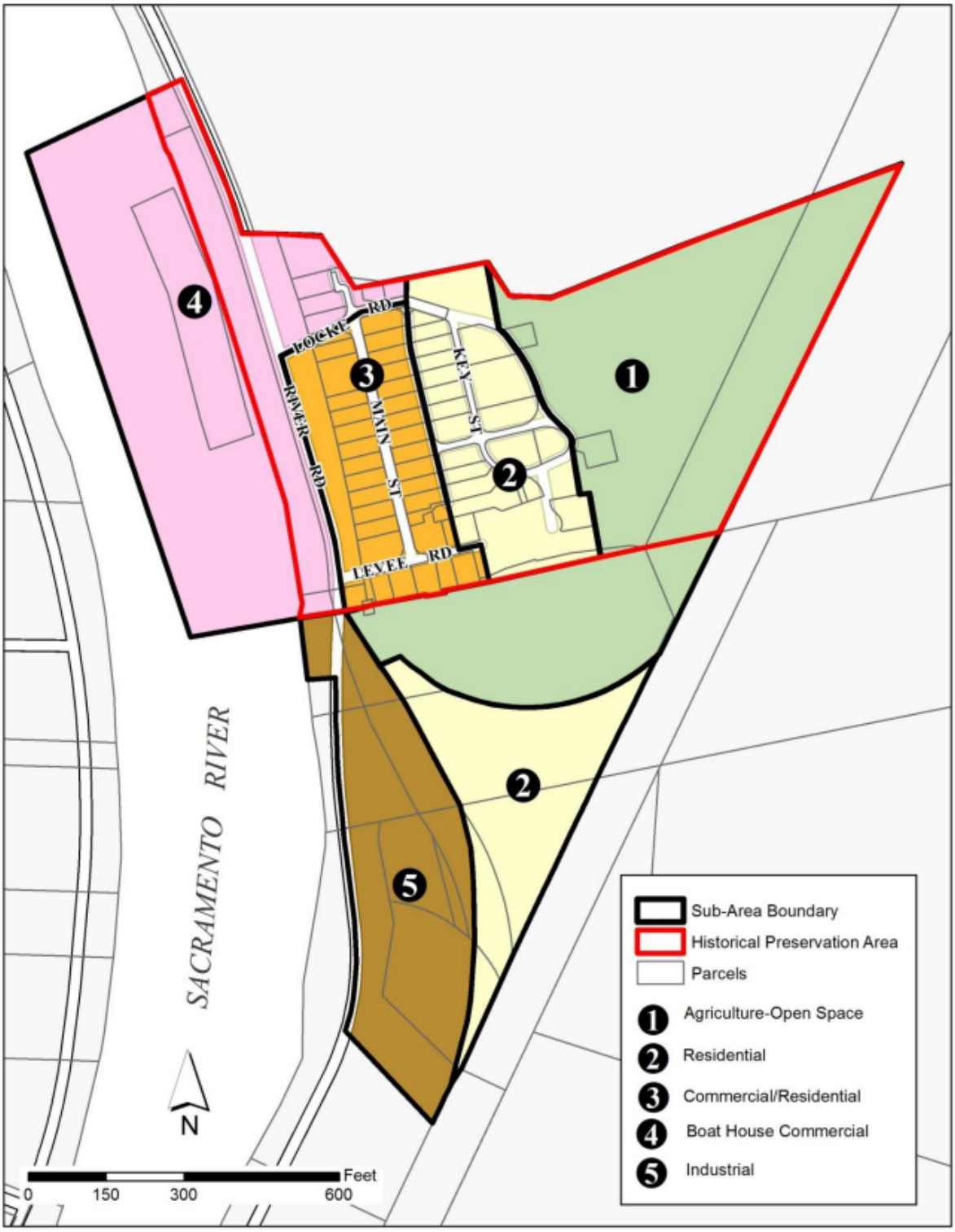

Figure 2-3. Locke Special Planning Area (County of Sacramento, 2016)

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 floodprone 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 (Hood, Ryde, Walnut Grove) is permitted within 23 California Code of Regulations (CCR) Section 5010 (*Locate New Urban Development Wisely)* and exempt from 23 CCR Section 5013 (*Require Flood Protection for Residential Development in Rural Areas)* of the Delta Plan (Figure 2-4). Section 5010 of the Delta Plan requires new residential, commercial and industrial development be limited to those areas designated by city or county general plans, while Section 5013 prescribes floodproofing requirements for new residential development. 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.

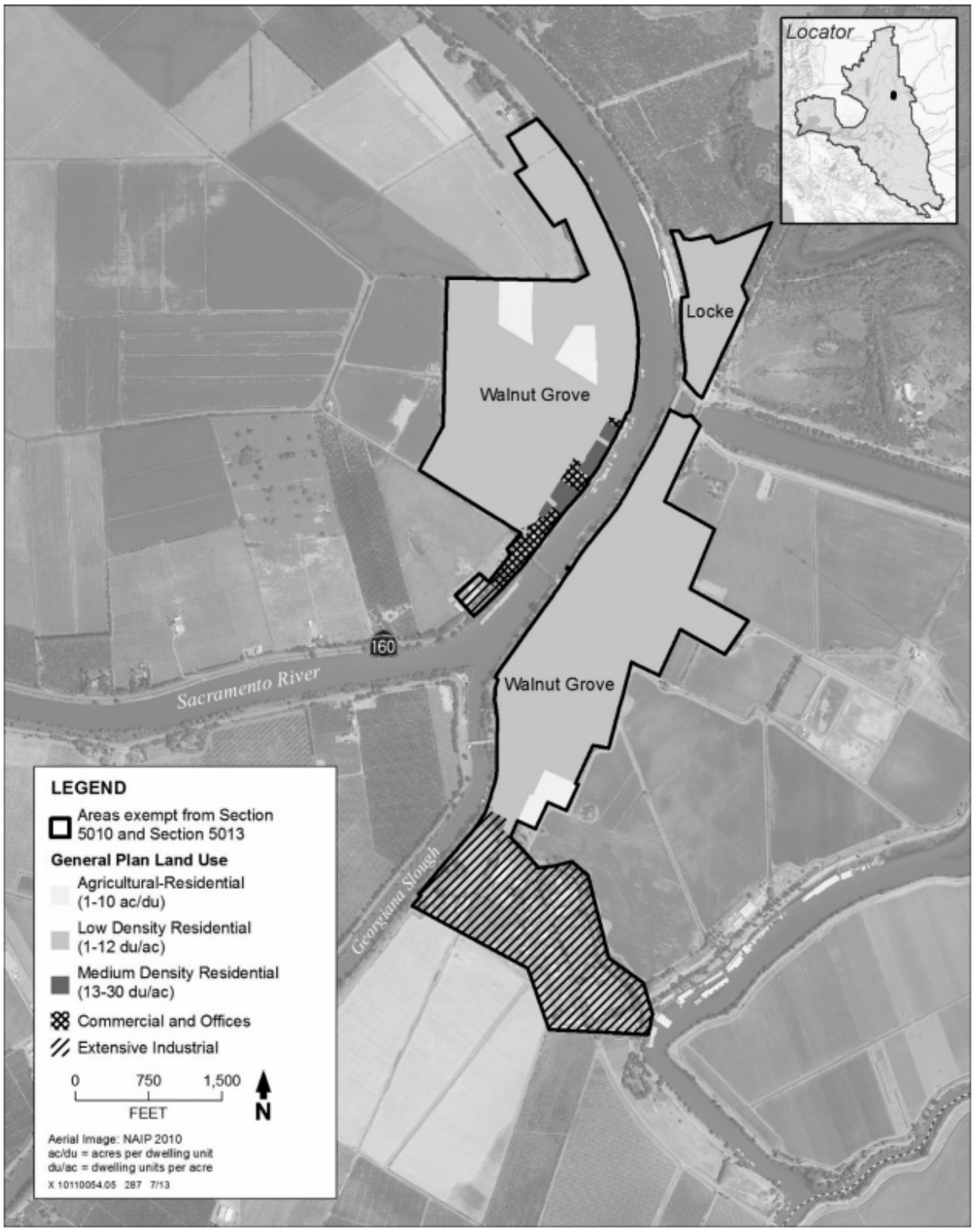

Figure 2-4. Locke Land Use under the Delta Plan (DSC, 2013)

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 percent) away from the Lower Sacramento River immediately adjacent to the Locke study area, inclusive of 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 1-2 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 J. The existing 100-year peak flow in the Sacramento River from Steamboat Slough to Georgiana Slough is approximately 65,200 cubic ft. per second (cfs). For this reach, the future 100-year peak flow is approximately 10 percent lower at 59,200 cfs, due to upstream 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 ft. 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 Channel Capacity Atlas of the Sacramento River prepared by DWR in December of 2016 indicates that there may be a freeboard deficiency on the left (east) 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 J 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.

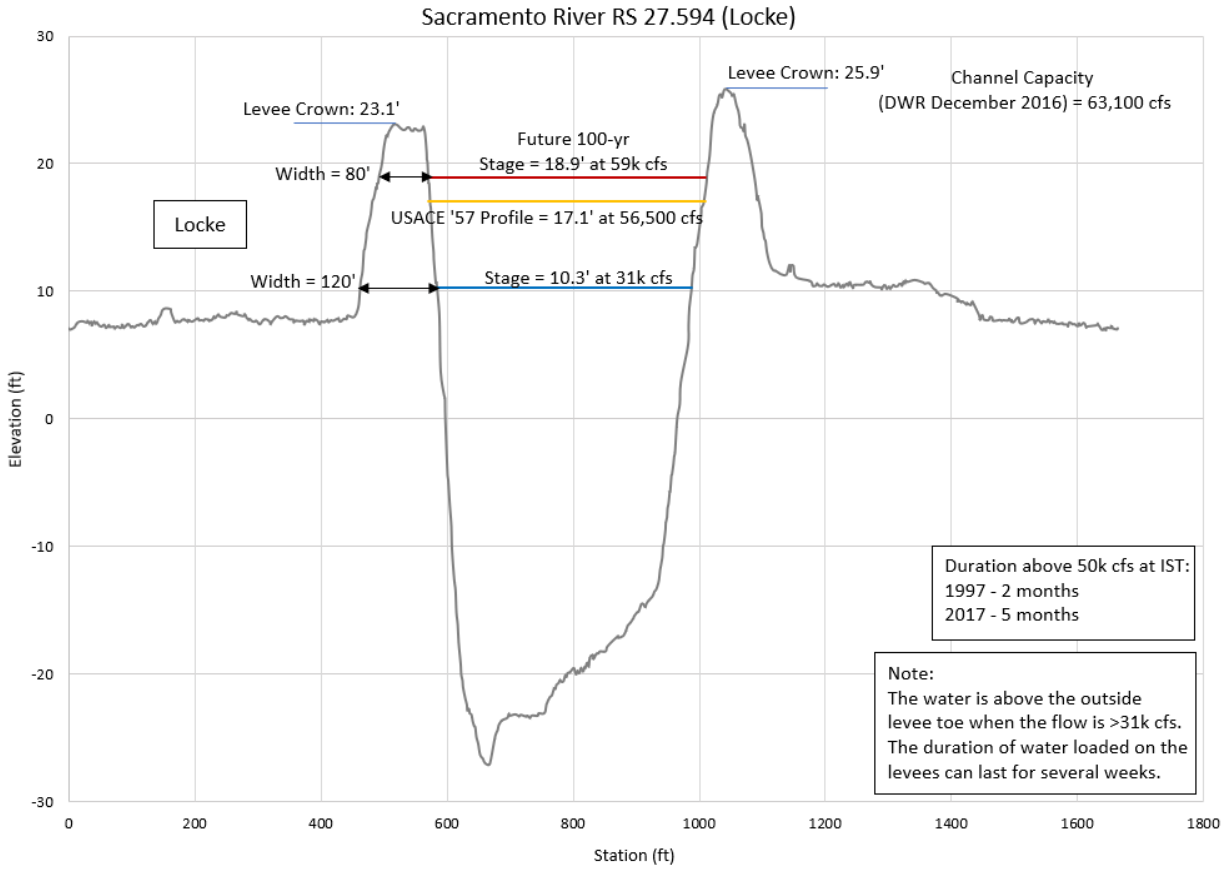

Figure 2-5. Cross Section at Sacramento River Station 27.594 at Locke Viewing Downstream

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 provide vital agricultural water supply and flood protection to local farmers and also convey 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 fifteen miles northeast of Locke.

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

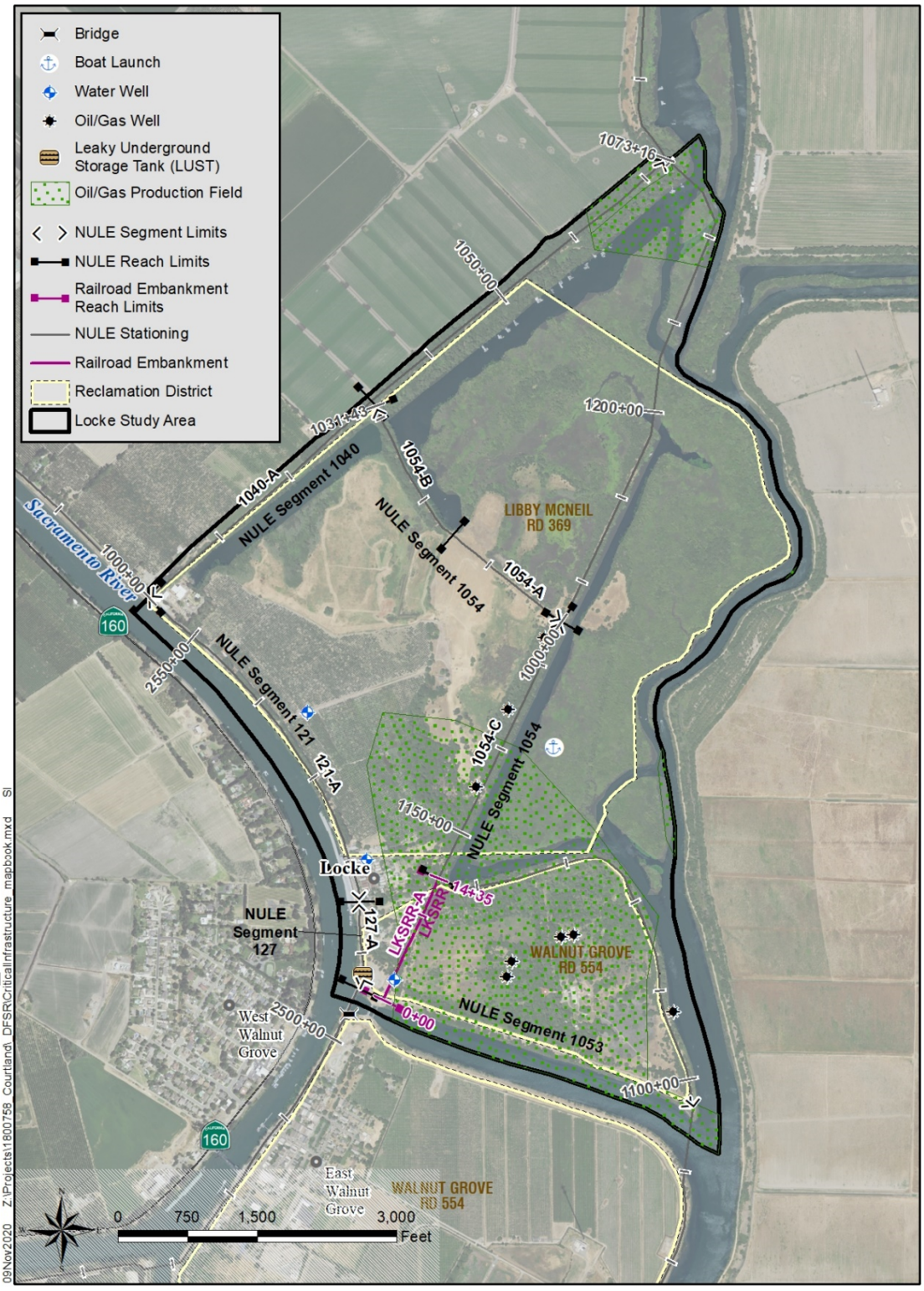

Figure 2-6. Critical Infrastructure within the Study Area

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.

Roughly half of the Locke study area is designated as prime farmland or farmland of local importance (Figure 2-7**Error! Reference source not found.**). Prime farmland is located along a portion of Delta Meadows Slough, and along the Sacramento River north of the densely populated community of Locke. Farmland of local importance is located in RD 369 along Snodgrass Slough and the Delta Meadows Cross Slough levee northeast of Locke.

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 construction period of August 1 through October 31 due to the presence of special-status and endangered fish species and supporting habitat.

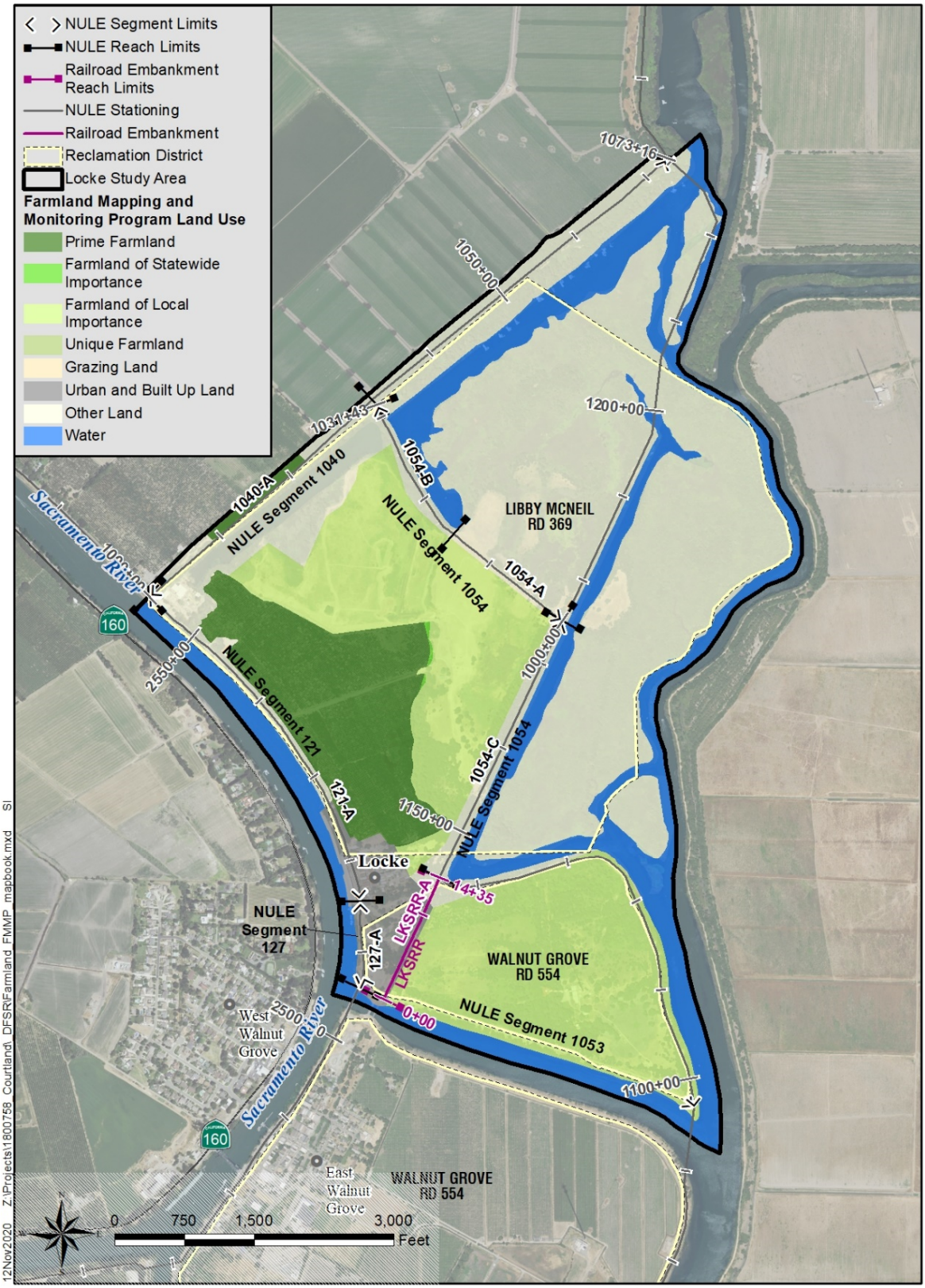

Figure 2-7. Farmland Designations within the Study Area

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 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.

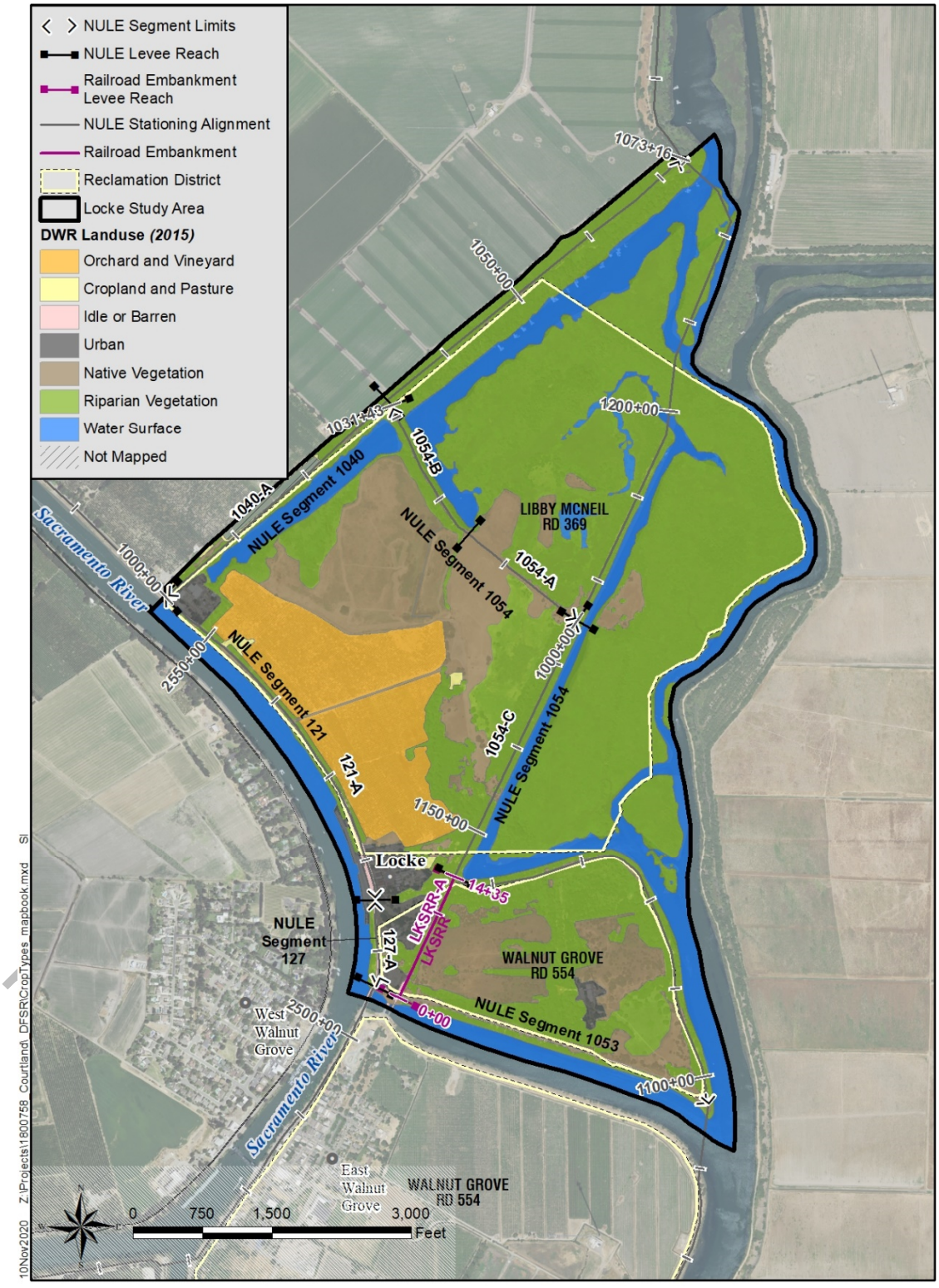

Figure 2-8. Crop Types within the Study Area

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.

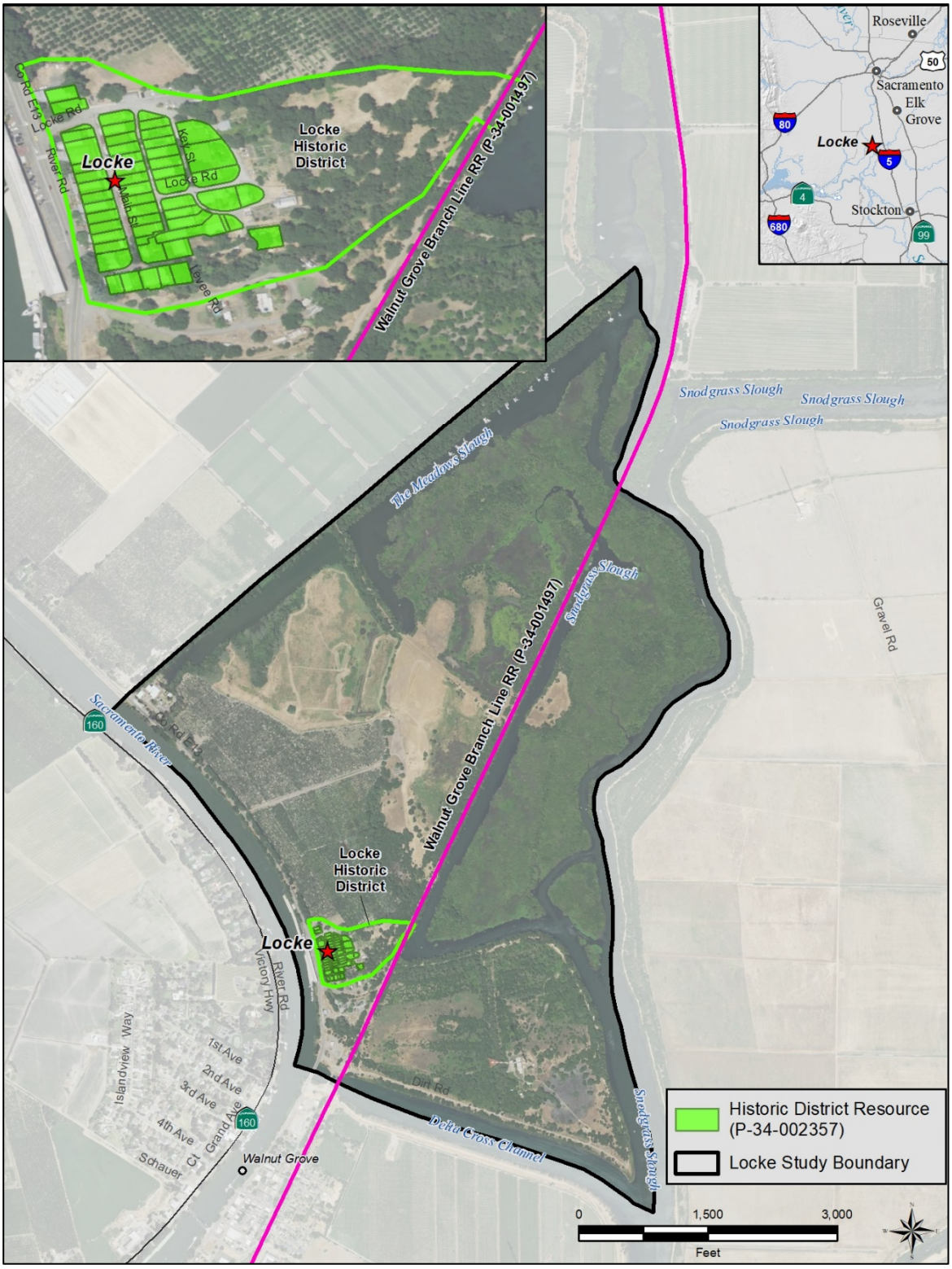

Figure 2-9. Historic Resources within the Study Area.

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 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 two 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 two 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, a total of 8 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 management actions 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, and by DWR in the FSRP, 2017 CVFPP and through the NULE program.

Within the context of this study, consequences of levee failure are defined in terms of life loss and property damage. However, 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. 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 2017 CVFPP. 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 the RDs.

This Section describes the flood risk for the study area by considering the factors which influence risk, including probability of a levee failure, floodwater depths and velocities, inundation time, life loss, and property damage. A brief history of flooding within the study area is also provided.

3.1.1.1 History

There is no record of flooding on RD 369 – Libby McNeil in recent decades. Additionally, 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, probability of levee failure within the study area has been historically evaluated by DWR as part of the FSRP, the NULE program and the 2017 CVFPP and by the DSC as part of the DLIS. The collective CVFPP and FSRP suggest that the SAC 51 (RD 369) impact area has an estimated 50-year level of flood protection. 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. The levels of flood protection offered by the current levee system are currently being

updated under this study with new geotechnical information being gathered during the course of this study and a revisit of the hazard classifications by DWR and Sacramento County to update the existing levee performance curves.

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 WSE. 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 WSE (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 WSE (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 and Sacramento County 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[1]	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 Flood Depths and Velocities

Inundation mapping was conducted in May 2017 for RD 369 as part of the 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 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 ft. along the SPFC levees located along the left bank of the Sacramento River, with flood depths increasing towards 15 ft. 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 ft. In the community of Locke, flood depths are predicted to reach near 10 ft., with some areas flooding in excess of 10 ft. 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

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

along NULE Segment 121 in RD 369. Figure 3-1 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 ft. or more as shown in Figure 3-1 down to the Base Flood Elevation (BFE) of 17.0 ft. NAVD 88 indicated if a downstream relief cut could be implemented in the lower reaches of RD 551 into Snodgrass Slough (see Section 5.2.8 for more information).

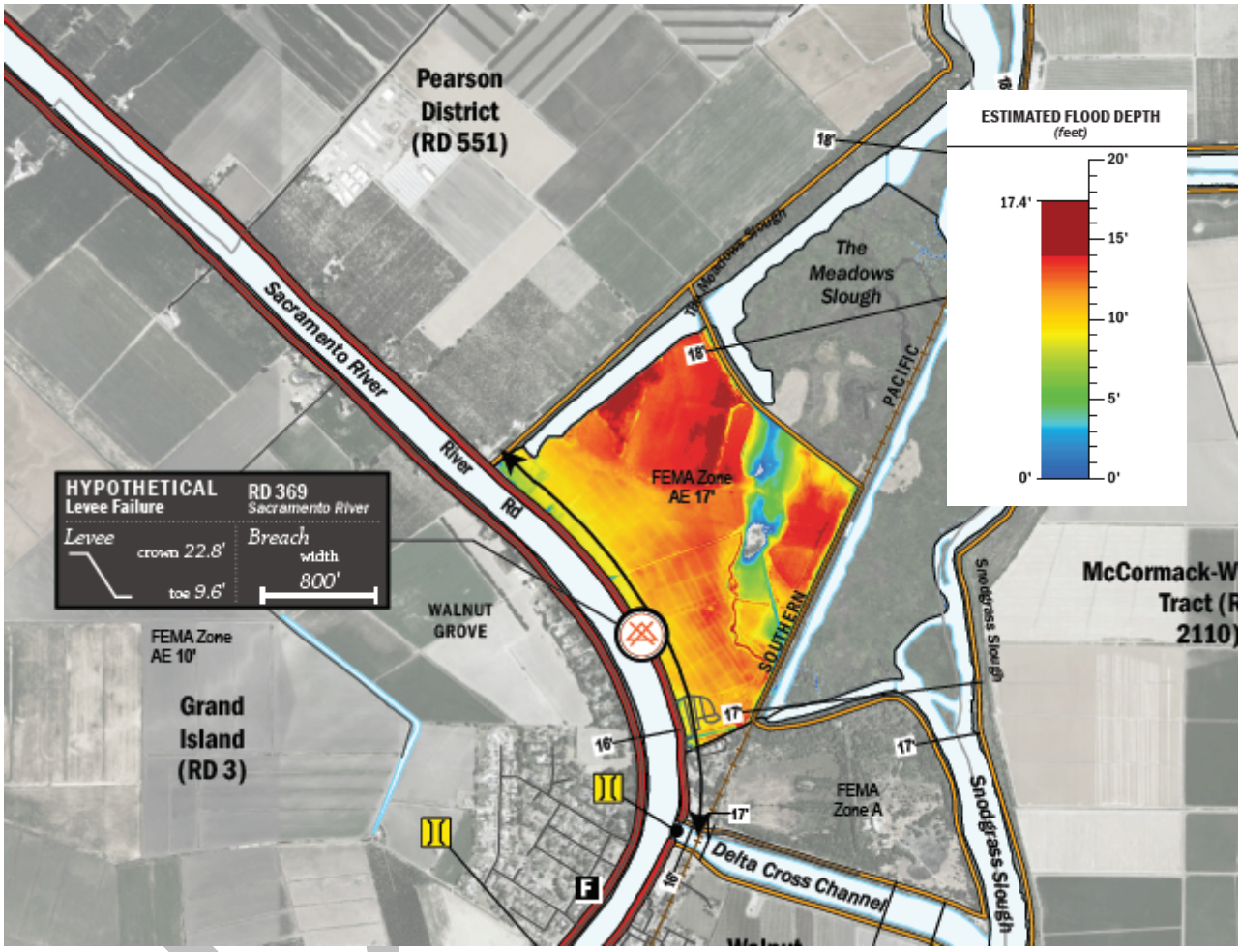

Figure 3-1. Study Area Maximum Flood Depths (Dynamic Planning + Science, 2017).

3.1.1.4 Inundation Time

Using the same breach location discussed in the preceding Section 3.1.1.3, the time to 1 ft. 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 ft. 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.

3.1.1.5 Life Loss

The 2017 CVFPP 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, 2017d).

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 ft. combined with floodwater velocities in excess of 5 fps. 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.

3.1.1.6 Property Damage

Structure counts, agricultural acreage, and vehicle counts, along with their associated values, were quantified as part of the 2012 and 2017 CVFPPs. Within the study area, the value of structures, agricultural crops and vehicles total over $55 million in July 2020 dollars:

- Total estimated depreciated replacement value of the 89 structures in the Locke Study area (RDs 369 and 554): $54.46 million
- Total estimated vehicle value: $734,000
- Total estimated value of agricultural crops: $435,000

Structures at risk of flooding are summarized in Table 3-2. The Locke study area contains approximately 89 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. *Placeholder definition for depreciated replacement value*

versus full replacement value. As shown in Table 3-3, the total depreciated replacement value for the Locke study area escalated to July 2020 dollars is nearly $54.5 million, with commercial and public structures comprising the majority of this value. *Placeholder discussion for full replacement value.*

Table 3-2. Structures within the Locke Study Area (DWR, 2017d).

CVFPP Impact Area for Locke	Total Structures Count				
	Residential	Commercial	Industrial	Public	Total
SAC 51 (inclusive of RD 369 and a portion of RD 554 north of Dela Cross Channel)	40	20	3	26	89

Table 3-3. 2017 CVFPP Depreciated Replacement Value for Locke (DWR, 2017d).

CVFPP Impact Area for Locke	Depreciated Replacement Value (thousands)				
	Residential	Commercial	Industrial	Public	Total
SAC 51 (inclusive of RD 369 and a portion of RD 554 north of Delta Cross Channel)	$6,350	$22,175	$3,916	$22,018	$54,459

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, as provided in the 2017 CVFPP and escalated to July 2020 dollars. In summary, the total vehicle value within the study area is nearly $734,000, and pear orchard crops within the study area are valued at nearly $435,000, 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 (DWR, 2017d).

CVFPP Impact Area	Total Vehicle Count	Total Vehicle Value (thousands)
SAC 51 (inclusive of RD 369 and a portion of RD 554 north of Delta Cross Channel)	67	$734

Table 3-5. Agricultural Acreage and Total Value for the Study Area (DWR, 2017d).

CVFPP Impact Area	2013 Agricultural Acreage (acres)									Total Value (thousands)
	Citrus	Deciduous Pears	Field	Grain	Pasture	Rice	Truck	Vineyard	Total	
SAC 51 (inclusive of RD 369 and a portion of RD 554)	0	92	0	0	>0	0	0	0	92	$435

The 2017 update to the CVFPP also estimated EAD for the Locke study area. 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. Total EAD for the Locke study area is estimated at just over $215,000[2] based upon the 2017 CVFPP analyses and escalated to July 2020 dollars. This EAD value is being updated during the course of this study with new geotechnical data that will be used to update the levee performance curves and subsequent EAD value.

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 17.0 ft. NAVD 88. 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

[2] EAD as defined by the 2017 Without-Project Scenario from the 2017 CVFPP.

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.

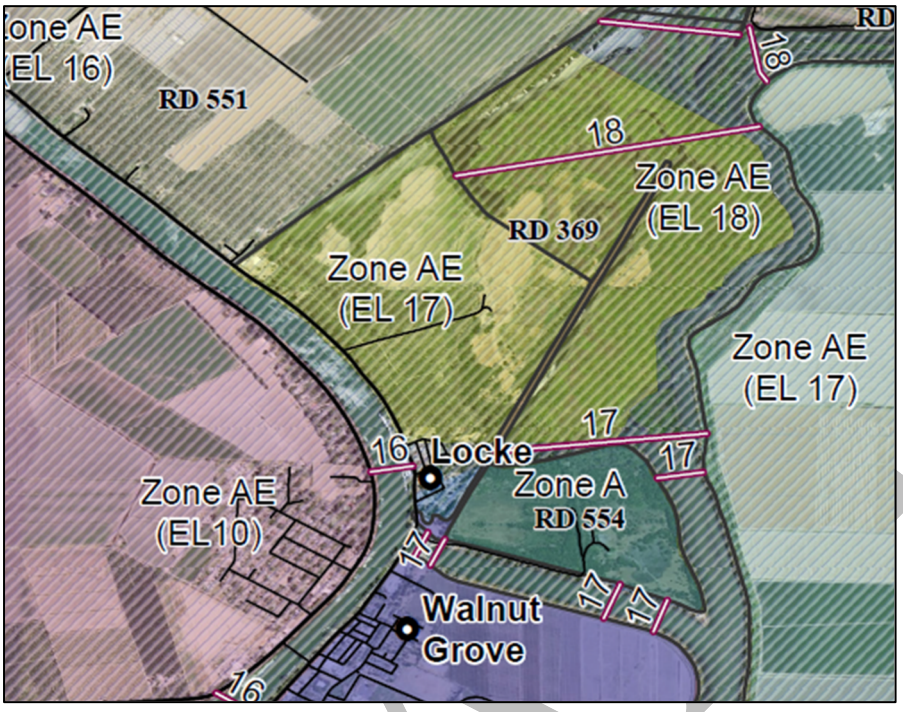

Figure 3-2. Locke's 100-Year BFE Floodplain Recognized by FEMA.

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 and the Homeowner Flood Insurance Affordability Act (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 ft. 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 5 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 ft. below the FEMA BFE of 18 ft. 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 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 89 structures in the Locke study area valued with an estimated replacement value of $54.5 million[3], there are only 5 NFIP polices (valued at $350,000 maximum per policy inclusive of structure contents) providing less than $2 million[4] in coverage.

To remove the entire project study area from the current FEMA BFE of 17 ft. NAVD 88, the entire combined perimeter levee system would require reparing and strengthening in-place to current engineering standards, consistent with the FEMA 100-year accreditation standards contained in 44 CFR §65.10. Click here 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

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

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. 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 3 million acres of agricultural lands and a population of 25 million. 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

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

[3] 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.
[4] These estimates are sourced from the FEMA Open Source policy database.

"Delta as a Place", and it reduces flood risk to the Delta Legacy Communities, inclusive of 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 1.0 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.

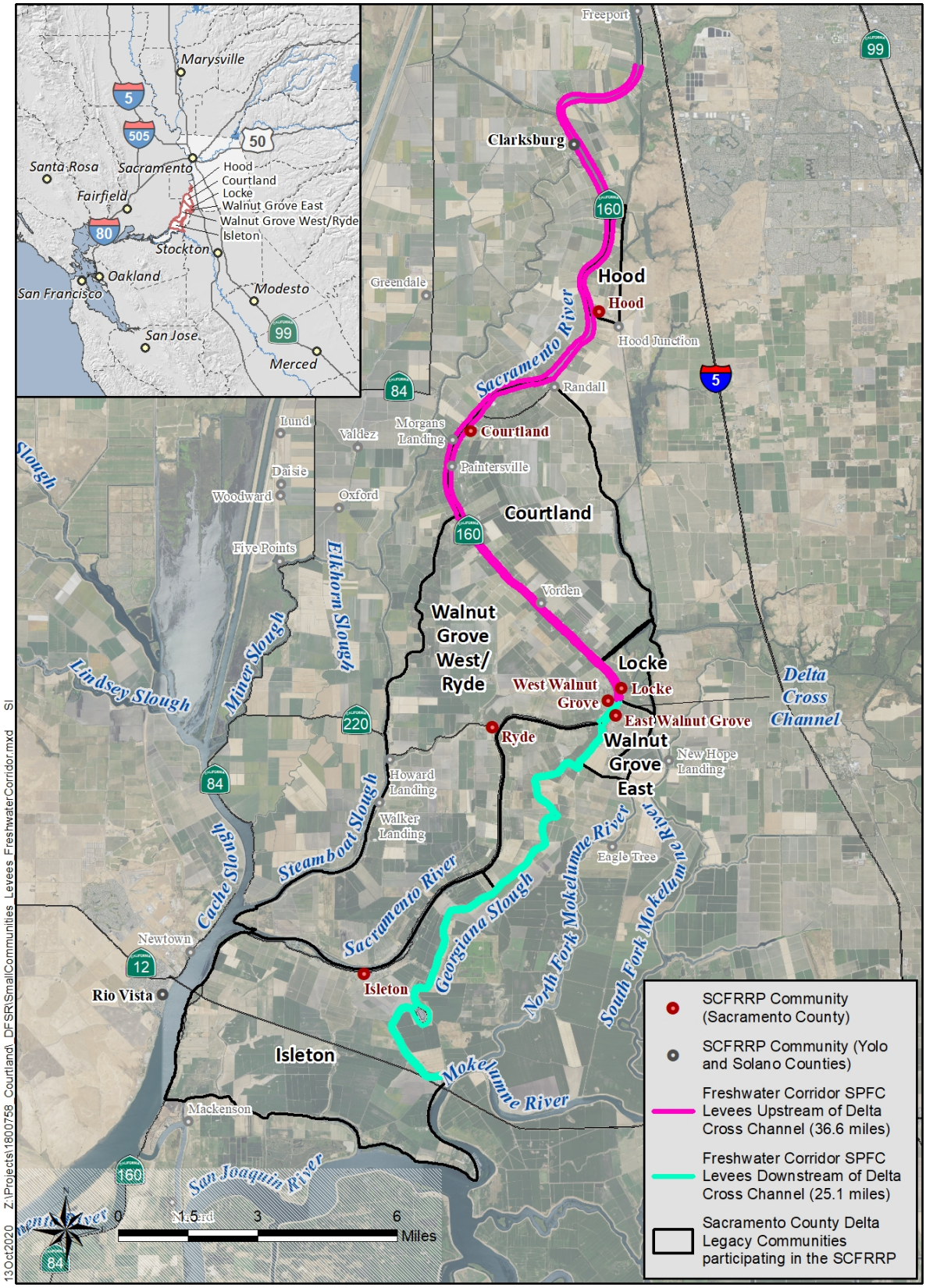

Figure 3-3. SPFC Levees which Comprise the Delta's Freshwater Corridor.

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 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 (aka 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 J, 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 ft., with the 200-year flood stage along the same extent increased by 0.71 ft. 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 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 Sacramento Weir and Yolo Bypass widening enhancements. 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. By improving the levees protecting the community to the current engineering standards, there is opportunity to not only reduce the risk of levee failure, life loss and property damage, but securing levee improvements to FEMA accreditation standards can also: (1) enhance the resiliency and reliability of the through-Delta water conveyance; and (2) reduce NFIP insurance premium rates.

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 ensure that communities and areas located behind the accredited levee(s) are protected during high water events. As a result, by improving levees up to FEMA standards, overall flood risk is reduced, along with reducing the potential for life loss and property damage. Additionally, fortifying and strengthening the levees to current engineering standards helps reduce their vulnerability, thus enhancing the resiliency and reliability of through-Delta water conveyance, and helps 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, inclusive of 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:

- Floodproofing the Delta, as far as feasible, mainly by 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).

3.2.3 Potential Ecosystem Restoration Opportunities

Restoration opportunities adjacent to the Locke study area 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, and 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.

3.2.4 Enhance Resiliency and Reliability of Through-Delta Conveyance

Levees within the study area are vulnerable to potential subsidence, 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 local-state cost share program, 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 SCFRRP, 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 without a local funding source, LMAs are unable 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 $200 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 in funding repairs is that LMAs are responsible for mitigation costs associated with repairs and maintenance. These cost 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 (DWR, 2019). 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.

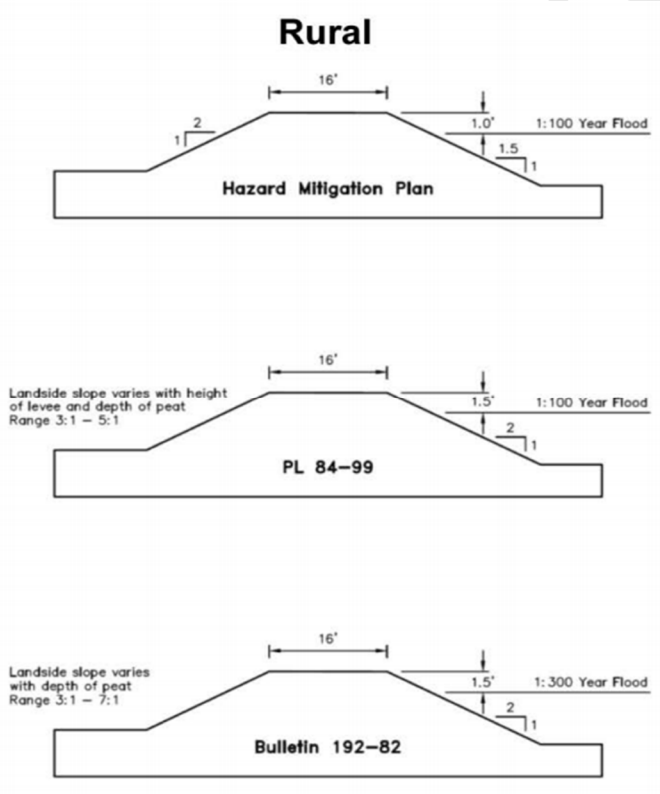

Figure 3-4. Agricultural Levee Design Standards

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-percent 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) (DWR, 2019). The economic sustainability of the Delta Legacy Communities cannot be assured when applying the lower agricultural levee standards previously established for the Delta.

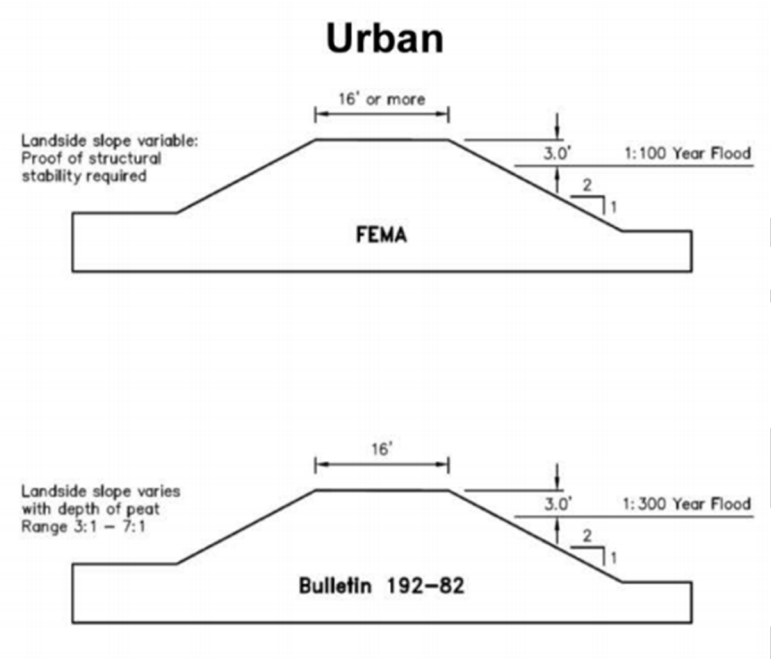

Figure 3-5. Urban Levee Geometry Design Standards

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 ft.

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 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 fall (between August 1 and 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 the County of Sacramento but only 2 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 China Town 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 408 permission is generally needed for any work on SPFC levees and within easements generally within 15-20 ft. 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.

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 management actions 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 management actions 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. Since the mid-1800s, 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.

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 the USACE, as documented in the 2017 CVFPP, flooding in 1986 and 1997 together caused over $1 billion in damage to the areas protected by the Sacramento River Flood Control Project. Within the Locke study area, as previously discussed in Section 3, the value of land and structural improvements, agricultural crops, and vehicles are valued at over $55 million. 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 management actions which reduce the risk to property damage and to achieve the goal of 100-year flood protection for the study area.

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 Limitation of High Insurance Premiums

As previously noted in Section 3.1.2, of the estimated 89 structures in the Locke study area valued at an estimated $54.5 million, there are only 5 NFIP polices (valued at $350,000 maximum/policy) providing less than $2 million 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 risk, 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 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 enhances 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 3 million acres of agricultural lands and to over 25 million residences 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, 2017c). 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 management actions 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.

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 ft. on average, with the 200-year flood stage along the same extent increased by 0.71 ft. 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). Note, however, 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.

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, inclusive of 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.

4.2.3 Land Subsidence in the Delta

While land subsidence is prevalent through most 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 is not expected in the future.

4.3 Alignment with Goals and Policies of Delta Agencies

Actions required to meet the objectives outlined above need to be in alignment with goals and policies of other requirements. Projects and management actions 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 as Appendix H.

4.3.1.1 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 H.

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 H.

4.3.1.2 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 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 H.

4.3.1.3 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 H.

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 management actions 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.

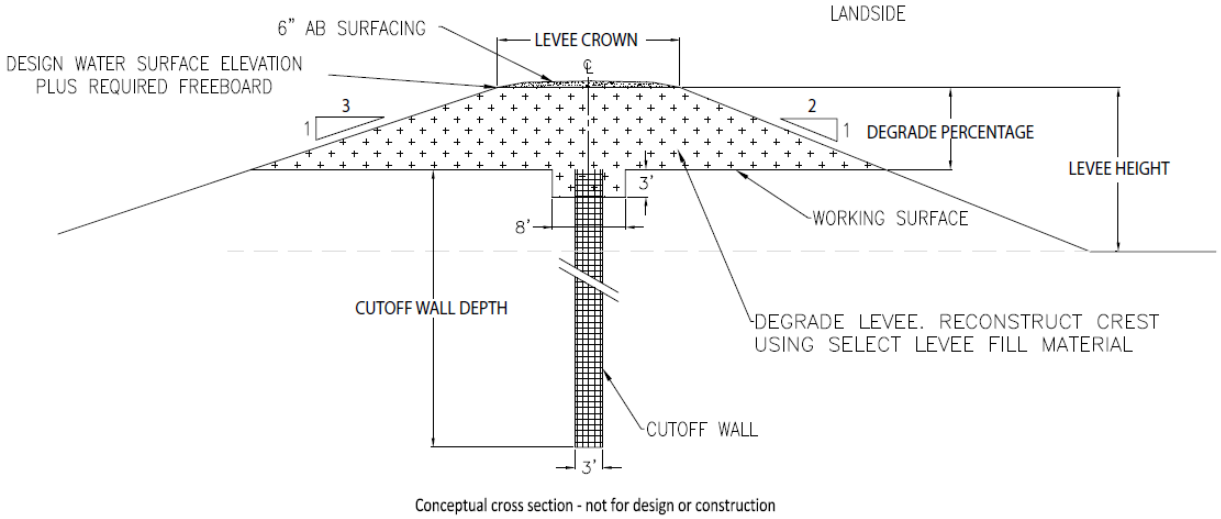

Figure 5-1. Typical Cutoff Wall.

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.

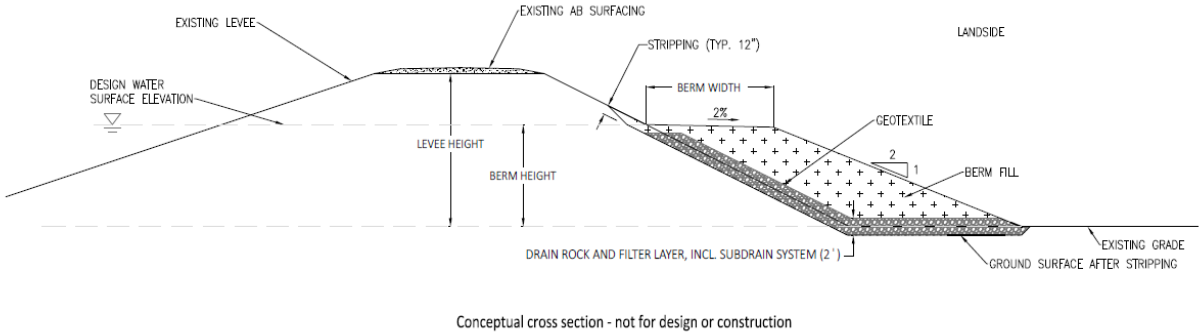

Figure 5-2. Typical Stability Berm.

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 ft. 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

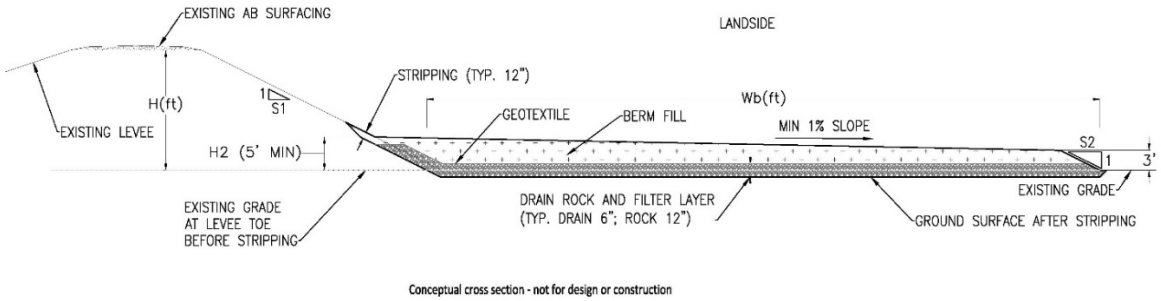

Figure 5-3.

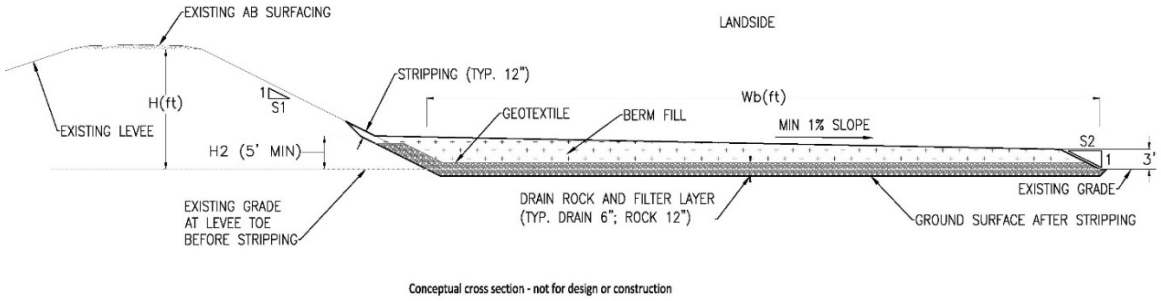

Figure 5-3. Typical Seepage Berm.

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.

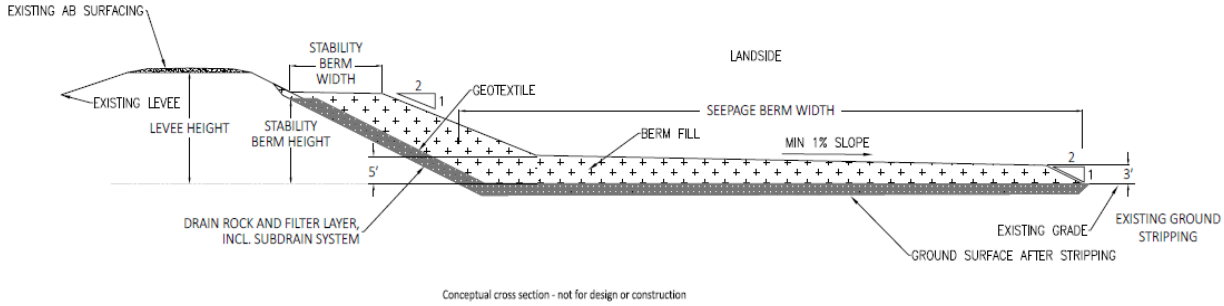

Figure 5-4. Typical Combination Seepage and Stability Berm.

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.

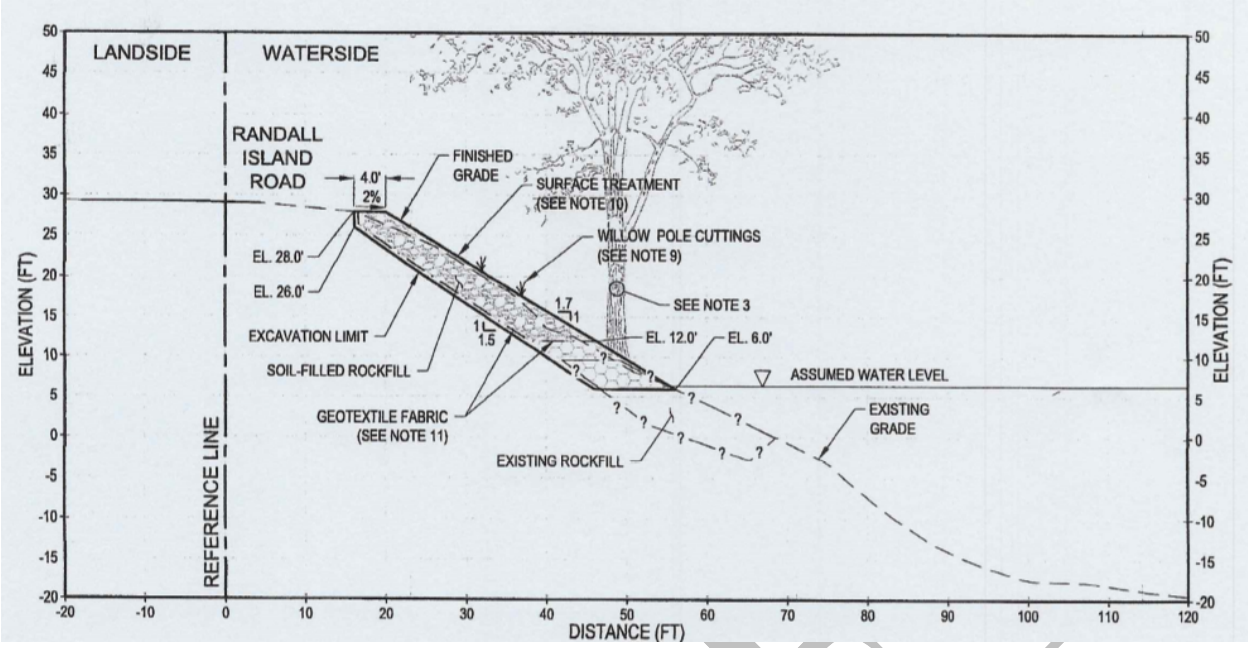

Figure 5-5. Typical RSP Detail for Remediation of Erosion Within the Study Area (AECOM, 2020).

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 form 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 ft. 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 ft. (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 Geotechnical Assessment Report (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 of December 2016.

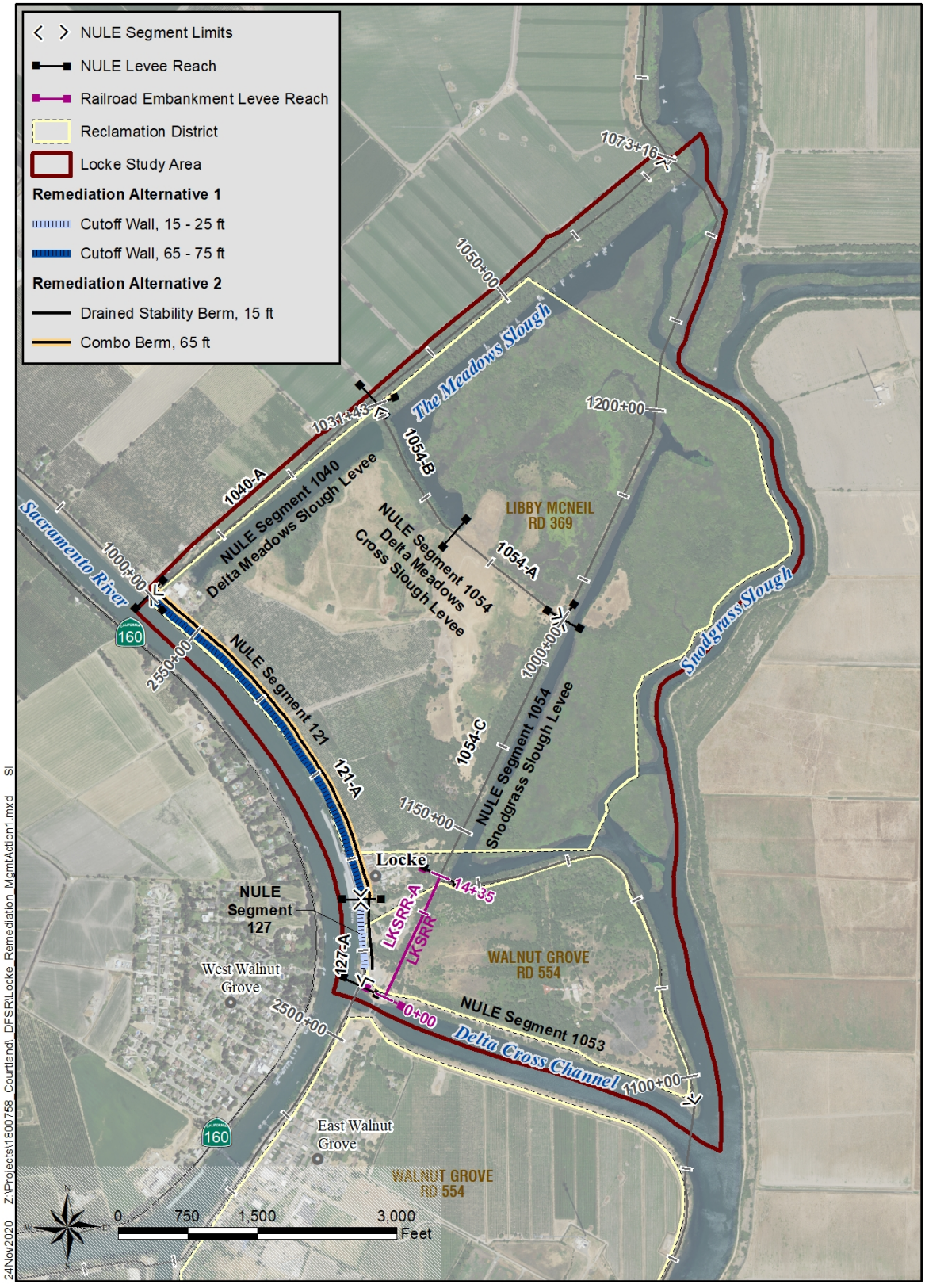

Figure 5-6. Remedial Alternatives to Repair and Strengthen the Sacramento River Left Bank SPFC Levee West of Locke, Within RDs 369 and 554

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

[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 miles) and the adjoining Snodgrass Slough right bank levee (0.6 miles) in RD 369, as well as the most northerly 0.20 miles 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 the levee fronting the community may or may not be vulnerable to slope stability and to confirm there are no freeboard deficiencies, in addition to the known vulnerabilities to through seepage and underseepage.

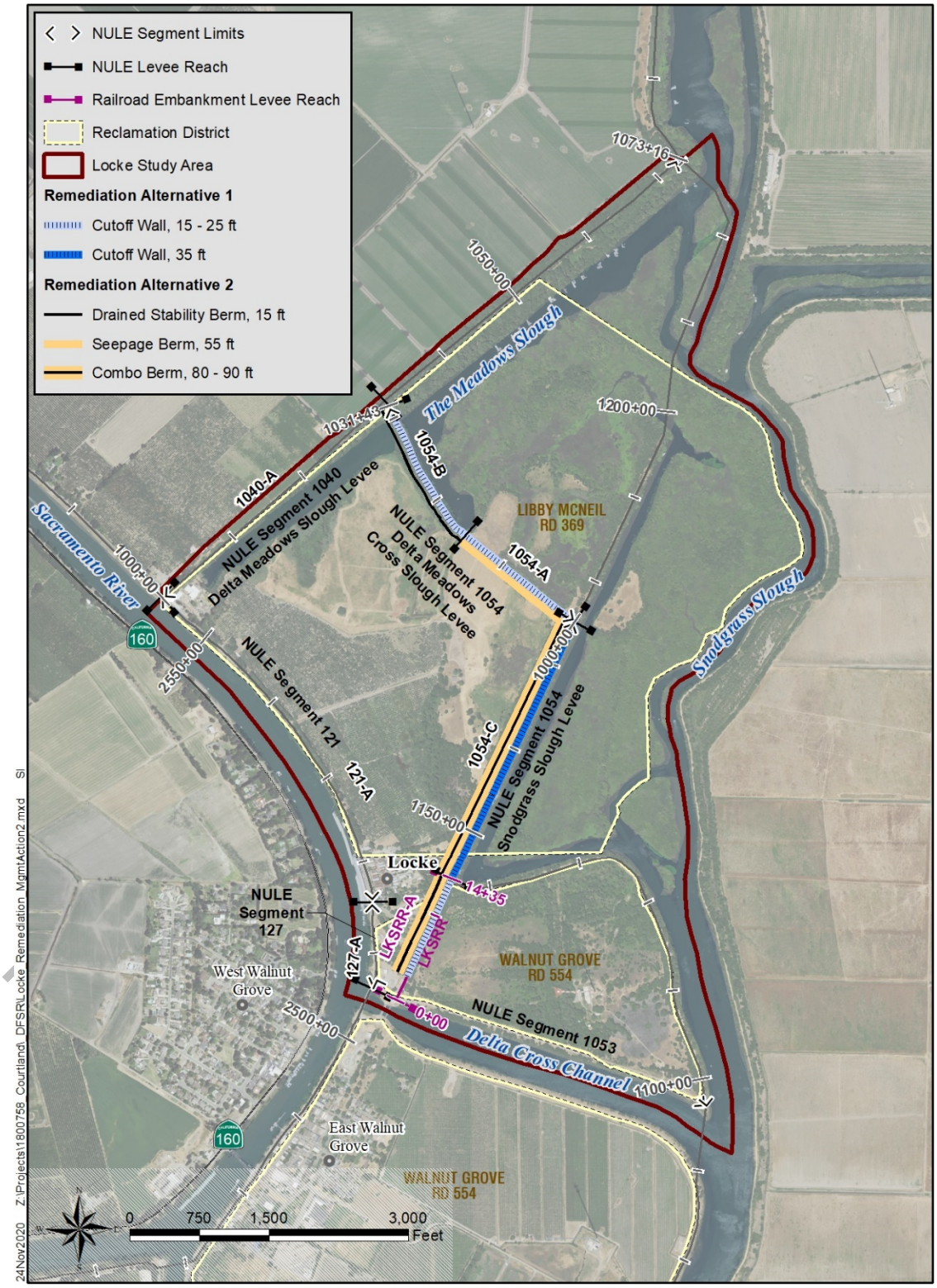

Figure 5-7. Remedial Alternatives to Repair and Strengthen Non-SPFC Levees and Former Railroad Embankments Easterly of Locke within RDs 369 and 554t

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	-	-

* 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 ft. deep cutoff wall (Remediation Alternative 1) or a 135 ft. wide, 15 ft. 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.

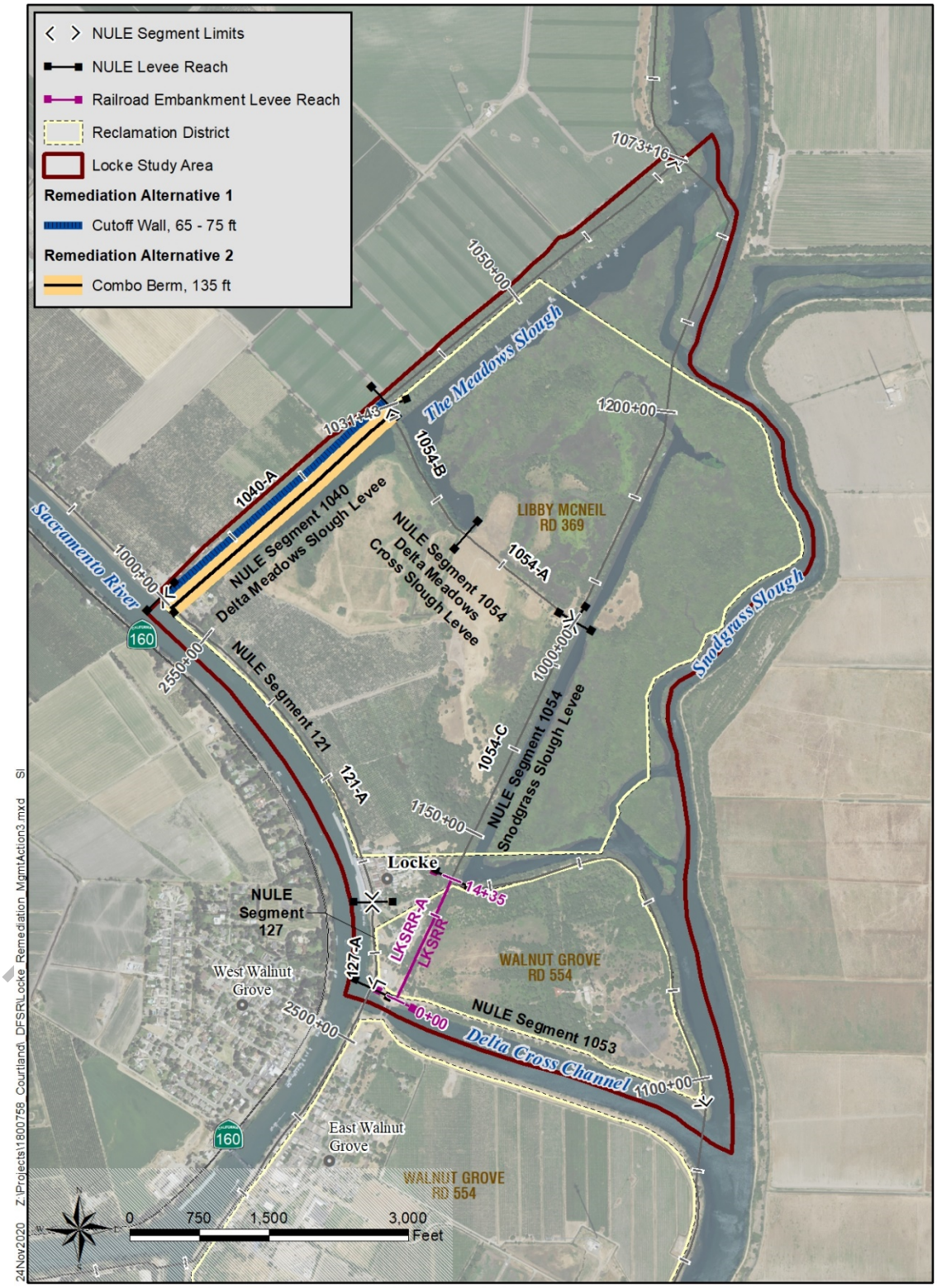

Figure 5-8. Remedial Alternatives to Repair and Strengthen the Delta Meadows Slough Non-SPFC Levee North of Locke Within RD 551 (portion of NULE Segment 1040 in RD 551)

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 ft. north of Locke along the left bank of the Sacramento River for a distance of approximately 1,600 ft. (0.30 miles) 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 ft. wide crown width, 3H:1V landside and waterside slopes, and levee crest elevation of 20 ft., assuming design WSEL of 17 ft. NAVD 88 and 3 ft. of freeboard (Table 5-3).

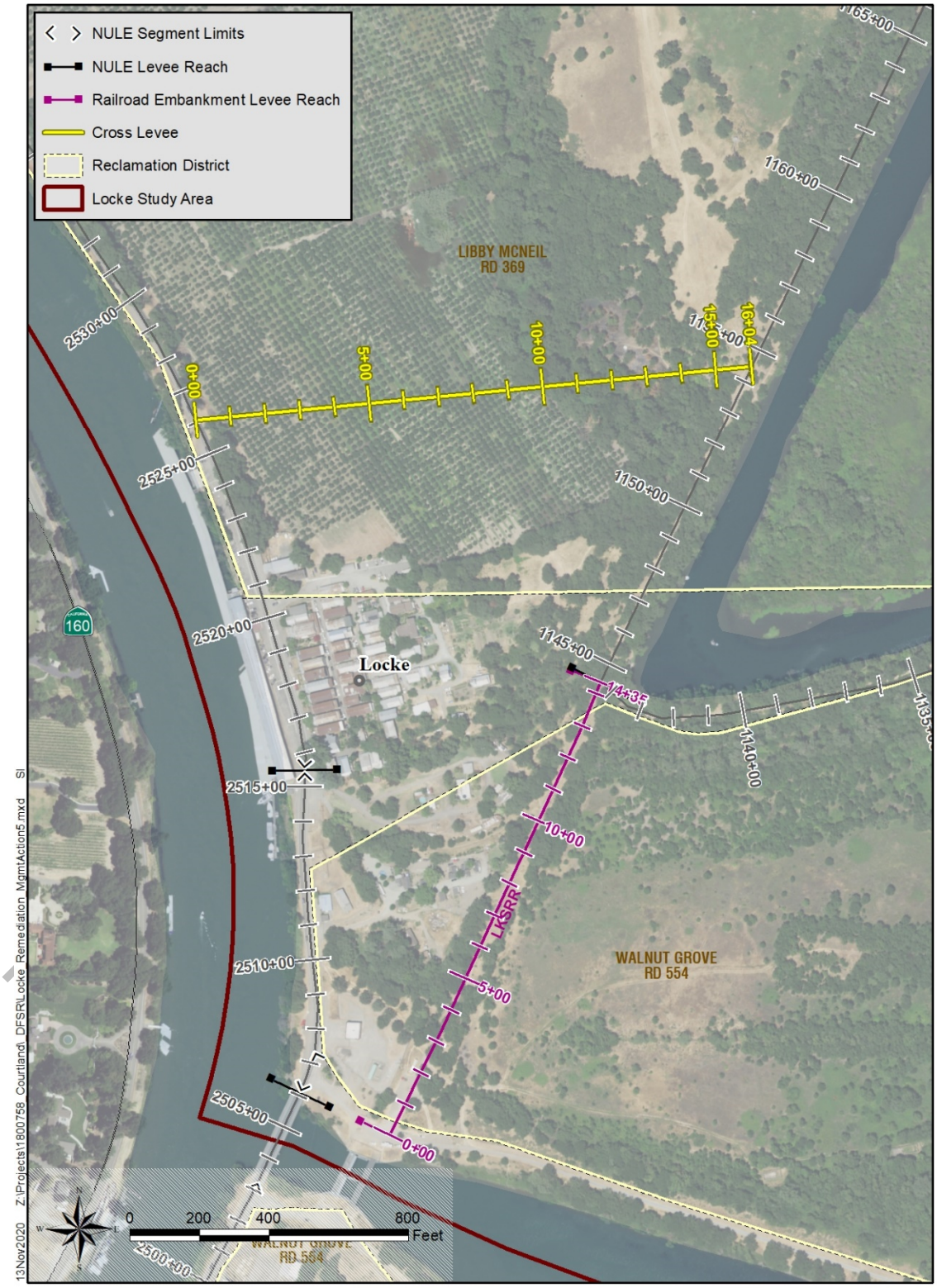

Figure 5-9. Conceptual Alignment of Potential Cross Levee North of Locke in RD 369

Table 5-3. 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 miles 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 miles 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 three ft. above the 100-year water-surface level, preferably that addresses both climate change and sea level rise. An additional 1 ft. above the minimum is required within 100 ft. 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 (COE) 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 COE 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 ft., 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.

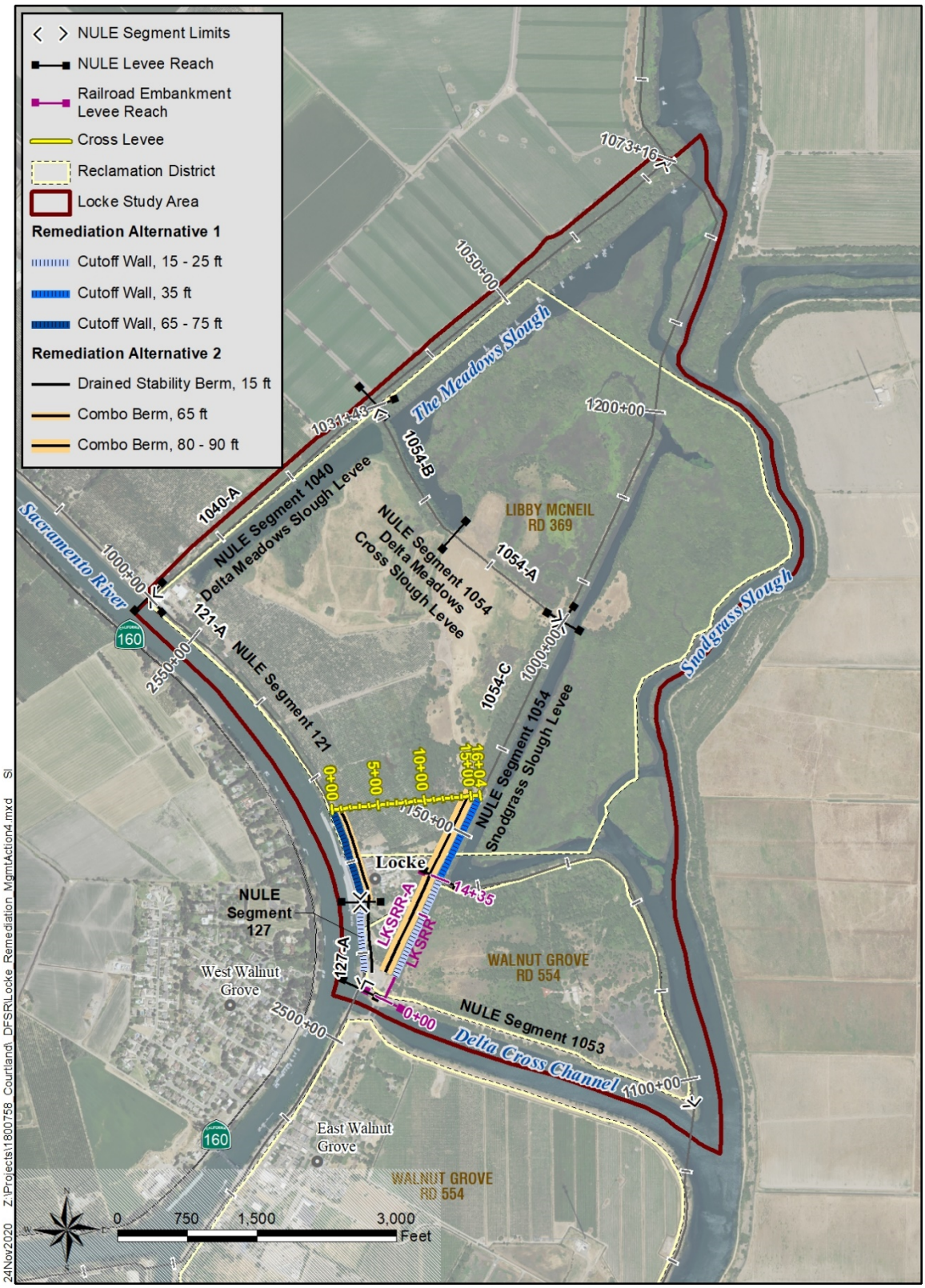

Figure 5-10. Potential Cross Levee North of Locke Paired with Remedial Alternatives to Repair and Strengthen Levees South of Potential Cross Levee.

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 ft. portion of NULE Segment 127, RD 554); 2) Delta Meadows Slough Non-SPFC levee (portion of NULE Segment 1040 in RD 551, 0.6 miles); 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 miles 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.

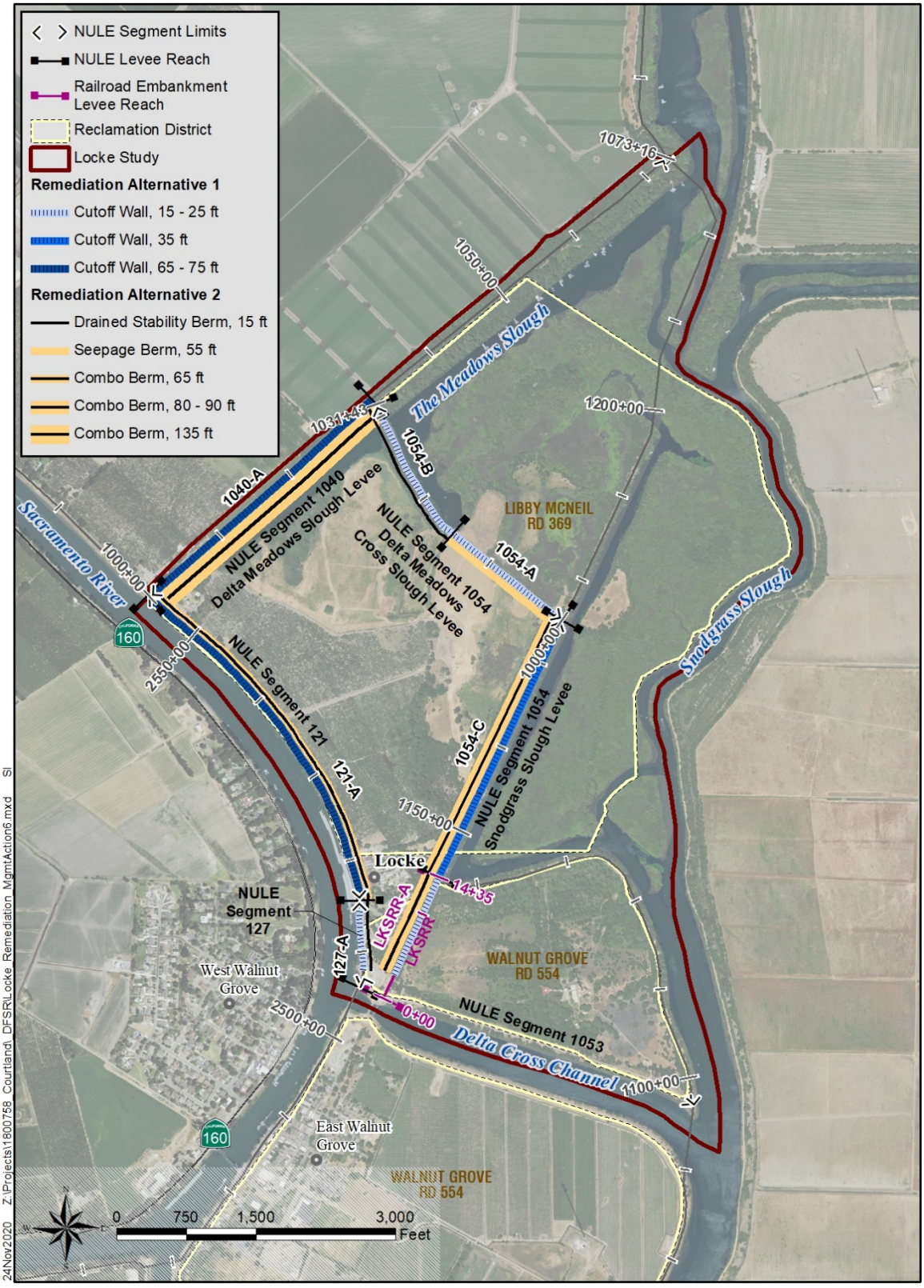

Figure 5-11. Proposed Improvements of RD 369 Perimeter Levee System, (Including 0.60-mile Westerly Portion of RD 554's Delta Meadows Slough non-SPFC Levee

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 Section 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 miles of 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 levee along the right bank of Snodgrass Slough (portion of NULE Segment 1054 in RD 369), and; 3) 0.20 miles 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 suite of non-structural measures considered in this feasibility study are summarized below and include:

- Deferred vegetation removal and levee crown maintenance/improvement with all-weather access roads
- Improved governance between neighboring LMAs/RDs and community
- Voluntary elevation of structures
- Wet or dry floodproofing
- Acquisitions or relocations
- Improved emergency response
- Alternatives to NFIP – community and flood risk based insurance program
- Local hazard mitigation plan and relief cuts
- Public education and awareness
- Improve FEMA CRS
- NFIP flood insurance enhancements, risk-based insurance program, and potential enhancements via AFOTF
- Mokelumne River conveyance improvements/flood easements

This suite of non-structural measures is summarized in Appendix I.

5.2.1 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 element 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, RD 551), primarily in support of providing better access for flood fight activities.

This element 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 for the communities in the Sacramento River Basin adjoining SPFC levee reaches, 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 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 Structural Elevation

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 ft. 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 ft. 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 ft. 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.

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 ft. However, agricultural-related structures have been known to be flood-proofed for flood depths far exceeding 5 ft. 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 ft. 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 ft.

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 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, 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 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). For over 60 years the NFIP has been the principle source of flood insurance in the United States. Since its inception, the NFIP has encouraged homeowners to buy flood insurance by providing homeowners with older homes the opportunity to purchase flood insurance at a discounted or grandfathered rate. Today, roughly half of all policies in the Sacramento Legal Delta are grandfathered policies. The NFIP is increasingly viewed as unsustainable. In response to increasing solvency concerns, congress passed BW-12[1] in 2012. BW-12 eliminated subsidies for some types of policyholders and moved premiums toward more risk-based pricing. BW-12 progressively phased out the pre-FIRM subsidy at a rate of up to 18 percent per year for primary residences and 25 percent per year for non-primary residences. After expressed outrage in the rapid increase of insurance premiums, congress reevaluated the rate increases and subsequently passed the Homeowner Flood Insurance

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 K for further details for a Community-Based Flood Insurance Program for Locke

[1] Public Law 112-141, Div. F. Title II, Subtitle A

Affordability Act (HFIAA). While the new law slowed the rate increases, capping them at 15 percent for primary residences for homeowners receiving subsidized rates, it did not eliminate the premium increases.

As NFIP premiums increase, 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. These models, the number of which is increasing, vary in their complexity and detail. 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 http://www.FloodFactor.com one 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, coastal, and pluvial analyses as shown in Figure 5-12 below.

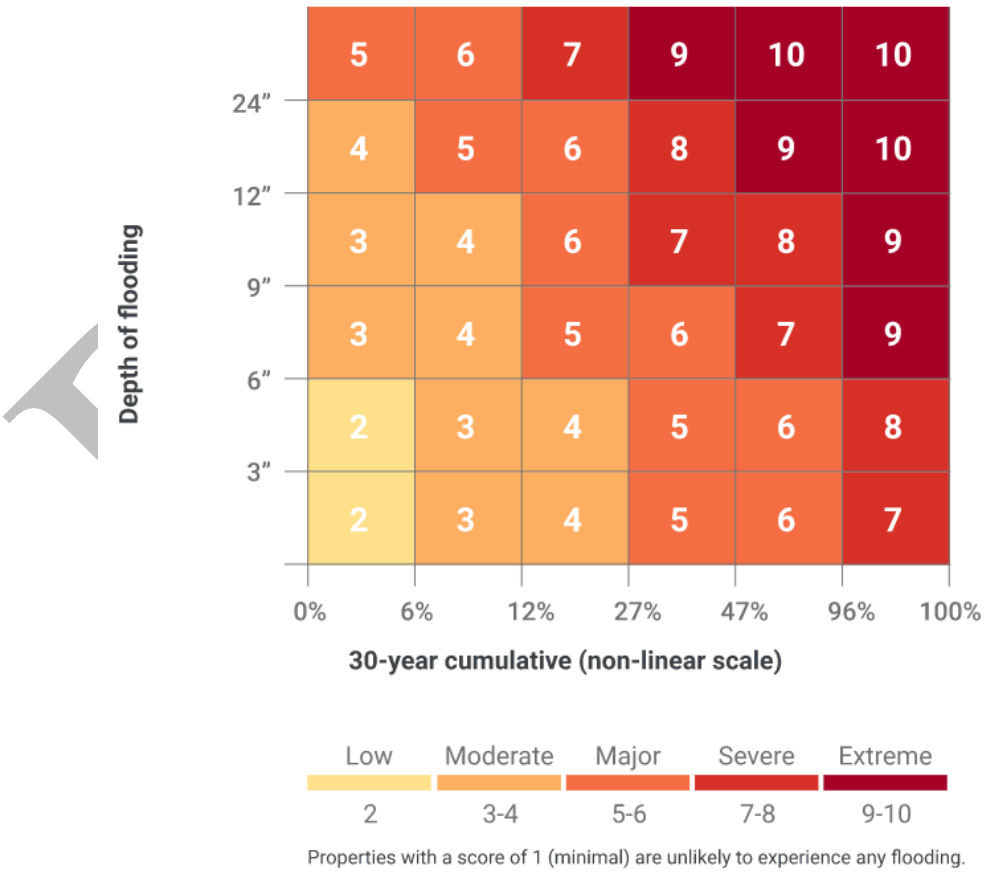

Figure 5-12. Flood Factor Matrix (First Street Foundation, 2020)

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. Homeowners and decision makers should recognize that there is a tradeoff between ease of use and flood extent precision and exercise judgement when assessing their appetite for flood risk.

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 sell their risk to an insurer, they might choose to finance the risk through a capital markets or they might 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 operation and maintenance.

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 Geologic Hazard Abatement District (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.

Under this scenario, the community of Locke might decide to establish a GHAD. It would be an independent political subdivision of the State governed by a locally elected board by the community of Courtland and/or by a small collection of communities within the Delta. It would not be an agency or instrument of a local agency, and thus would not be subject to the control of by a local agency. The board of the GHAD would compile the historical flood loss information, and details of the physical flood risk. They would share this information with an insurance broker and risk financing entity.

In a manner similar to other municipal insurance contracts, the broker, the GHAD board, and the insurance and financing sellers would negotiate the best combination of risk transfer options and flood damage payment options. The GHAD might choose to negotiate a traditional flood insurance policy that is capped at $100,000. An analysis of NFIP claims for the Delta finds that 75 percent of all claims payments are less than $50,000 and that the full $250,000 has only been paid once, suggesting that a policy capped at $100,000 would generally meet the recovery needs of homeowners in the community of Locke. Conversations with insurance providers finds that capping a policy at $100,000 significantly reduces the price and increases the financing options. An additional policy providing the $250,000 of coverage required by lenders could be purchased separately.

Alternatively, the GHAD could issue a parametric insurance policy. A parametric policy is one in which insurers receive a predefined amount given a predefined triggering event, such as a

river stage warning triggering and evacuation and/or a levee failure within RD 369 or RD 554 basins. The payment could be a fixed amount or a percentage of the property's appraised value. Under this scenario, payments would be capped at a maximum dollar amount per property per flood event. As with the traditional payment option, homeowners wishing to purchase additional "wraparound" coverage could do so.

Sacramento County is encouraging the North Delta Legacy Communities to consider alternatives to the current NFIP, including a community-based flood insurance program, that could be administered with or without developing a GHAD.

See Appendix K for further details for a community-based flood insurance program for Locke and neighboring Delta Legacy Communities.

5.2.8 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.

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 ft. 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 ft. over the entirety of the RD, while waiting for the lower, downstream levee reach to overtop. The RD personnel will determine if a relief cut will be necessary should flooding occur; however, in most cases there is no written description nor agreement for a planned relief cut. Potential relief cut locations should be identified and further evaluated 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.

5.2.9 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 and enter their address to get the most information on State-Federal levees in their area.

5.2.10 Improve FEMA Community Rating System

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, inclusive of the entire Courtland 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 2nd highest ranked CRS community in the entire Country behind Placer County.

5.2.11 NFIP Flood Insurance Enhancements, Risk-Based Insurance Program, and Potential 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 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 Courtland 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

5.2.12 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 of 1986. These documents identify potential flood risk reduction measures that could be carried forward to reduce flood risks to the community of Courtland.

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 Maintenance Area 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 1.0 mile of 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 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, and 3) in concert with 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. This later 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 detailed discussion of ecosystem opportunities.

5.3.3 Public Recreation and Education

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.

Cross Levee Community Loop Trails

The proposed cross levee alignment on the north side of Locke will have a wider crown (approximately 20 feet) and could easily be modified to act as a community trail for walking or biking, which would allow residents and community visitors to more easily avoid traffic on State Route (SR) 160. Modifications to the cross-levee alignment could be included to restrict access for portions of the alignment adjacent to residences along the alignment, if necessary. 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, 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 community. Minor brush clearing along the currently overgrown 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 portion of Locke.

The levee crown from the Locke boathouse up to RD 551 is extra wide, since a train spur used to run along the levee top, 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 a

trailhead 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, or Locke 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. 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.

Regional Connection Trail

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 could be 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 River Road. Additionally, with the installation of a foot/bike bridge or small ferry at the location of the now defunct 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 levee adjacent to Locke, and then connect to other Delta Legacy Communities, to the adjacent Delta Meadows State Park (with facility improvements in partnership with State Parks), north to Stone Lakes National Wildlife Refuge, and finally to Freeport and Old Sacramento.

These concepts 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, stakeholders, including the Locke Management Association Locke 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

6. Identification and Trade-Off Analysis of 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 based on risk reduction and responsiveness to planning objectives, as well as constraints regarding funding, implementation, and capital costs. These management actions 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 management action, 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 management actions 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 management actions, 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.

The seven management actions are summarized below. These management actions are compared against the no action, future without project condition to quantify how well each management action 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. These conditions do not include any flood management improvements that have been authorized and have funding, or that have started construction or implementation.

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 previous studies conducted by DWR and the DSC DLIS, it is estimated that the community of Locke has an estimated 32-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-ft. These flood depths could result in damages to the community and the larger study area on the order of $55 million. With the current level of flood protection noted above, this equates to an EAD annualized value of nearly $215,000.

- 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 East 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 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 was selected as the most efficient, no regrets means of reducing this flood risk. Remedial alternatives for Management Action 1 are described in Section 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 miles 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 miles 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 miles 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 Management Action 2 are described in Section 5.1.1.2 and 5.2.1.

6.1.4 Management Action 3: Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee North of Locke (portion of NULE Segment 1040 in RD 551)

The portion of the Delta Meadows Slough levee common to the RD 369 and RD 554 boundaries which extends eastwards approximately 0.6 miles from the confluence with the Sacramento River is estimated to have a moderate likelihood of failure due to vulnerabilities to underseepage and slope stability. Life loss and property damage in Locke and the larger study area are also possibilities 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 was thus selected as Management Action 3. Remedial alternatives for Management Action 3 are described in Section 5.1.1.3 and 5.2.1.

6.1.5 Management Action 4: 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 since a levee breach 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, would likely result in high floodwater velocities, leaving little 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 miles of levee along the left bank of the Sacramento River (NULE Segment 121, 0.8 miles, and a 0.13-mile portion of NULE Segment 127 downstream of Locke) was prioritized as Management Action 4. Management Action 4 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 Management Action 4 are described in Section 5.1.1.1. This management action 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.

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 miles 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 high NFIP insurance premiums. 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. As a result, securing 100-year FEMA certification for this levee system was prioritized as Management Action 5. 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.

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 failure along the entire left bank of the Sacramento River, along Delta Meadows Slough to the north, along Snodgrass Slough to the west, and along the former railroad embankment which extends from the south side of the Snodgrass Slough levee southwest towards the northwest entrance to the Delta Cross Channel. Improvements to these levee segments would protect lives and property within both the community of Locke and within RD 369. 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, helps to limit high NFIP insurance premiums, 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. 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. As a result, securing 100-year FEMA certification for this levee system was prioritized as Management Action 6. 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.

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

Management Action 7 combines the repairs and improvements associated with Management Action 4 (repairing and strengthening-in-place the 0.93 miles of SPFC levee along the left bank of the Sacramento River) with Management Action 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 Management Action 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 6.1.5 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 Management Action 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.

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 G.

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) – RD 369 and 554	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
Locke South Railroad Embankment – RD 554	LKSR R-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**

[1] Reach lengths rounded to the nearest 100 feet

6.2.1 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)

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 miles of NULE Segment 121 and 0.13 miles 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.

6.2.2 Repair and Strengthen-in-Place Delta Meadows Cross Slough Non-SPFC Levee East of Locke

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.

6.2.3 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

The range of cost estimates to repair and strengthen-in-place the 0.6-mile Snodgrass Slough levee and the most northerly 0.20 miles 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.

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

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. With an estimated length of 0.60 miles, 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

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 miles 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 6.2.1 through 0 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)

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 ft. 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 6.2.4 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 (Management Action 7)

The cost of Management Action 7 is the summation of costs associated with Management Action 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 Management Action 4. The estimated cost for Management Action 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 percent of item 1 above for remediations only south of Cross Levee; and 5 percent 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 percent of item 1 above for remediations only south of Cross Levee; and 5 percent 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 Management Actions 1 through 7 is 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	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 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
4: 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
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 Management Actions 1-4)	$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 Management Action 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 Potential Cross Levee	$38,414,000	$20,226,000	$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

Management Actions 1-7 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 management actions.

6.3.1 Planning Objectives

6.3.1.1 Reducing Risk to Life

A breach within the levee fronting the community could contain high instantaneous floodwater velocities and depths of imminent danger within the community that would most likely result in life loss in Locke. Management Actions 4, 5, 6, and 7 are the only management actions which fortify the levee fronting the community. As a result, these four management actions would result in the greatest measurable reduction in life loss. Management Action 1, which repairs and strengthens the Delta Meadows Cross Slough levee (portion of NULE Segment 1054 in RD 369), could also result in a measurable reduction in life loss. To the north of Locke, the western end of Delta Meadows Slough does not connect to the Sacramento River and is affected by backwater conditions. The Delta Meadows Cross Slough levee protects the community of Locke from this backwater flooding and from flooding when the adjacent slough to the southeast overtops its bank. Similarly, Management Action 3, which repairs and strengthens the Delta Meadows Slough levee (portion of NULE Segment 1040 in RD 551) could result in a measurable reduction in life loss. The Delta Meadows Slough levee protects the community of Locke from floodwaters originating in the adjacent RD 551 – Pearson District. Management Action 2, which repairs and strengthens the Snodgrass Slough levee (portion of NULE Segment 1054 extending southwest from the Meadows Cross Slough levee), results in the lowest reduction in life loss.

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. 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 management action meets the objective of reducing risk to property damage.

EAD placeholder, scheduled for completion December 2020/January 2021.

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 results in a moderate reduction in the probability of levee failure through the repair and improvement of the most westerly 0.60 miles of the Delta Meadows Slough levee (NULE Segment 1040). Repair of this portion of NULE Segment 1040 would likely eliminate the probability of an instantaneous levee failure since this levee segment is estimated to have a moderate likelihood of failure due to underseepage and slope stability vulnerabilities.

Management Action 4 strengthens and improves the SPFC levees along the left bank of the Sacramento River within the Locke study area, inclusive of the levee immediately fronting the community of Locke. Strengthening these levees would likely eliminate the potential of a levee failure, both immediately adjacent to the community and along the entirety of the levee segment. However, these levees are estimated to currently have a low probability of levee failure, and as a result, Management Action 4 results in a low reduction in the probability of levee failure.

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, Management Action 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, Management Action 6 results in the highest reduction in the probability of levee failure of all management actions 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 Management Actions 4 and 5.

6.3.1.4 Reduction of High Insurance Premiums

Those management actions which result in 100-year FEMA certification could result in a net reduction in NFIP insurance premiums. Management Actions 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 Management Actions 1-4 in concert with a community- or risk-based insurance program, could also result in a net reduction in flood insurance premiums for the community.

6.3.1.5 Improved Preparedness and Response

6.3.1.6 Enhancing Resiliency and Reliability of Through-Delta Water Conveyance

Management Actions 4, 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. Management Action 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. Management Actions 1-3 do not directly improve through-Delta water conveyance.

6.3.1.7 Environmental Stewardship and Multi-Benefits

Since the entire suite of management actions involve improvements to perimeter or internal levees in the study area, or the construction of a 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 adjacent to the communities of Locke and East Walnut Grove, and 3) SRA habitat creation or enhancement.

Under all management actions, 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, if improvements to the levee crowns facilitate a multi-use trail. 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 loop trail is most likely if Management Action 6 is implemented, since this is the only option that includes a cross levee, and a smaller loop trail would 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 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). This concept could also be combined with improvements proposed for the adjacent communities.

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), restoration of waterfront and downtown historic structures, development of a community garden in existing open space to the east of Locke, and development of additional commercial and overnight amenity uses, in areas that do not include historic structures.

6.3.2 Other Considerations

6.3.2.1 Agricultural Sustainability

Under Management Actions 2-5, 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 ft. to 135 ft. wide, 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 Management Actions 1-6 is summarized below in Table 6-5. Under Management Action 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 (Management Action 4) 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 Management Actions 2, 3, 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 management action. Implementing berms and a cross levee for Management Action 6 is estimated to result in the greatest displacement of permanent crops at nearly 55 acres. As shown in Table 6-6, these impacts are reduced when implementing cutoff walls for each of the proposed management actions.

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

Management Action	Estimated Displaced Agricultural Acreage: Remediation Alternative 1 (Cutoff Walls)	Estimated Displaced Agricultural Acreage: Remediation Alternative 2 (Berms)
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)	2	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	3	18
Management Action 3: Repair and Strengthen-in-Place Delta Meadows Slough Non-SPFC Levee North of Locke (portion of NULE Segment 1040 in RD 551)	2	19
Management Action 4: 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
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	7	17
Management Action 6: Secure 100-Year FEMA Certification for Entire RD 369 Perimeter Levee System	10	53
Management Action 7: Sacramento River Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke	12	22

6.3.2.2 Local Support

Those management actions which result in the least impacts to agricultural sustainability garner the most local support. Consequently, under Management Actions 1-7, 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.

6.3.2.3 Cost

Management Action 1 (repairing and strengthening the Delta Meadows Cross Slough levee) and Management Action 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 $10.4 million and $13.7 million, respectively. Management Action 4 (repairing and strengthening the SPFC levees fronting the community of Locke), Management Action 3 (repairing and strengthening the Delta Meadows Slough levee), and Management Action 5 (securing 100-year FEMA certification with a cross levee and perimeter levee improvements), are the next lowest cost solutions ranging between $14.5 million and $31.6 million. Management Action 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 $44.3 million The highest cost solution to reduce flood risk in the study area, with an estimated cost of $50-$76 million, is Management Action 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.

6.3.2.4 Cultural Resource Considerations

Under all of the management actions, 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 Management Actions 5 and 7, cultural resources could be affected by construction of the foundation of the cross levee.

6.3.2.5 Ecosystem Considerations

Under Management Actions 1, 2, 3 and 5, biological resources could be affected, since substantial existing riparian habitat exists on the Delta Meadows Slough and Snodgrass Slough levees. Implementation of Management Action 4 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 Management Actions 5 and 7, a small amount of open space would be affected by construction of the cross levee (up to 20 ft. wide) 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, inclusive of the subject 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 H.

Generally, all of the proposed management actions 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 management action 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 management action.

Historically, levee repairs can induce population growth and encourage development within the floodplain. Although levee repairs are proposed under all of the various management actions, 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 6-7 below.

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

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 *Pending NOV 2020 Public Mtg*	Multi-Benefit, Eco-System and Recreation Enhancements	Cost
	Reducing Risk to Life	Reducing Risk to Property Damage	Reduced Probability of Levee Failure						
1	High	High	Medium-High	No	2/3	No		High	High
2	Low	High	Medium-High	No	3/18	No		High	High
3	Low-Medium	High	Moderate	No	2/19	No		High	High
4	High	High	Low	No	3/13	Yes		Medium	High
5	High	High	High	Yes	7/17	Yes		High	High
6	High	High	Moderate	Yes	10/53	Yes		Low	High
7	High	High	High	Yes	12/22	Yes		High	High

7. Recommendations

Section 7 details the suite of management actions recommended for implementation. Stakeholder and public input on these management actions is 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-Related Management Actions

Of the seven management actions previously identified, Management Actions 1-4 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 Delta Meadows Slough Non-SPFC Levee North of Locke (portion of NULE Segment 1040 in RD 551)
- **Management Action 4**: 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 5: Secure 100-Year FEMA Certification, with Potential Cross Levee North of Locke Paired with Perimeter Levee Improvements is identified as an alternative to Management Actions 1-4.

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 Management Actions 1-5.

Management Action 7: Sacramento River Levee Improvements Paired with Securing 100-Year FEMA Certification for the Community of Locke is identified as an alternative to Management Actions 5 and 6.

Long-term management actions 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 (Management Action 6).

As previously discussed, repairing and improving the SPFC levee along the left, east bank of the Lower Sacramento River (identified in Management Actions 4-7) 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 Management Actions 4, 5, 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.

It is also recommended that any of the structural-related management actions 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 management actions 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 ft. and 25 ft. deep, and berms (stability or combination seepage and stability berms) ranging between 15 ft. wide and 65 ft. wide. Each remedial alternative is also paired with RSP ranging between 65 ft. wide and 100 ft. wide. Cutoff walls were selected as the recommended remedial alternative to repair and improve the northwesterly 0.3 miles of the Delta Meadows Cross Slough levee, with berms implemented for the remaining 0.3 miles. Conceptual cross sections for these remediations are provided in Section 5, Figure 5-1,

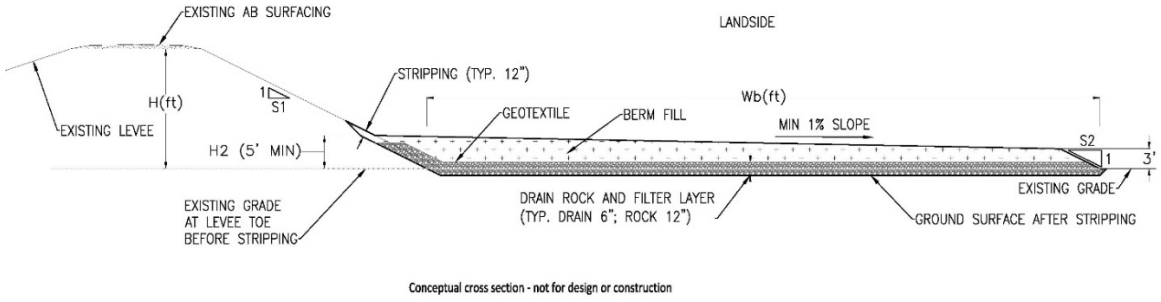

Figure 5-3, and Figure 5-5.

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 ft. deep cutoff wall or a 90 ft. wide, 9 ft. tall combination seepage and stability berm. Both remedial alternatives are paired with 110 ft. wide RSP for a

total of 500 ft. 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 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 include a 65 ft. deep cutoff wall or a 135 ft. wide, 15 ft. 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.

7.1.4 Management Action 4: 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 include cutoff walls ranging between 15 ft. and 75 ft. deep, and berms (stability or combination seepage and stability berms) ranging between 15 ft. wide and 65 ft. 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.

7.1.5 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 Management Actions 1-4.

7.2 Stakeholder and Public Input on Structural and Non-Structural Flood Risk Reduction Elements

The recommended suite of six management actions were informed by stakeholder and public feedback received following preparation of the draft feasibility study report in November 2020. Stakeholders and the public expressed support for repairing the weakest link in the perimeter levee system of the Locke study area (Management Action 1) and securing 100-year FEMA certification for the community of Locke with a potential cross levee (Management Actions 5 and 7). No formal input was provided for Management Actions 2-4 or Management Action 6.

7.3 Non-Structural Measures Recommended for Implementation

The following non-structural measures are recommended to be carried forward to reduce flood risks within the Locke study area:

- Vegetation removal and levee crown maintenance
- Improved governance between neighboring LMAs/RDs, and the community of Locke
- Voluntary structural elevation
- Wet or dry floodproofing
- Improved emergency response
- Alternatives to NFIP – community and flood-risk based insurance program
- Local hazard mitigation plan and relief cuts
- Public Education and Awareness
- Improve FEMA CRS
- NFIP flood insurance enhancements, risk-based insurance program, and potential enhancements via AFOTF
- Mokelumne River conveyance improvements and flood easements

All of the above non-structural measures recommended for implementation are described in detail in Section 5.2 and summarized in Appendix I. Acquisitions or relocations are not included in this recommended suite of non-structural measures as they are not a preferred flood risk reduction action for the historic community of Locke due to the residents' preferences and the historic nature of this particular Delta Legacy Community.

The recommended suite of 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 7-1. Associated recommendations and costs, as applicable, are summarized below.

Table 7-1. Recommended Timeline for Implementation of Other Non-Structural Measures.

Non-Structural Measure	Ongoing	Recommended: Near Term	Recommended: Long Term
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
Improved Emergency Response	X	X	X
Alternatives to NFIP – Community and Flood-Risk Based Insurance Program		X	X
Local Hazard Mitigation Plan, and potential Relief Cut into Snodgrass Slough		X	X
Public Education and Awareness	X	X	X
Improve FEMA CRS	X	X	
NFIP Flood Insurance Enhancements, Risk-Based Insurance Program, and Potential Enhancements via AFOTF		X	X
Mokelumne River Conveyance Improvements/Flood Easements			X

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

Placeholder

7.3.2 Improved Governance between Neighboring LMAs/RDs and Community

Placeholder

7.3.3 Voluntary Structural Elevation

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 89 structures in the Locke study area, inclusive of the portion of RD 554 located north of the Delta Cross Channel. The 2014 RFMP identified a cost of nearly $9 million in 2011 dollars for raising all of the reported structures in the Locke study area by one story at $100,000 per structure, as documented in the 2012 CVFPP. Per the County of Sacramento, this per-structure cost could be as high as $170,000 to raise a structure 8 to 10 ft. within the Locke study area. Using this per-structure cost, raising all 89 structures within the populated community of Locke would cost an estimated $15.1 million. This cost is considered an upper limit excluding multi-benefit considerations (such as through Delta water conveyance or other attributes) of what the state would potentially consider funding to implement levee system improvements in the study area. 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 solution would need to be voluntary for residential structures as expressed during public outreach meetings. This element is recommended for implementation, on a case-by-case basis, in the long term for only areas located outside the historic district of Locke.

7.3.4 Wet or Dry Floodproofing

7.3.5 Improved Emergency Response

RD 369 is currently utilizing the DWR Delta Flood Emergency Response Grant Round 2 funding to update its Delta Flood ESP. RD 3 is the grantee within the funding agreement which covers plan updates for several other RDs in Sacramento County, including RD 369.

The intent is for the ESP to be consistent with AB 156, FEMA's Comprehensive Preparedness Guide 101, and regional formatting standards. This includes the development of supporting annexes, namely a flood-specific annex that details the RDs' field response operations. The written flood annex will be transferred to a Flood Contingency Map annex that is quick to access and easy to interpret during an emergency.

The ESP will also be reviewed for consistency with SEMS and National Incident Management System standards such as appointing an incident commander, assigning specific response actions to objective conditions, and emergency spending authorities. The Emergency Operation Plan's (EOP) format will also be updated to be consistent with regional standards (San Joaquin, Yolo, and Solano County Flood ESPs).

Additional district specific enhancement will include: identifying the gauges listed in the already-developed EOPs that need datum conversions to NAVD 88 (in order to meet grant requirements); identifying any other critical infrastructure and elevations (pump stations, etc.); and evaluating the feasibility of a relief cut(s) where appropriate, with a brief technical memorandum summarizing the conditions in which a relief cut may be a feasible option (see Section 7.3.7 below for more information).

Coordination on the plan update began in September 2020 and the final plan update is scheduled for completion February 2021.

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

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

Refer to section 5.2.7 and Appendix K

7.3.7 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 is 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, inclusive of RDs 369 and 554, and to establish updated goals and prioritize projects to reduce these impacts on people and property within RDs 369 and 554. It is recommended that Sacramento County continue to update the LHMP every 5-years.

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 ft. 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 ft. over the entirety of the RD, while waiting for

the lower, downstream levee reach to overtop. The RD personnel will determine if a relief cut will be necessary should flooding occur; however, in most cases there is no written description nor agreement for a planned relief cut. Potential relief cut locations should be identified and further evaluated 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 (R D 554, RD 563, and others) as there may be coinciding high stage conditions within the Snodgrass Slough, Cosumnes River, and Mokelumne River basins.

7.3.8 Public Education and Awareness

Sacramento County conducts annual outreach efforts aimed at informing the public of flood hazards and risk mitigation strategies. Sacramento County and other communities that participate in the NFIP CRS receive credit points for developing and implementing a PPI. Sacramento County established such a program in 2015 and has produced Annual Evaluation Reports each subsequent year in which the PPI Committee monitors, evaluates, and revises (as needed) established outreach goals.

Currently, outreach topics in the Sacramento County PPI include both mandatory and community specific topics related to understanding, insuring, and taking responsibility for flood hazard.

Placeholder. **Should also include/reference the CVFPB and DPC annual notifications**

7.3.9 Improve FEMA Community Rating System

7.3.10 NFIP Flood Insurance Enhancements, Risk-Based Insurance Program, and Potential Enhancements via AFOTF

7.4 Right-of-Way and Easements

Seepage and stability berms will require additional land (mimic discussion from previous section)

Landowners along the study area levees actually own land up to OHWM. State has an easement to maintain and improve levees.

7.5 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.

LMA activities are guided, in part, by O&M manuals developed by the USACE in the mid-1950s and associated hydraulic design criteria. The original project assurances provided to the federal government in the 1950s make no mention of repair, rehabilitation, and replacement (RR&R). The term was first introduced in the Water Resources Development Act of 1986. Responsibility for the RR&R of SPFC facilities is not widely agreed upon across agencies. As the responsibility for portions of OMRR&R has shifted, funding issues have become more pronounced, requiring additional interpretation of SPFC assurance agreements, O&M manuals, and governing codes and regulations. Accordingly, interpretations of responsibility and necessary funding can differ.

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 84-994 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 investment in levees, 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.

Placeholder for subventions claims.

7.6 Regulatory Requirements

Environmental requirements associated with implementation of the preferred management action 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 management action 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 the 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.

The Districts 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. The 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.

As described previously, a total of 13 resources were identified during the records search and from information provided by the County of Sacramento. 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 town of Locke, and therefore near to elements of the proposed management actions, including remediation of levees along the Sacramento River and the cross levee north of Locke. Further evaluation of these 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.

7.7 Financial Feasibility

Local funding ability for construction and O&M. Cost share partners

GHAD or HOA-type assessment?

8. Implementation of Recommendations

Discuss next steps to implement recommended alternative, expected level of protection, and next steps to continue non-structural measures, i.e. community-based flood insurance.

8.1 Implementation Schedule

8.2 Roles and Responsibilities

8.3 Project Finance Plan

- *Capital costs*
- *Costs of O&M*
- *Costs of acquiring lands, ROW, and easements*
- *Cost of project development and permitting*

8.4 Additional Studies, Reports, Permits, Approvals

Integration with other state agencies, regional plans and delta-centric programs/plans

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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 Small Communities Flood Risk Reduction Feasibility Studies

Appendix E: Geotechnical Assessment Report – Delta Small Communities Flood Risk Reduction Program – Community of Locke

Included with Appendix A

Appendix F: Expected Annual Damages Technical Memorandum for the Delta Legacy Community of Locke

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

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

Appendix I: 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 J: 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 K: Community-Based Flood Insurance Program Technical Memorandum