Community of Yolo

Small Community Flood Risk Reduction Feasibility Study

DRAFT

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Table of Contents

Figures

Tables

List of Appendices

Acronyms and Abbreviations

AEP	Annual Exceedance Probability
AFOTF	Agricultural Floodplain Ordinance Task Force
ASFPM	Association of State Flood Plain Managers
BFE	Base Flood Elevation
BWFS	Basin Wide Feasibility Studies
CCAP	Cache Creek Area Plan
CCRMP	Cache Creek Resources Management Plan
CCSB	Cache Creek Settling Basin
CDIAC	California Debt and Investment Advisory Commission
CEQA	California Environmental Quality Act
CFR	Code of Federal Regulation
CFS	cubic feet per second
CR	County Road
CRS	Community Rating System
CRHR	California Register of Historical Resources
cT	credit score(per the Community Rating System)
CVFED	Central Valley Floodplain Evaluation and Delineation
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
CVHS	Central Valley Hydrology Study
DAC	Disadvantaged Community
DWR	California Department of Water Resources
FEMA	Federal Emergency Management Agency
FIRM	Floodplain Insurance Rate Maps
FIRO	Forecast-Informed Reservoir Operations
FIROP	Forecast-Informed Reservoir Operations Plan
FIS	Flood Insurance Study
FSRP	Flood System Repair Program
GAR	Geotechnical Assessment Report
GPM	gallons per minute
HCP	Habitat Conservation Plan

LCCFS	Lower Cache Creek Feasibility Study
LF	linear feet
LiDAR	Light Detection and Ranging
LMAs	Local Maintaining Agencies
LOI	Letter of Intent
LSDN	Lower Sacramento/Delta North
NFIP	National Flood Insurance Program
NLD	National Levee Database
NULE	Non-Urban Levee Elevation
OCMP	Off-Channel Mining Plan
RD	Reclamation District
RFMP	Regional Flood Management Plans
RSP	Rock Slope Protection
SCFRR	Small Community Flood Risk Reduction
SFHAs	Special Food Hazard Areas
SPFC	State Plan of Flood Control
SPRR	Southern Pacific Railroad
SWIF	System Wide Improvement Framework
TCRs	Tribal Cultural Resources
ULE	Urban Levee Elevation
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WSE	Water Surface Elevation
YCFC&WCD	Yolo County Flood Control and Water Conservation District

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Executive Summary

The community of Yolo (formerly knowns as Cacheville) is on a high ground located adjacent to the left bank of the Cache Creek levee directly downstream of where Interstate-5 crosses Cache Creek, approximately 5 miles northwest of Woodland, California. The Cache Creek levees were improved by the United States Army Corps of Engineers (USACE) in 1958 for a target flow of 30,000 cubic feet per second (cfs) with 3-feet of freeboard, which corresponds to a 10-percent annual chance flood. The flood protection system levees on Cache Creek adjacent to Yolo were initially designed in anticipation of the Wilson Valley Dam and Reservoir being constructed upstream, but due to seismic concerns and a subsequent Wild and Scenic designation for Upper Cache creek the flood control regulation reservoir was never constructed. Due to the lower design flow, the 100-year peak flow of 63,680 cfs can over top the Cache Creek banks and limited sections of levees both upstream and downstream of the community of Yolo. As a result, the community of Yolo hasn't experienced flooding yet.

In 2017, Yolo County received a grant from the California Department of Water Resources (DWR) Small Community Flood Risk Reduction (SCFRR) Program to conduct a feasibility study with the purpose of reducing flood risks to the community of Yolo. The scope of this study is to identify structural and non-structural flood risk reduction actions and multi-benefit opportunities, and compare implementation costs and schedules, to identify a preferred alternative that will reduce the flood risk to Yolo along with identifying local funding requirements while sustaining adjoining agriculture and the regional economy. The study goal is to achieve a 100-year level of flood protection and remove Yolo from the Federal Emergency Management Agency (FEMA) 100-year floodplain through potential repairs and improvements to the levee system, and if necessary, the adjoining highway embankments immediately west of the community. Section 3 provides planning goals and objectives in detail.

To address the study goals, six structural alternatives were formulated and evaluated:

- Alternative 1 – Sediment Removal/Dredging
- Alternative 2 – Setback Levees
- Alternative 3 – Flood Control Storage Reservoir
- Alternative 4 – Restore Left Bank Levee of Cache Creek to USACE 1957 Design Profile
- Alternative 5 – Levee Improvements for Left Bank of Cache Creek to Pass 100-year Flow
- Alternative 6 – Restore Left Bank Levee of Cache Creek to USACE 1957 Design Profile and Levee Improvements to Pass 100-year Flow

Chapter 4 describes in detail six structural alternatives along with preliminary screening, final screening, and the selection of the Preferred Alternative. Alternatives 1, 2, and 3 were screened out preliminarily because the hydraulic benefit was either insignificant or cost prohibitive and the impacts to agricultural sustainability were considered substantial.

Alternative 4 was eliminated, even though it provides adequate freeboard to pass the 100-year flow, as it does not include levee improvements to fix the existing levee structural deficiencies. Alternatives 5 and 6 not only provide adequate freeboard to pass the 100-year flow, but they also include levee improvements to address existing levee deficiencies. Alternative 6 provides adequate freeboard for USACE 1957 Design Profile which is higher than the 100-year water surface elevation (WSE). Per California Water Code 8361, on behalf of the State, DWR is required to maintain and operate certain portions of the Sacramento River Flood Control Project. As Alternative 6 provides 100-year level of protection to the community of Yolo, which is the primary objective of this study, and also meets the California Water Code 8361 requirement, it was selected as the Preferred Structural Alternative.

The Preferred Structural Alternative, Alternative 6 – "Restore Left Bank of Cache Creek to USACE Design Profile and Levee Improvements to Pass 100-year Flow" – includes 0 to 4 feet of levee raise above its current height near the community of Yolo and the levee widening at the base by as much as 10 to 15 feet in certain locations, particularly along the downstream easterly portion of the levee system. In addition to the levee raise, these levees protecting the community of Yolo would have improvements to address underseepage, through seepage, and erosion.

Chapter 5 provides a detailed description of the several non-structural solutions that were evaluated for their potential to reduce residual flood risk and can be implemented independent of, or in combination with, the structural improvements. The following non-structural solutions have been identified and are highly recommended for implementation, some of which are already in the early stages of implementation:

- Voluntary flood proofing
- Improve NFIP Community Rating System (CRS) for Yolo County/community of Yolo
- Mapping of flood depths, timing, duration, and evacuation maps for community of Yolo
- Base Flood Elevation (BFE) Study to Share with Community of Yolo and FEMA
- Forecast-Informed Reservoir Operations (FIRO) for Indian Valley reservoir releases
- Consolidation between, Yolo County at Huffs Corner and DWR for OMRR&R and improvements to Cache Creek SPFC levee system

In addition to these structural and non-structural measures, the feasibility study team identified several multiple-benefit concepts to include habitat enhancement, water supply improvements, and recreation. **Chapter 6** provides a detailed description of the four habitat restoration concepts with the highest potential to be implementable in connection with the flood risk reduction structural alternatives identified in this study. These four concepts include the Cache Creek Non-Native Species Control Concept, the Working Waterways Projects Implementation Concept, the

Cache Creek Gravel Pit Restoration Concept, and the Cache Creek Gravel Pit Recharge Basin Concept.

This feasibility study also evaluated recreational opportunities and identified the Cache Creek Parkway Plan as a long-term vision for recreational opportunities to optimize the recreational benefits for the town of Yolo. It is recommended that any flood system planning, or design improvements proposed within Yolo also consider the integration of the multi-benefit recreational opportunities identified in the Cache Creek Parkway Plan, particularly those east of County Road 94B near the town of Yolo along with Class II bike path improvements between Yolo and Woodland. The feasibility study also identified water supply infrastructure improvements to the existing water supply wells that can be potentially implemented in the community in conjunction with flood risk reduction measures that are explained in detail in **Chapter 6**.

The total cost for the preferred structural levee improvements is estimated to be approximately $16.7 million. Since the elements of the preferred alternative include all the elements for 'Restore Left Bank Levee of Cache Creek to USACE 1957 Design Profile,' which is primarily the State's responsibility per California Water Code 8362, the study indicates that the State should pay for approximately $8.7 million. The remaining $8 million could be potentially cost-shared by the State, Yolo County, the community, and other available funding sources. The Study suggests that the preferred alternative could be implemented in phases – repairing all known levee performance deficiencies immediately adjacent to the community followed by raising the levee for adequate freeboard. Section 7 describes in detail the implementation of the preferred structural alternative along with additional non-structural management actions required for levee accreditation and other recommendations for implementation.

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1 Introduction

1.1 Background

Yolo County received a grant from the California Department of Water Resources (DWR) Small Community Flood Risk Reduction (SCFRRP) Program to complete a feasibility study of structural and non-structural actions that can reduce flood risk to the town of Yolo. This report meets the State of California's feasibility study process, documents the planning process to identify and evaluate an array of alternatives for flood risk reduction, identifies multiple objective alternatives, and recommends a flood risk reduction plan for the town of Yolo.

The town of Yolo's original name – "Cochran's Crossing" – was given to honor the founder, Thomas Cochran, who is thought to have arrived there around 1849. He built a hotel for those travelling along the west side of the Sacramento River, which grew popular enough to attract a Yolo Post Office in 1853. Over the next decade, parts of this land were sold and re-sold to various businessmen, eventually earning it the name of "Hutton's Ranch" after one of its owners, who also called it "Travelers' Home" in honor of the hotel which brought the community into being. Later it was named "Cacheville" to emphasize its position along Cache Creek, before finally adopting its current name of "Yolo," from the Patwin "yoloy" meaning a place abundant with rushes.

According to a 2010 census, the population of Yolo is 450 residents[1], which has remained fairly steady, with an estimated 453 residents in 2000, constituting a 0.66% decrease[2]. In 2010, the median household income in the community was less than $46,166. As this median household income is less than 80% of the California median income, the town of Yolo is designated as a "disadvantaged community" (DAC).

1.2 Purpose and Scope

The purpose of this report is to identify preferred structural, non-structural, and multi-benefit alternatives; compare implementation costs and schedules; and identify local funding requirements to assess options which will reduce the flood risk to Yolo while sustaining agriculture and the regional economy. Opportunities to provide recreational or ecosystem benefits are also included in the scope.

[1] https://www.census.gov/2010census/popmap/ipmtext.php?fl=06:0686804
[2] http://censusviewer.com/city/CA/Yolo

1.3 Location and Project Study Area

Town of Yolo is located approximately 5 miles northwest of the City of Woodland, California, along CR 99W and the Union Pacific Railroad, south of CR 17 and Washington Street, west of Cache Creek and CR 98, and north of CR 97B and Interstate-5. Specifically, the town of Yolo is on a high ground adjacent to the left bank of the Cache Creek levee directly downstream of where Interstate-5 crosses Cache Creek as shown in Figure 1. The study area for this flood risk reduction study includes the left bank Cache Creek levees maintained by DWR adjoining the community of Yolo, and a small reach of levee on the right bank of Cache Creek extending from Interstate-5 upstream approximately 0.59 miles to high ground. Even though the study area encompasses a large area outside the community of Yolo, this study focused primarily on the flood risk reduction efforts for the community of Yolo.

1.4 Related Plans, Programs, Studies and Projects

1.4.1 Central Valley Flood Protection Plan

The Central Valley Flood Protection Plan (CVFPP) is California's strategic blueprint to improve flood risk management in the Central Valley. The CVFPP includes a program to reduce flood risk in existing small communities (with populations less than 10,000 protected by State Plan of Flood Control (SPFC) levees), where feasible, and at a level of investment to preserve development opportunities without providing an urban level of flood protection. Additional State investment in small-community flood protection would be prioritized based on relative community flood-threat, considering factors such as population, the likelihood of flooding, proximity to the flooding source, and depth of flooding. Financial feasibility and achievement of the program objectives to promote multiple benefits would also be considered.

The CVFPP identifies several structural and non-structural actions that the State would consider implementing to protect small communities, including:

- Protecting small communities in-place using ring levees, training levees, cut-off levees, or floodwalls when improvements do not exceed a certain predetermined cost threshold identified in the CVFPP and supporting Basin Wide Feasibility Studies (BWFS).
- Reconstructing or making improvements to existing SPFC levees providing protection to the basin(s) where small communities remain at risk to flooding.
- Implementing non-structural improvements, such as raising or elevating structures, flood proofing, land or easement purchases, relocating structures, or some combination of these when the in-place improvements described are not feasible.

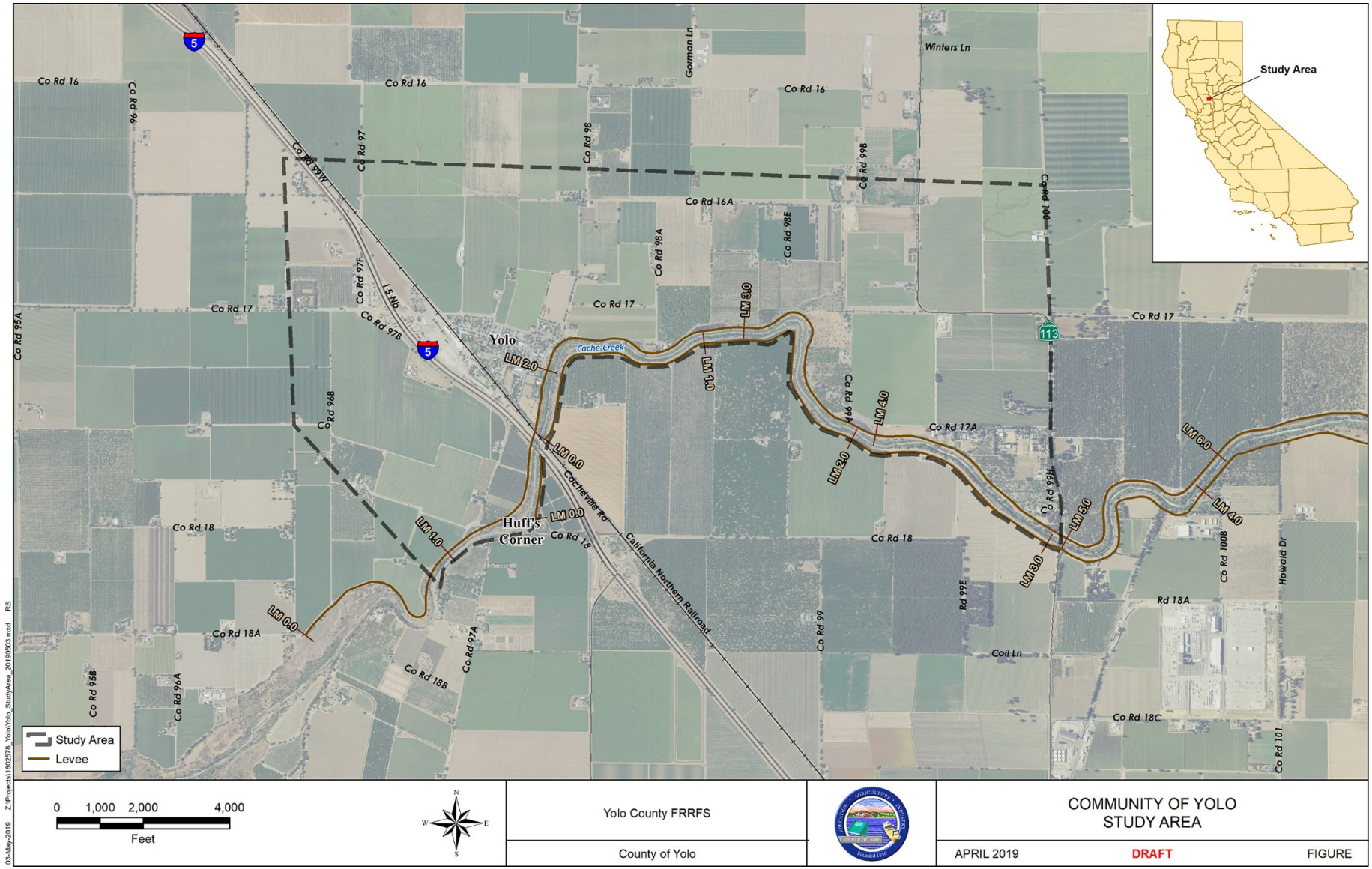

Figure 1: Community of Yolo Study Area

Small-community flood protection is also included in the 2017 CVFPP Update (DWR, 2016a). Specific actions contemplated in the CVFPP have been refined to reflect updates from the BWFS and Regional Flood Management Plans (RFMP). The CVFPP Conservation Strategy supports integrated flood system planning and the development of the 2012 CVFPP and 2017 Update, and the formulation of multi-benefit project concepts articulated in the Sacramento and San Joaquin BWFS.

1.4.2 Lower Sacramento/Delta North RFMP

RFMPs, called for by the 2012 CVFPP, discuss flood management problems in specific regions within the Central Valley. Flood risks and management strategies for the community of Yolo are evaluated in the Lower Sacramento/Delta North (LSDN) RFMP. The LSDN RFMP recommended a feasibility study that evaluates structure raises and fix-in-place levees.

1.4.3 FEMA Flood Insurance Study for Yolo County, 2012

The current Federal Emergency Management Agency (FEMA) Flood Insurance Study (FIS) for Yolo County is dated May 16, 2012 (FEMA, 2012). The countywide FIS investigates the severity of flood hazards for Yolo County and maps areas within the 1-percent annual chance floodplain. The FIS uses a flow of 63,680 cfs for Cache Creek at CR 94B for the1-percent annual chance event. Regarding the Cache Creek levees, the FIS states:

> "The restudy of Cache Creek in the City of Woodland indicates that there are no existing local flood-protection measures or structures to reduce flood hazards within the restudied reach of Cache Creek in Yolo County and the City of Woodland. The existing Cache Creek levees are not in compliance with the requirements set forth in the National Flood Insurance Program (NFIP) regulations for protecting against the 1-percent annual chance flood."

1.4.4 Lower Cache Creek Feasibility Study

The City of Woodland and the Central Valley Flood Protection Board (CVFPB) are the non-Federal sponsors for the U.S. Army Corps of Engineers (USACE) Lower Cache Creek Feasibility Study (LCCFS). The purpose of the USACE LCCFS is to identify potential alternatives that could reduce flood risk to lands adjacent to Cache Creek, specifically on the right side of the stream where floodwaters flow towards the City of Woodland. The studys is evaluating the federal interest in authorizing a project to reduce the risk of flooding and resulting damages along Lower Cache Creek in the Woodland area. The LCCFS proposes to implement structural and flood protection measures to protect the City of Woodland. The proposed structures are offset from the right overbank of Cache Creek, near the City of Woodland. These proposed floodplain structures do not alter the Cache Creek levees or impact the flow leaving the Cache Creek levees.

1.4.5 Cache Creek Levee Improvement Project

The System Wide Improvement Framework (SWIF) for Cache Creek Reclamation District (RD) 2035 Willow Bypass Levee System identifies that the levees along the south bank of Cache Creek have approximately 32,000 linear feet (LF) of settlement deficiencies. According to the 2013 periodic inspection, the levee crown is up to five feet lower than the original design crest elevation in some places. DWR has identified the Cache Creek Levee Improvement Project as a capital investment project needed to restore the original elevation. DWR is conducting a study that will be completed in June to inform the design and cost of this project.

The purpose of a Levee SWIF – established in 2011 – is to address levee deficiencies identified by USACE. Segment 41 is 61,700 feet long (11.69 miles), maintained by DWR, and part of System 412.

The Cache Creek is comprised of two levee systems. The right bank is within the Cache Creek-RD2035-Willow Bypass system. The left bank is within the Cache Creek U1-Yolo Bypass U2 – Knights Landing U1 system. The CVFPB is the non-federal sponsor for both systems. On November 25, 2015, the CVFPB submitted a Letter of Intent (LOI) to the USACE announcing that the local Levee Maintaining Agencies (LMAs) intend to develop and implement a SWIF plan for the Cache Creek – RD 2035 – Willow Bypass system to regain eligibility in the PL 84-99 Program. The LOI to develop a SWIF was approved by USACE on August 4, 2016.

The right (south) bank of Cache Creek between CR 18 and Interstate-5 is maintained by Yolo County Public Works and both the right and left banks of Cache Creek between Interstate-5 and Yolo Bypass is maintained by DWR. DWR is taking the lead in preparing a LOI for the Cache Creek U1 – Yolo Bypass U2 – Knights Landing U1 system which the CVFPB will submit to the USACE by the end of 2019.

1.4.6 Agricultural Floodplain Ordinance Task Force

In 2014, FEMA officials and the Governmental Accountability Office encouraged exploration of ideas to address sustainability of modern agriculture in deep floodplains. The Agricultural Floodplain Ordinance Task Force (AFOTF) was formed in late 2015, using RFMP grant funding from DWR, to explore ideas that could be implemented administratively by FEMA without changing law or regulation for improving sustainability of agriculture in leveed Special Flood Hazard Areas (SFHAs). The Task Force is comprised of officials from FEMA, DWR, CVFPB, RDs, levee districts, flood control agencies, counties, engineers, farmers, and non-governmental organizations (including various farm bureaus, the Association of State Flood Plain Managers (ASFPM), the National Association of Flood and Stormwater Management Agencies, and American Rivers).

1.4.7 The Yolo Habitat Conservation Plan/ Natural Community Conservation Plan (2018)

The Yolo County Habitat Conservation Plan (HCP) (ICF 2018) is a comprehensive, county-wide plan that identifies 12 sensitive species and the natural communities and agricultural land they

use as habitat. The HCP provides a streamlined permitting process to address any potential effects to these sensitive species. As the entire project area is within Yolo County, it falls under the guidance of this document.

1.4.8 Cache Creek Area Plan

The Cache Creek Area Plan (CCAP) is a rivershed management plan adopted by Yolo County in 1996 for 14.5 miles of Lower Cache Creek, between the Capay dam and the town of Yolo. The CCAP was adopted as a "specific plan" pursuant to Section 65450 et seq of the State Government Code. It was adopted as a part of the County's General Plan and as a result, changes to the CCAP are regulated as general plan amendments. The CCAP consists of two distinct complementary plans governing different areas of the overall plan area: the Cache Creek Resources Management Plan (CCRMP) and the Off-Channel Mining Plan (OCMP). The revisions to the CCAP included edits that ensure consistency with the HCP/ Natural Community Conservation Plan (NCCP).

1.4.9 DWR Non-Urban Levee Evaluation Geotechnical Assessment Report (GAR)

DWR's Levee Evaluation Program was initiated in 2006 and concluded in spring 2015. The Levee Evaluation Program was divided into two projects, the Urban Levee Evaluation (ULE) Project and the Non-Urban Levee Evaluation (NULE) Project, which were further divided into multiple study areas. These two projects have completed an unprecedented geotechnical evaluation of over 1,900 miles of levees. NULE has evaluated approximately 1,220 miles of SPFC levees and approximately 280 miles of appurtenant non-SPFC levees in the Central Valley in areas with populations of less than 10,000. NULE was performed in two phases. For all NULE levees, DWR has conducted extensive historic data collection and performed preliminary geotechnical evaluations using existing data. This phase was reported by major river basin with separate reports prepared for the Sacramento River Basin and for the San Joaquin River Basin. For NULE levees protecting populations greater than 1,000, DWR conducted a second phase of evaluations. These evaluations included physical explorations and geotechnical analyses and reporting for approximately 270 miles.

1.4.10 Cache Creek Environment Restoration Recon Report (1995)

The purpose of this study was to examine options for environmental restoration along the Cache Creek riparian corridor to improve habitat for fish and wildlife. The results of this reconnaissance study indicate that there is a Federal interest in cost-shared feasibility studies for environmental restoration on Cache Creek. Three alternatives were identified for future study:

Alternative 1 included the following:

- Rehabilitation of the abandoned gravel pits into wildlife habitat
- Acquisition of land along the creek to preserve the riparian corridor
- Revegetation of bank slopes and areas cleared of nonnative plants

- Construction of a low-flow meandering stream to restore fish and wildlife habitat

Alternative 3 included the features of Alternative 1 plus a setback levee plan to provide 100-year flood protection to the City of Woodland and town of Yolo.

Alternative 4, a multi-objective corridor management plan, included the features of Alternatives 2 and 3, plus long-term restoration measures including control of nonnative plant species and acquisition and development of water supplies to establish a perennial stream.

1.4.11 Sacramento Bank Protection Project

In 2006, USACE identified 24 sites referred to as "2006 Critical Erosion Repairs" on the Sacramento River and its tributaries. These sites included Cache Creek left bank (North) at levee mile 3.9 and 4.2 that required immediate remediation to prevent levee failure. DWR, as part of the Sacramento River Bank Protection Project, constructed setback levees at each of these erosion sites to improve flood protection, also known as Cache Creek North Levee Setback Project. The setback levee at levee mile 3.9 was approximately 215 feet north of the existing levee and was approximately 1,259 feet in length. The setback levee at levee mile 4.2 was approximately 90 feet north of the existing levee and would be approximately 670 feet in length.

1.4.12 Huff's Corner Improvement Project

Huff's Corner is a small reach of levee on the right bank of Cache Creek (Figure 1) extending upstream approximately 0.59 miles from Interstate-5 to high ground. The levee was reconstructed by USACE in 1960 and has a 20-foot crown. Yolo County is the local agency responsible for operation and maintenance of this reach as documented in the assurance agreement dated 29 July 1960.

In 2012, Yolo County sent a letter to the CVFPB stating they no longer desire to maintain the project. The state determined that a Maintenance Area would be needed and began the process to form one, once levee is brought up into compliance.

Yolo County and DWR have entered into a Flood System Repair Program (FSRP) agreement for the design to repair the levee to correct the freeboard deficiency, realign the channel to address erosion, and remove sedimentation and vegetation to allow the flows to more efficiently flow downstream.

1.5 Stakeholder Engagement

Stakeholders played a significant role in this Feasibility Study. The following agencies and stakeholders participated and were involved throughout the study.

- DWR Sacramento Maintenance Yard,
- Community members of Yolo,
- Land owners adjacent to Yolo,
- Yolo County Board of Supervisors

- Yolo County Department of Emergency Services

Representatives from the DWR Sacramento Maintenance Yard participated in several team meetings. There were two high-water events along Cache Creek during the course of the study and the team engaged with Yolo County Emergency Services, DWR, the local fire department and the Board of Supervisors in post flood fight discussions and presentations. Yolo County hosted two public meetings over the course of the study to educate the public about the study efforts and to garner input on the recommendations.

On December 10th, 2018, Yolo County hosted a public open house at the Yolo Library to solicit input on known flooding issues and concerns and the community's interest in other multi-benefit opportunities such as recreation or habitat enhancement in the area. DWR Sacramento Maintenance Yard was there to discuss and answer any questions about the maintenance of the levees at and across the community of Yolo.

Yolo County provided an update on the county's emergency response planning and planned maintenance action at Huff's Corner. The study team provided a summary of the CVFPP and the resulting Small Community grant. The discussion provided an overview of the scope and schedule and discussed the basis of the team's findings to date. Specifically, the history of the FEMA floodplain mapping for the community and current flood risks were discussed.

- There is no history of flooding in the community of Yolo. There was an emergency evacuation in the 1990's but there was no flood risk; it was based on a faulty gage. There was some ponding between the rail road track and Interstate-5 one time but have not seen this since the culverts and improvements were made at the Interstate-5 and railroad bridges.
- Residents recalled playing in the channel when they were young (about 40-50 years ago) and noted that now the channel is overgrown and very incised.
- Residents upstream of the community of Yolo described times when the banks overflowed and flooded their lands. They asked why the study area does not include them.
- Residents upstream and in the community of Yolo cited that in the past, the channel was routinely dredged.
- Residents across from the community of Yolo asked how this project is connected to the feasibility study for Woodland [DWR/USACE Lower Cache Creek Study]
- Residents expressed concern about the cost (approximately $10,000) and lengthy process to receive a building permit from the County to determine the flood depth in the area.

On April 3rd, 2019, Yolo County hosted a meeting at the Yolo Fire Department. The community was supportive of the recommendations and concerned about how the past two high water events reacted.

On April 7th,2019 County staff and the flood team presented to the Board of Supervisors, they were supportive of the recommendations.

2 Problems, Opportunities, and Constraints

2.1 Existing Conditions

2.1.1 Hydrology and Hydraulics

Cache Creek drains from west to east, starting near Clear Lake and terminating at CCSB The Cache Creek Setting Basin is bounded by levees on all sides and flows into the Yolo Bypass by means of an outlet weir. The purpose of the basin is to preserve the capacity of the Yolo Bypass by entrapping sediment from Cache Creek. The Cache Creek levees were constructed in 1958 (USACE, 1958) with the anticipation of Wilson Valley Dam and Reservoir being constructed for flood control upstream shortly after the levees were completed. The Wilson Valley Dam and Reservoir project was never constructed due to seismic concerns.

Based on the proposed reservoir construction, the design of the levees was minimized for a targeted flow of 30,000 cfs with 3-feet of freeboard. This design flow corresponds to a 10-percent annual chance flood. Over time, subsidence of the levee system has reduced the capacity of the channel, and subsequently the amount of freeboard available for passing the 10-percent annual chance flood (LCCFS, 2015). As a result, Cache Creek cannot pass USACE 1957 Design Flow of 30,000 cfs with 3-feet of freeboard at several locations including the portion of the channel adjacent to the community of Yolo.

The estimated 100-year peak flow of 63,680 cfs would overtop levees and natural high ground at several locations upstream off the community of Yolo. Because of this upstream overtopping, community of Yolo hasn't experienced flooding yet.

2.1.1.1 *Lower Cache Creek Feasibility Study*

The most extensive and the current modeling of the Cache Creek is by the USACE in support of the LCCFS. The LCCFS routing determined that the nominal capacity of Cache Creek upstream of Highway 113 is approximately 34,500 cfs. Flows exceeding this capacity spill out of the channel banks, over the top of levees and natural high ground. However, there are two high water events in February 2019, nearly overtopping the levees, suggesting that the consequence of flooding is greater at lower stages. These events are described later and have resulted in DWR preparing a study to inform this changed existing condition. The LCCFS determined the maximum water surface for storms equal to or greater than the 50-year event are the same downstream of Interstate-5.

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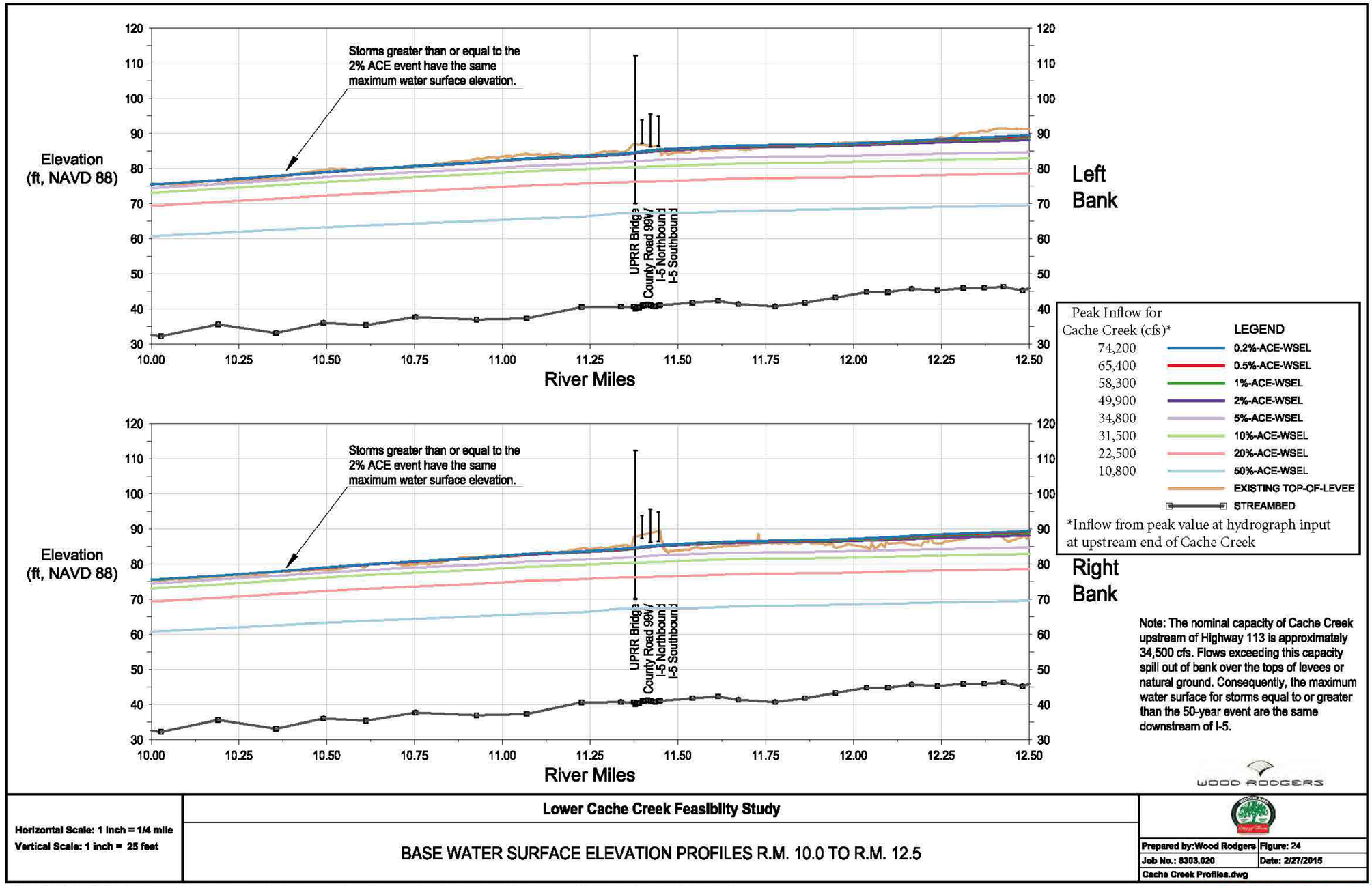

Figure 2: WSE profiles for Cache Creek (LCCFS, 2015)

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2.1.1.2 *Current FEMA Floodplain*

The current FEMA FIS for Yolo County is dated May 16, 2012 (FEMA 2012). The current FIS maps the floodplain for the 1-percent annual chance floodplain on the Floodplain Insurance Rate Maps (FIRM) for Yolo County. The community of Yolo is shown as mapped in Zone A (Figure 7). FEMA defines Zone A as "the flood insurance rate zone that corresponds to the 1-percent annual chance floodplains that are determined in the FIS by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone." Though there is not a detailed study to provide BFE, the non-compliance of the Cache Creek levees leads to the Zone A determination. Figure 3 shows the FEMA flood map for Yolo County near the community of Yolo.

Figure 3: FEMA 2012 flood map for Yolo County near community of Yolo

2.1.2 Topography and Levees

The levee elevations near the community of Yolo range from about 75 to 80 feet above mean sea level, and topography of the land surrounding the levee is flat with the exception of the bed of Cache Creek itself, which is estimated to be 40 feet below the level of those adjacent lands. The community is at an elevation between 75 and 82 feet and receives an average annual precipitation of 21 inches[3]. Figure 4 shows the elevations in the community of Yolo and surrounding areas based on Light Detection and Ranging (LiDAR) elevation from Central Valley Floodplain Evaluation and Delineation (CVFED) Program.

The study area includes the levees maintained by DWR known as Segment 41, and a small reach of levee on the right bank of Cache Creek maintained by Yolo County known as Huff's Corner.

[3] http://www.worldclimate.com/climate/us/california/woodland

Segment 41 is a non-urban SPFC levee located on the left (north) bank of Cache Creek. The Segment extends from the intersection of CR 96b and CR 18a in Yolo County to approximately 1.7 miles north of where Interstate-5 crosses over the Yolo Bypass.

The levees were constructed as part of the Sacramento River Flood Control Project authorized by the Flood Control Act of 1917 and built in 1943. The work included repairs, enlargement of the levees, rebuilding 1,800 feet of the levee upstream of the Southern Pacific Railroad (SPRR), and construction of levees from the intersection of CR 96b and CR 18a to approximately 1 mile southeast of the intersection of CR 102 and CR in Yolo County. The purpose of the work was to provide direct protection to adjacent agricultural land and several CRs. In addition, the levees protect U.S. Highway 99W, alternate Highway 40, and the town of Yolo.

The levees are mostly built of sandy and silty materials. The levees overlie over-bank deposits, which indicates very high underseepage susceptibility. The subsurface information indicates the foundation materials consist of silty, gravelly sand underlain by sandy fat clay. The upper 2 to 3 feet of the levees are denser because of compaction by traffic and by the periodic addition of base rock or other paving materials. The grade of the adopted floodplain profile varies from elevation 92.0 feet (U.S.C.E. Datum) at the upper end to elevation 35.1 at the Yolo Bypass. The design crown width is 12 feet, the design waterside slope is 3H:1V, and the design landside slope is 2H:1V.

Huff's Corner is a small reach of levee on the right bank of Cache Creek extending from Interstate-5 upstream approximately 0.59 miles to high ground. It should be noted that the DWR plat and levee log shows the levee stopping 0.29 miles upstream of Interstate-5 where CR 18 meets the levee, but most other reports, including USACE and DWR inspection reports, describe the entire 0.59-mile reach stopping where CR 18 leaves the levee at high ground. The levee was reconstructed by USACE in 1960 and has a 20-foot crown. Yolo County is the local agency responsible for operation and maintenance of this reach of levee.

2.1.3 Infrastructure and Land Use

As explained in Section 1.3, this study focuses mainly on the flood risk reduction efforts for the town of Yolo. The town of Yolo occupies approximately 1.4 square miles of land with an estimated 186 structures: 2 industrial, 12 public and 172 residential, including one fire station, one library, and one school. Griffith Mansion, a historic residence, is also located in the town of Yolo. While the community is largely residential, crops that are grown in the study area include grain and hay crops, truck nursery and berry crops, field crops, and deciduous fruit and nut crops. The remaining land is pasture, young perennial, urban, or idle. Plowed agricultural fields, orchards, and rural residences occupy the land just adjacent to the levee, which borders the community to the south. Land use in the study area is shown in Figure 5.

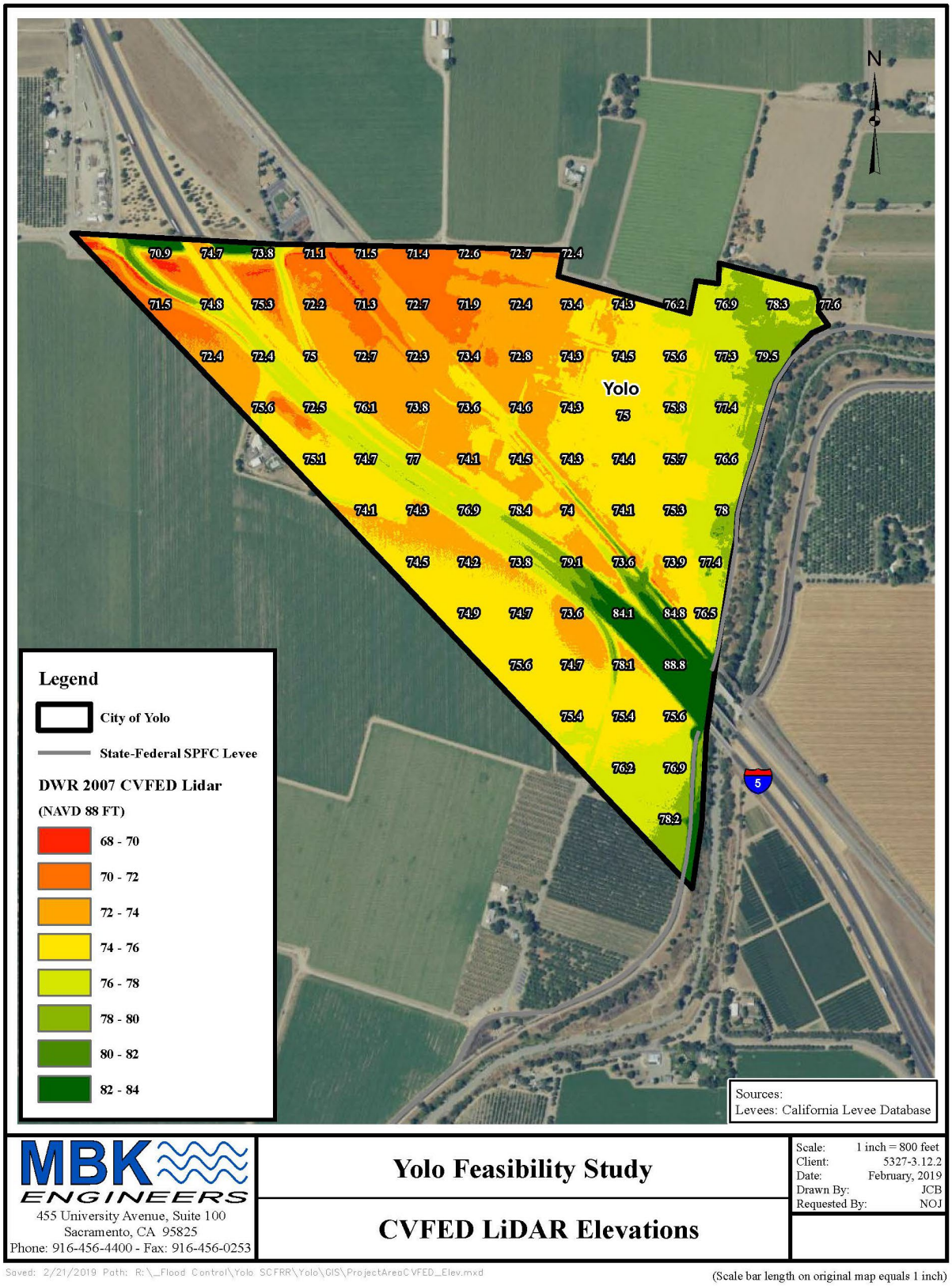

Figure 4: Elevation for community of Yolo

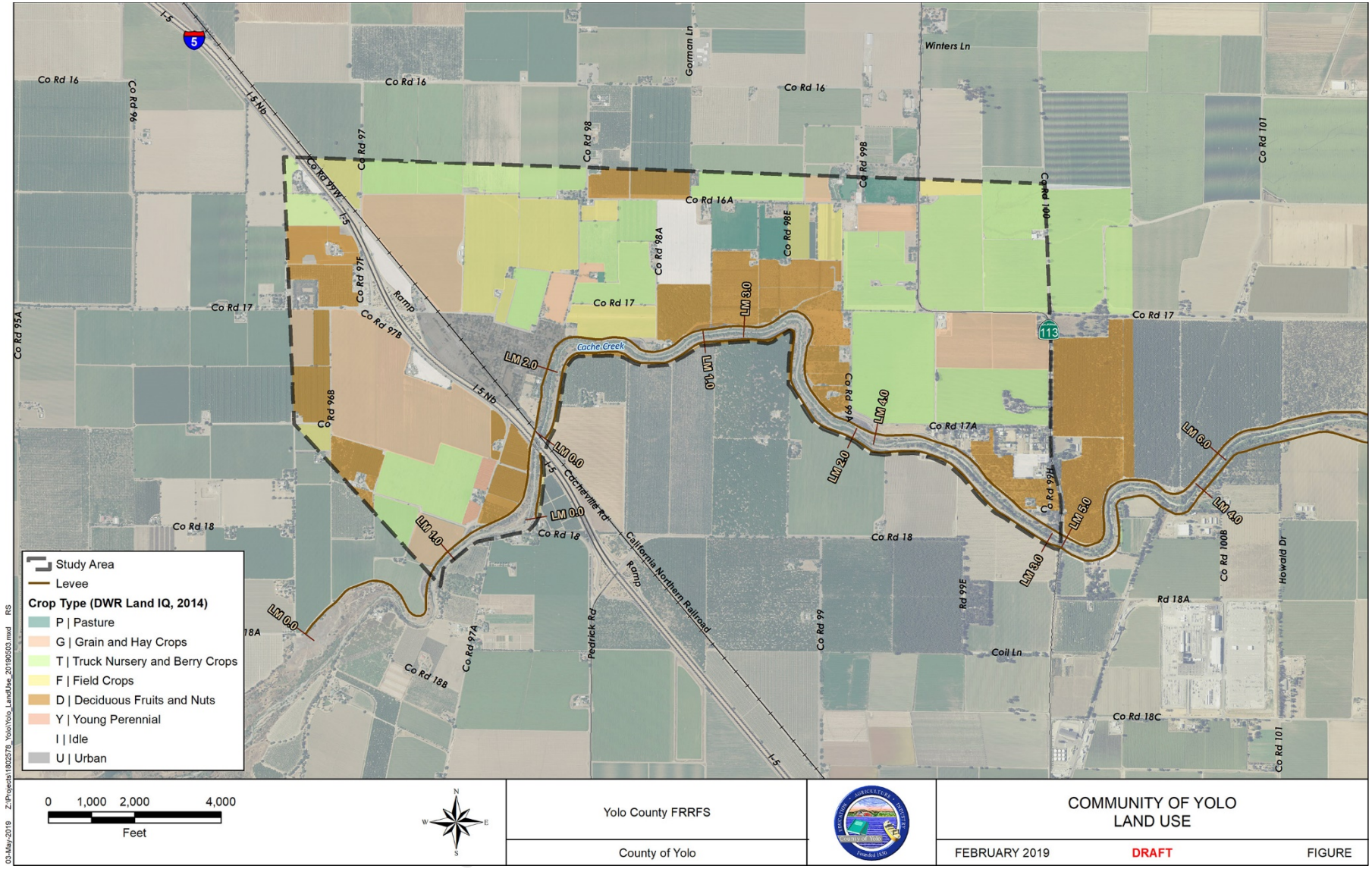

Figure 5: Land use in community of Yolo Study Area

2.1.4 Biological Resources

2.1.4.1 *Vegetation Communities*

Five vegetation communities occur in the project area, including irrigated agriculture, orchard, pasture, riparian, urban, and open water. Agricultural ditches and potential aquatic resources were also recorded in the project area. These resources are described in detail below. The vegetation communities in the project area also includes habitat used by special status species with a potential to occur in the study area. Several special-status species included in the database query results were ruled out due to absence of suitable habitat or the project area being located outside of known species ranges and are not included in Table 2; but can be referenced in Appendix D: Environmental Constraints Analysis. Additionally, United States Fish and Wildlife Service (USFWS) designated Critical Habitat units, conservation easements, and other protected areas are located in or adjacent to the project area and described in greater detail below.

2.1.4.2 *Special Status Species*

Database query results returned a large number of special status species with a potential to occur in the vicinity of the project area (Attachment A of Appendix D). Through review of these results many species were determined to not have the potential to occur in the project area due to absence of suitable habitat or the project area being located outside of known species ranges. Attachment A of Appendix D provides a description of the special status species that have the potential to occur in each of the delineated vegetation communities. Any potential project related effects to these species or their habitats would require compliance with the California Environmental Quality Act as well as permits/authorizations from the appropriate State or federal agency; as a result, a site-specific biological resources assessment would need to be conducted prior to project implementation to assess impacts on special-status species and their habitats.

2.1.4.3 *Critical Habitat*

There is no critical habitat within or adjacent to the project area.

2.1.4.4 *Sensitive Habitats and Aquatic Resources*

Sensitive habitats included are those that are of special concern to resource agencies or those that are protected under various state or federal regulations. Aquatic resources provide a variety of functions for plants and wildlife. Aquatic resources provide habitat, foraging, cover, migration, and movement corridors for both special-status and common species. In addition to habitat functions, these features provide physical conveyance of surface water flows capable of handling large stormwater events.

Cache Creek, which is delineated as open water, and its adjacent riparian corridor are the only sensitive habitats and aquatic resource that were identified within the project area. These communities would be considered sensitive communities due to their unique hydrophytic vegetation and ability to support special-status species. It is recommended that a formal

delineation of aquatic resource be completed prior to any project work in order to determine the level of impact to sensitive communities. Consultation and permitting through the appropriate agencies would need to occur where appropriate.

2.1.5 Cultural Resources

As explained in Section 1.1, town of Yolo was previously known as Cacheville. Cacheville acted as the Yolo County seat from 1857 to 1860 and had three stores, two saloons, a hotel, the county courthouse, and several homes and businesses by 1870. Due to the economic boon which agriculture in the area represented, irrigation systems were put in place early-on. In 1864, James Moore built a dam across Cache Creek and nine miles of canals to provide farmers in the area with water. Droughts in later decades necessitated larger-scale projects over time. The construction of the railroad network and implementation of the Central Valley Project allowed the area's agriculture to play a major role in the economic and political development of the Sacramento Valley[4]. In the 1950's, the building of the interstate highway system resulted in a large demand for sand and gravel for concrete. The lower Cache Creek – the portion bordering Yolo – became an important source of these materials. Over the next few decades, the amount of sand and gravel extracted from the channel became high enough to cause public concern for the degradation of the creek.

Archaeological and built environment sensitivity within the project area and 0.25-mile buffer is variable and contingent on the type of resource (prehistoric vs. historical) and geography (proximity to the river and the town of Yolo). For most of the project area, near-surface archaeological sites have likely been disturbed, and possibly destroyed, by decades of agricultural practices.

There have been 22 previous cultural resources investigations intersecting the project area. Previous investigations were primarily archaeological or architectural/historical field studies and were conducted for levee repair and rehabilitation projects, culvert construction, pipelines, energy facility, railroad, and transportation projects. These studies documented 177 prehistoric and historical archaeological sites and historical built environment resources.

2.1.6 Tribal Cultural Resources

Tribal Cultural Resources (TCRs) as defined by PRC Section 21074, are either (1) sites, features, places, cultural landscapes, sacred places, and objects with cultural value to a California Native American Tribe that is either on or eligible for inclusion in the California Register of Historical Resources (CRHR) or a local historic register; or (2) the lead agency, at its discretion and supported by substantial evidence, chooses to treat the resource as a TCR. Additionally, a cultural landscape may also qualify as a TCR if it meets the criteria to be eligible for inclusion in the CRHR and is geographically defined in terms of the size and scope of the landscape. Other

[4] http://www.spk.usace.army.mil/Portals/12/documents/usace_project_public_notices/Final_CacheCreekEA_APR13_wAppendices.pdf p. 39

historical resources (as described in PRC 21084.1), a unique archaeological resource (as defined in PRC 21083.2(g)), or nonunique archaeological resources (as described in PRC 21083.2(h)) may also be TCRs if they conform to the criteria to be eligible for inclusion in the CRHR.

The available documentation for several of the large Native American mound sites indicates that the mounds had been, or were in the process of being, levelled. The records also note extensive artifact collections among local landowners. The full extent of these sites has never been explored and significant, intact (likely buried) cultural deposits may still be present. However, most of the project area has not been previously surveyed and, accordingly, there is a low-to-moderate potential for near-surface unrecorded prehistoric or Native American sites within the unsurveyed portions of the project area; as well as a moderate-to-high potential for buried archaeological sites throughout the entire project area, particularly along the floodplain along Cache Creek. The Yolo area, especially that which is nearest to Cache Creek, is known to contain archaeological evidence of past human settlements, including early Native American sites. Multiple prehistoric sites exist on the banks of Cache Creek. This includes CA-Yol-135, a large early Native American interment site on the south bank of Cache Creek across from Yolo, and CA-Yol-187, a burial site close to Casa Linda Lane and Second Street in Yolo. If flooded, these resources can be severely damaged.

2.2 Problems

Although the town of Yolo has not flooded, there is a risk of flooding and a history of overtopping upstream and downstream along with erosion, and boils that indicate seepage. The channel is incised, and invasive non-native species have increased channel roughness and decreased channel capacity.

DWR Levee Evaluation

DWR's Levee Evaluation Program gave ratings for each of the potential geotechnical failure modes. This levee segment was given Hazard Level A for stability, meaning when water reaches the assessment WSE, there is a low likelihood of either levee failure or the need to flood-fight to prevent levee failure. For the categories of under-seepage, through seepage, and erosion, the segment received Hazard Level C, meaning when water reaches the assessment WSE, there is a high likelihood of either levee failure or the need to flood-fight to prevent levee failure. The overall rating was Hazard Level C.

2.2.1 Flood History

As explained in Section 2.1, Cache Creek levees were designed for a target flow of 30,000 cfs, which corresponds to a 10-percent annual chance flood. Due to this lowered capacity, the 100-year peak flow of 63,680 cfs would over top at several locations upstream of the community of Yolo. As a result, Community of Yolo hasn't experienced flooding yet; however, the water levels in Cache Creek came very close to overtopping the left bank near the community of Yolo in 1997, 2006, and 2019.

Historically, floods occurred in the Cache Creek basin since 1900. The most recent floods downstream of Clear Lake occurred in 1955, 1956, 1958, 1964, 1970, 1983, 1995, 1997. The January and March 1995 storms threatened the City of Woodland and town of Yolo. In March 1995, the storm peak spilled over the top of the levees by about 1 foot for approximately 3 hours, as noted by the town of Yolo Fire District. Overtopping upstream and downstream of the town occurred in 1995 at levee mile 2.3, levee mile 2.4, and levee mile 5.4. Maintenance personnel reported that the segment nearly overtopped at levee mile 2.5 and levee mile 5.35 during 1997 and at levee mile 5.35 during the 2007 high-water event. The levee was raised at levee mile 2.5 after the 1997 event.

2.2.1.1 *2019 High Water Events*

Cache Creek experienced two high water events in February 2019. On February 14th, the stream gage located at the intersection of Interstate-5 and Cache Creek recorded a peak stage of 82.2 feet that corresponds to a flow of 21,735 cfs. This resulted in water levels encroaching freeboard at several locations, however, Cache Creek did not overtop.

The February 27th event recorded a peak stage of 84.9 feet which corresponds to a flow of 26,468 cfs. This peak flow is lower than the design flow of 30,000 cfs that is stated in the USACE 1957 profile. Water levels were near overtopping on the left bank at levee mile 4.3 and 5.2 and Cache Creek levees overtopped the left bank at levee mile 2.8, 4.0 and right bank at levee mile 3.1. Emergency flood fight actions were undertaken by DWR Sacramento Maintenance Yard, with assistance from other resources to top the levee crown waterside hinge with sandbag berms to cutoff over-topping flows yet retain a passable levee crown.

Figure 6: High water on February 27, 2019 adjacent to the community of Yolo

The overtopping of the left bank levee was downstream of Yolo and overtopping of the right banks was at the high ground upstream of the project levees. Though there was overtopping upstream and downstream of the community of Yolo, there was approximately 4-5 feet of freeboard adjacent to the community. During this event there were also numerous boils and seepage concerns along both banks of the Cache Creek levees downstream to Highway 113. DWR and local agencies performed emergency flood fight sandbagging to raise the top of levee along Cache Creek in order to prevent additional overtopping.

Additionally, sandbags were used to fight seepage and boils on the land-side of the levees and an emergency rock berm was constructed at Huff's Corner (Figure 1) on the landside of the right bank levee upstream of Interstate-5 where a significant through-seepage boil threatened levee stability. After the event, DWR followed up by repairing and raising the levees at the locations where the overtopping occurred.

It was also noted that the WSEs also receded at approximately 50% lower rate than past events. As a result, DWR has initiated a Cache Creek study to investigate the reasons behind the change in flooding capacity. As a part of this Study, DWR is collecting recent topography data (LiDAR and bathymetric survey) and recent high-water survey data. This data will be used to develop and calibrate a hydraulic model to compare the bench mark elevations from 2019 as well as 2013 and 2010. DWR anticipates completing this study by July 2019.

2.2.1.2 *Flood Risk Analysis*

The area around Cache Creek was mapped for the 1-percent annual chance flood for the LCCFS. The hydrology used for the flow routing and subsequent floodplain mapping is based on the DWR 2012 Central Valley Hydrology Study (CVHS) adopted for the CVFED program (USACE, 2012). From the CVHS hydrograph for the Cache Creek flows, the peak flow for the 1-percent annual chance flood is 58,300 cfs. This peak value closely correlates to the FIS flow for Cache Creek (63,680 cfs at CR 94B). The resulting floodplain near the community of Yolo for the 1-percent annual chance flood, assuming all levees are allowed to overtop without failure (as determined by the LCCFS), is shown Figure 7. The assumption of levees overtopping without failure is not a realistic assumption for levee performance based on what was observed during the February 27, 2019 event, but this assumption was made to provide a base hydraulic run.

With the existing conditions, for the 1-percent annual chance flood, Cache Creek overtops both upstream and downstream of the community of Yolo. Interstate-5 is raised when compared to the adjacent farmland and acts as a berm, preventing upstream overland flow from entering the community of Yolo. As a result of the upstream overtopping, the resulting WSE in Cache Creek downstream of Interstate-5 is lower than the levee elevations adjacent to the community.

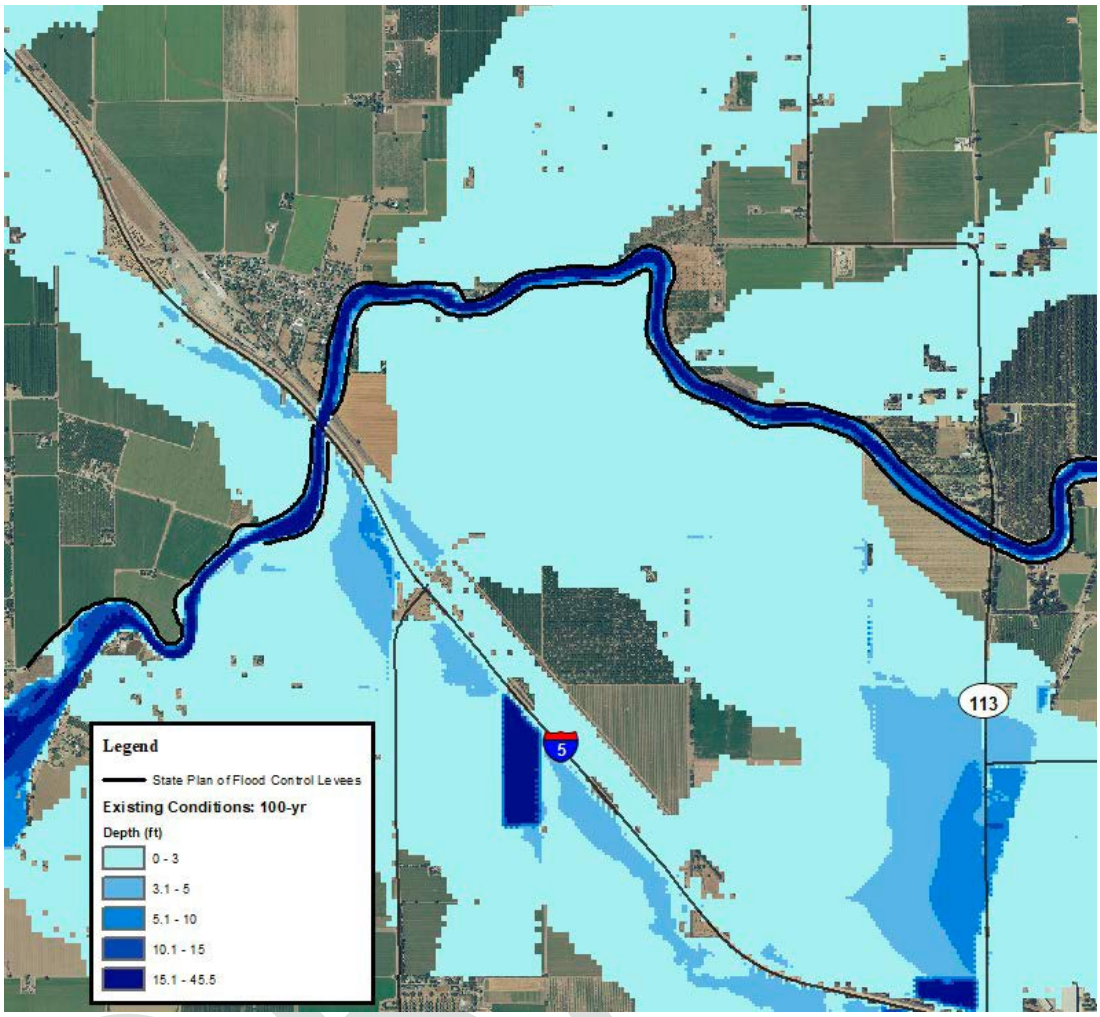

Figure 7: Floodplain for 1-percent annual chance flood near the community of Yolo

Cache Creek levees are not certified and are not in compliance with the NFIP for the 1-percent annual chance flood and would likely have failures in a large event. For areas protected by non-certified levees, FEMA requires a breach analysis to determine the floodplain. A breach was configured on the left bank of Cache Creek, at the community of Yolo. The breach parameters were estimated using the methodology established by CVFED in 2012. This breach analysis indicated that when there is breach on the left bank of Cache Creek adjacent to the community, the community of Yolo would be inundated.

In accordance with FEMA criteria for the accreditation of levee systems, a minimum earthen levee freeboard of 3 feet is required in evaluating the ability of levee systems to provide protection from the 1-percent annual chance flood. If an earthen levee does not provide the specified 3-foot freeboard during a 1-percent annual chance flood, it is assumed to fail/not exist for flood protection purposes. Therefore, the floodplains in the area of such an inadequate levee reflect flood conditions as if this flood-control structure did not exist. The criteria used to evaluate protection from the 1- percent annual chance flood are (1) adequate design, including freeboard, (2) structural stability, and (3) proper operation and maintenance. Levees that do not

provide protection from the 1-percent annual chance flood are not considered in a FEMA hydraulic analysis of the 1-percent annual chance floodplain.

2.2.2 Erosion

Cache Creek flood control issues have been longstanding. On December 16, 2003, an assessment of the equilibrium of Cache Creek was performed (DWR 2005a). This assessment concluded that the creek is extremely incised near the town of Yolo and there is a substantial risk of flooding at several erosion sites. The erosion sites are deep, steep-walled, and in proximity to the levee section. Therefore, the effectiveness of traditional water side fill and bank armoring methods is questionable, especially over the long-term and because these armoring methods could encroach into the design flow capacity. Upstream of the project reach, gravel mining has caused the lower reach of Cache Creek to become sediment starved. Because of sediment depletion, the creek is no longer in dynamic equilibrium. Since 1958, the creek has down cut as much as 35 feet. When a creek is in dynamic equilibrium, the water and sediment flowing through it are generally in balance and erosion and deposition are not excessive.

2.2.3 Seepage

Boils were observed at multiple locations along Segment 41 of Cache Creek in 1995. Pictures of the boils show that the events occurred on the landside slope and beyond the levee toe, which indicates both underseepage and through seepage. The events at levee mile 2.7, levee mile 2.8 and levee mile 2.95 were observed on the landside slope, on the upper slope, and near the levee crown. These were likely caused by rodent holes/burrows. The remaining events were observed near the levee toe and beyond. The levees overlie over-bank deposits, which indicates very high underseepage susceptibility.

Figure 8: Seepage during February 2019 High Water Event

2.2.4 Subsidence

Subsidence is the gradual settling or sudden sinking of earth's surface with little or no horizontal motion due to subsurface movement of earth materials. Subsidence caused by groundwater extraction has occurred historically and continues to occur in portions of the Sacramento Valley. Lower Cache Creek has experienced small amounts of land subsidence due to groundwater withdrawal. USACE's Lower Cache Creek Feasibility Report (March 2003) indicated that between 1942 to 1987, the City of Woodland has an estimated maximum cumulative land subsidence of 2.25 feet. The 2017 GPS Survey of the Sacramento Valley Subsidence Network by DWR reported that the largest spatial extent of subsidence in Yolo County ranges from -0.3 to -1.1 feet at 31 monuments between 2008 and 2017. As a result of this subsidence, it is estimated that the capacity of Cache Creek has decreased over the years.

2.2.5 Agricultural Sustainability/ Escalating NFIP Insurance Premium Rates

The loss of agricultural lands would adversely affect the economy of the region through the loss of high-value crops and the decrease in the critical mass of agricultural production necessary to support agriculture-related industries. The loss of agricultural lands would also diminish the agricultural character of the region, the maintenance of which is an important priority for the Region, as reflected in both the Sacramento Area Council of Governments Blueprint adopted in December 2004 and the Next Economy Prosperity Plan adopted in March 2013. Such loss may have the unintended consequence of inducing development in the agricultural areas.

An additional concern for rural agricultural communities is the much higher level of flood protection provided to urban areas compared to rural areas. Due to the inherently low population base within rural agricultural areas, sufficient financial resources are typically not allocated to reducing the flood risk in rural areas. The lower level of flood protection in rural agricultural areas results in higher life safety risks for residents and agricultural enterprises within these areas when compared to urban areas. With the increase in flood insurance costs, it may diminish the ability of these agricultural areas to remain viable and sustainable over the long-term.

2.2.5.1 *Escalating NFIP Insurance Premium Rates*

The Biggert Waters Flood Insurance Reform Act of 2012 indicated that the NFIP's current insurance pricing trends are greatly burdensome, further stifling community and agricultural development in the region. Annual insurance premium rates for FEMA have the potential to increase significantly. In 2010, the community of Yolo was remapped by FEMA as being in a 100-year floodplain[5]. As a result, plans to strengthen, diversify, and expand the economy of Yolo were suspended until the community could be more adequately protected from flooding. Yolo was placed into a Levee Flood Protection Zone, mandating strict requirements for building in flood zones and purchasing flood insurance. These building requirements mandate that the

[5] http://www.yolocounty.org/home/showdocument?id=26961
[11] Yolo County 2030 General Plan Amendment #2011-03 Flood Hazards

lowest floor elevation for living areas must be "at or above the BFE", which could range from 3 to 12 feet above ground. Approximately 44 policies are in place in the town of Yolo at an average cost of $940 per year. These insurance premium rates have the potential to increase annually and resulted in an 8.2% annual increase from April 1, 2019.

FEMA updates FIRM to show new SFHAs behind previously accredited levees throughout many of the Sacramento Valley's agricultural areas, sustainability of Sacramento Valley agriculture has become a major concern. There are two primary impacts when an agricultural area is mapped into an SFHA: (1) land use requirements for elevating or flood-proofing new and substantially improved (which includes substantially damaged) structures to or above the BFE, and (2) a requirement to purchase a flood insurance policy through the NFIP for each structure with a federally backed mortgage (aka mandatory insurance purchase requirement).

A review of FEMA's mapping procedures, insurance requirements, insurance rates, and policies indicates that agricultural facilities in leveed areas of the Sacramento Valley are beginning to bear a disproportionately large share of the financial burden of the NFIP. The financial burden is substantially greater than the risk exposure as a result of the following practices and policies:

- Insurance premiums are based on the assumption that a non-accredited levee provides no flood protection, when in fact most non-accredited levees provide a substantial amount of flood protection that can be quantified and recognized. Since agricultural areas can rarely afford to have accredited levees, the effect is that many leveed agricultural areas pay insurance premiums that are much higher than the associated flooding risk.
- Insurance premiums for agricultural structures are generally the same as for retail business and industrial structures, which are thought to be more vulnerable to flood damage than agricultural structures.
- Fully wet flood-proofed structures are required to pay insurance premiums as if they had no flood-proofing.
- Each structure on a parcel is required to have an individual policy with a $250 annual surcharge. Farms typically have far more structures than other types of businesses.
- Low-value detached structures associated with agriculture are required to have flood insurance coverage when similar structures associated with a residence would not.
- Insurance premiums for structures in areas protected by reaches of levee that meet all federal requirements are charged at the Zone D rate instead of the lower Zone X rate, if the levee reach happens to be part of a larger levee system.
- Insurance premiums for structures in areas protected by well-studied sound reaches of non-accredited levee are charged at the Zone D rate, the same as areas of undetermined flood risk.

2.2.6 Water Supply

The town of Yolo has one main groundwater well that was installed in the early 1970's that has periodically failed. This existing well currently produces approximately 1,000 gallons per minute (gpm). This well supplies water to the Yolo water supply system. However, the number of water

supply connections are near the water supply system's existing capacity. Also, the system's delivery capacity is insufficient for the Yolo Fire Protection District's fire apparatus. The current fire apparatus pumps produce up to 1,250 gpm, which exceeds the production capacity of the existing well.

During fire events, the water system is quickly drawn down. Once drawn down, the negative pressure that results from continued apparatus pump operations can damage components of the water delivery system. This water system deficiency requires the Yolo Fire Protection District to carefully manage their use of water during fire events, which can affect their fire suppression effectiveness. When the backup water supply system is used in the community, it only produces 500 gpm. At this level, the District cannot draw water from the system during fires using their apparatus pumps (Tafoya, D. 2019).

2.3 Opportunities

There are opportunities to engage in projects which reduce the flood risk faced by Yolo while also incorporating features that allow for multiple resource benefits by increasing ecosystem enhancement, promoting agricultural sustainability, providing recreational benefits, and ultimately supporting greater economic stability. Furthermore, the opportunities that exist now to make Yolo's flood management system more robust and resilient may not be possible in the future as land use changes in the region.

2.3.1 Ecosystem Restoration Opportunities

Ecosystem restoration in rural areas often contain the best and most cost-effective opportunities for improving ecosystem functionality. Habitat restoration may limit life and economic exposure within the project footprint and increase public safety and economic resiliency by transitioning the land use to one that benefits from, rather than is harmed by, oncoming floodwaters.

The three invasive plant species – arundo, ravennagrass, and tamarisk – could be targeted for removal and replacement with native species. While assessment of changes and trends in native wildlife, invertebrates, and fish were primarily qualitative due to data limitations, over 200 species were observed from 1995–2016. Within the mosaic of riparian and upland habitat across the CCAP area, many species were consistently observed during the study period, such as Swainson's hawk, riparian bank swallow, numerous migratory songbirds, Western pond turtle, river otter, Columbian black-tailed deer, bobcat, Sacramento pikeminnow, and Sacramento sucker. The continued recovery of native vegetation and natural ecological processes should provide additional habitat and resources for these and other native species, further increasing the value of lower Cache Creek as habitat within the matrix of agricultural and urban lands in Yolo County.

When viable levee setbacks, land acquisitions, and floodplain storage activities represent the most resilient means of improving system performance within the small community footprint, they tend to limit exposure and add to system capacity rather than concentrating flows. These

types of activities also have the potential to contribute to other societal values by providing more flood-adaptive land that could be leveraged for ecosystem restoration.

2.3.2 Recreation Opportunities

The Cache Creek Parkway Plan identifies a number of recreational opportunities within relatively close proximity to the community of Yolo. These include the 98-acre Teichert Woodland Muller property, the Teichert Muller Bridge, the 7-acre County Borrow Pit, the 115-acre Granite Woodland Reiff property, the 30-acre Rodgers Property, and the 38.9-acre Correll Property. All of these current and former mining properties are located east of CR 94B along Cache Creek within a 10-minute drive from the community of Yolo. There are potential recreational opportunities for these properties.

The community of Yolo is located approximately 3.5 miles north east of the City of Woodland, which represents a relatively short bicycling distance between the two communities. However, the local roads that would be used for bicycle commuting, including Cacheville Road, CR 18, and CR 99, have narrow shoulders consisting of a mix of pavement and gravel, and vehicle speeds on these straight rural roadways can be quite high. These conditions discourage bicycle use on these roadways due to safety concerns. However, the Circulation Element of the 2030 Countywide General Plan (County of Yolo 2009) identifies a proposed Class II bike lane alignment that would more safely connect the community of Yolo to the City of Woodland's existing bicycle circulation system.

2.3.3 Water Supply Improvement Opportunities

The 2017 CVFPP Update strongly supports and encourages the planning and implementation of projects that provide multiple benefits. These benefits are not solely limited to ecosystem or recreational enhancements, they also include improving water supply and water quality. As mentioned earlier, the main groundwater well within Yolo was installed in the early 1970's and it has periodically failed. The number of water supply connections are near the water supply system's existing capacity of 1,000 gpm. The current fire apparatus pumps produce up to 1,250 gpm, which exceeds the production capacity of the existing well.

The improvements necessary to enhance the water supply system such that it meets applicable standards would likely include the drilling of a new well, the installation of new pumps, and the construction of water storage facilities. The integration of these water system improvements should be considered in any levee improvement planning and/or design within the community of Yolo, consistent with the integrated water management approach advocated for in the 2017 CVFPP Update. No preliminary screening was conducted for multi-benefit projects as part of this Feasibility Study.

2.4 Constraints

2.4.1.1 *Existing Levee Standards (CFR 65.10)*

Agricultural areas generally do not have the financial means to improve levees sufficiently for accreditation, so it is not possible in most cases for agricultural areas to avoid being mapped into an SFHA or to perform the levee investigations and repairs required for being mapped out of an SFHA. Further, many agricultural areas were developed prior to the NFIP or after original FIRMs showed these agricultural areas as low risk areas protected by levees (Zone X). Although development was basically unrestricted, these areas continued to maintain low risk agricultural development. It was not until FEMA's Map Modernization began in 2001 and the requirement in 2005 for communities to document that these levees meet rigorous engineering standards that these areas began to be mapped as SFHAs and were forced into strict building provisions and expensive flood insurance premiums that greatly impact the sustainability of agriculture.

3 Plan Formulation

The plan formulation process identifies and responds to problems and opportunities associated with the objectives and specified State and local concerns. The process provides a flexible, systematic, and rational framework to make determinations and decisions at each step so that the interested public and decision makers are fully aware of the basic assumptions employed, the data and information analyzed, the areas of risk and uncertainty, and the significant implications of each alternative plan.

A project to address channel and levee deficiencies at Huff's Corner has been proposed as part of the FSRP and will not be part of this plan formulation effort. As a comprehensive feasibility study for Community of Yolo, the formulation of alternatives includes structural and non-structural alternatives to reduce flood risk and alternatives to improve ecosystem and riverine habitat viability. These alternatives are not limited to federal, State or local activities. Thus, implementation can be phased and will require the work of numerous Federal, State, local, and private agencies and organizations.

3.1 Objectives

This feasibility study is conducted per DWR's SCFRRP guidelines in support of the CVFPP goals. As a result, this study shares some of the CVFPP goals. The primary goal of the feasibility study is to promote flood risk management actions to reduce flood risk to people and property protected by the SPFC facilities. For small communities, 100-year protection (1% probability of flooding per year or less) is an unofficial target established by Congress' 1968 National Flood Insurance Act, under which communities that voluntarily participate in the National Flood Insurance Program are no longer subjected to mandatory flood insurance. The goal of this study is to provide 100-year protection to the town of Yolo.

The objectives of the Yolo SCFRRP Study provide additional specificity to the SCFRRP goals as follows:

3.1.1 Improve Flood Risk Management/Provide for Flood Risk Reduction

- Reduce the risks of flooding to life, property, and critical infrastructure
- Attain a 100-year level of flood protection for the community of Yolo in accordance with FEMA's guidelines pursuant to Code of Federal Regulations (CFR) Section 65.10

3.1.2 Promote Multi-Benefit Projects

- Improve the dynamic hydrologic and geomorphic processes in the Yolo region to enhance ecosystem functions
- Increase and improve the quantity, diversity, quality, and connectivity of riverine aquatic and floodplain habitats

- Contribute to the recovery and sustainability of native species populations and overall biotic community diversity
- Reduce stressors related to the current operations and future improvements of the Yolo flood protection system that negatively affect at-risk species
- Integrate recreational components into identified flood system improvements to enhance public benefits for the Yolo community

3.2 Management Actions

A Management Action is a structural or non-structural action, plan or strategy that contributes towards achieving plan objectives. This study focuses on the following Management Actions:

- Levee improvements
  - Strengthening levees
  - Raising levees
- Setback levees
  - to address erosion
  - to increase channel capacity
- Sediment removal
- Channel dredging
- Non-Structural measures
- Ecosystem functions
- Multi-objective opportunities

These Management Actions can be integrated and modified to form Flood Risk Reduction Alternatives and Ecosystem Projects to achieve all the Yolo SCFRR Study objectives.

3.3 Alternatives Development

In this study, flood risk reduction alternatives, ecosystem and recreation elements are not mutually exclusive. Therefore, they are developed and screened independently to arrive at a preferred flood risk reduction alternative along with preferred ecosystem elements. The Yolo SCFRR Study preferred alternative(s) can be a combination of the flood risk reduction preferred alternatives and preferred ecosystem and recreation elements.

3.4 Evaluation Criteria

DWR provided guidance, consistent with CVFPP goals, that small communities may use to evaluate, compare, and inform selection of a preferred alternative within each SCFRR study. DWR suggested metrics were evaluated under without-Project conditions and with-Project conditions so that changes, particularly in flood risks, could be qualitatively compared. The

alternatives were evaluated to determine how well they meet the SCFRR alternative evaluation goals, criteria, and capital costs.

3.4.1.1 *Flood Risk Management*

The evaluation criteria include flood risk reduction to people and property within floodplains protected by the SPFC, flood system flexibility and resiliency, and floodplain management. The alternatives would be evaluated by the following:

- Level of existing and future flood protection
- Project will improve the ability of the flood management system to adapt to changing conditions (hydrologic, climate change, social, political, regulatory, or ecological conditions) and continue to function and recover quickly after damaging floods

3.4.1.2 *Promote Multi-benefit Projects*

A CVFPP goal is to promote multi-benefit projects or elements that integrate other resource needs including ecosystem restoration, recreation, open space, and water supply reliability. Evaluation criteria for this include the ability to integrate the recreational component into the flood improvements, the community interest in and support for the recreational component, and the ability of the recreational component to meet unmet needs in the community.

Metrics for improving and enhancing natural dynamic, hydrologic, and geomorphic processes include:

- Inundated floodplain habitat
- Natural bank
- River meander potential

Metrics for increasing and improving quantity, diversity, quality, and connectivity of riverine aquatic and floodplain habitats include:

- Riparian habitat
- Marsh and other wetlands habitat
- Shaded riverine aquatic habitat

Restoring habitat contributes to the recovery and stability of native species populations and overall biotic community diversity. Quantifiable metrics for reducing stressors related to development and operation of flood management system that negatively affect at-risk species include:

- Revetment removed
- Levees relocated to reconnect floodplain
- Fish passage barriers removed (or in place to detour stray migrants)
- invasive plants removal

3.4.1.3 *Capital Costs*

Costs to complete the project include planning and design, land/easement acquisitions, construction, structures, materials, equipment, and labor. The economic and practical feasibility of relocating roads, utilities, changing land use, or buildings needs to be accounted for as well.

3.4.1.4 *Financial Feasibility*

In addition to raising funds for project construction, a small community must be able to raise enough annual funding to pay for long term OMRR&R. Alternatives that lower flood risks to the disadvantaged community of Knights Landing, have lower local-match percentage requirements, and enhance OMRR&R will be deemed more feasible.

3.4.1.4.1 Tax Rate and Infrastructure Burden Considerations

In order to consider an area's ability to generate additional taxes and assessment, the uses of taxing capacity for all infrastructure and services should be considered. The California Debt and Investment Advisory Commission (CDIAC) promulgates guidelines with respect to land secured financing, including the use of assessments and Mello-Roos. CDIAC's Mello-Roos Guidelines (1991) suggest that jurisdictions should integrate Mello-Roos financing into the land use regulatory framework.

4 Structural Alternatives

As explained in Section 2.1, Cache Creek levees were designed to carry a peak flow of 30,000 cfs with anticipation of the Wilson Valley Dam and Reservoir construction that never happened. The estimated 100-year peak flow of 63,680 cfs over tops levees and natural high ground at several locations upstream of the community of Yolo. As a result of these overtoppings upstream, Yolo hasn't experienced flooding yet. However, with consideration of the goals to improve flood risk management, enhance habitat restoration, and provide recreational benefits in Yolo, a wide array of structural and non-structural alternatives has been formulated.

4.1 Structural Alternatives Formulation

Structural flood risk alternatives address erosion/stability problems to restore design flows; increase channel capacity by sediment removal, vegetation removal, or setback levees; and create additional upstream storage.

4.1.1 No Action Alternative

Without-Project conditions and with-Project conditions must be considered so that changes can be analyzed, compared, and quantified (if possible) when selecting the preferred alternative. The No Action alternative does not include any structural or non-structural actions and assumes current existing conditions to continue as future conditions.

4.1.2 Alternative 1 – Sediment Removal/Dredging

The CCSB was designed by the USACE as part of the Sacramento Flood Control Project and SPFC. CCSB is located in Yolo County approximately two miles east of the City of Woodland. The purpose of the CCSB is to preserve the capacity of the Yolo Bypass by entrapping sediment from Cache Creek. Historically, the system has functioned where sediment is carried through the creek and is deposited in the CCSB, which is located approximately 8.4 miles downstream of the community of Yolo.

Vegetation in the channel can reduce channel capacity and cause sediment deposition. When sediment deposits it reduces the channel capacity. Dredging is the removal of sediments from the bottom of water bodies like lakes and rivers. Dredging is often used to mitigate the effects of flooding for areas where sediment and silt have reduced the carrying capacity of the stream. Dredged material can be used to stabilize levees and to construct habitat restoration. As a result, sediment removal/dredging was proposed as one of the alternatives to reduce flood risk. This Alternative included dredging in Cache Creek channel from river mile 3.721 to river mile 14.611.

4.1.3 Alternative 2 – Setback Levees

A setback levee approach would involve constructing a new levee some distance from the stream bank or existing levee and removing the existing levee or breaching it at various locations. This approach could be used to increase conveyance capacity while minimizing the associated increases in WSEs and flow velocities. Doing so could reduce the need for improving the levee on both sides of the channel, the need for slope protection, and the environmental effects to the channel. The farther the levees are set back, the greater the increase in channel capacity, providing more conveyance capacity and reducing the overall channel velocity.

If current erosion patterns continue, levee integrity and flood protection along Cache Creek would be severely compromised. Construction of the proposed setback levees would serve to protect the integrity of the levee system and provide flood protection. Previous erosion problems were solved by constructing setback levees at levee mile 3.9L and levee mile 4.2L because of the infeasibility of traditional fill and bank armoring methods. Constructing setback levees has been the most efficient and least environmentally damaging method of protecting the integrity of the levee system.

Alternative 2 included evaluation of configurations of a setback levee on the right bank of Cache Creek to reduce flood risk. Due to the design flow for the levees corresponding to roughly a 10-percent annual chance flood, to provide flood protection for a 1-percent annual chance event the potential setback levee would have to follow the length of Cache Creek, from upstream of Interstate-5 to the CCSB.

Though a full setback levee might not be economically feasible to provide flood protection for the 1-percent annual chance event, short setback levees can provide some flood protection. DWR has previously constructed short setback levees in response to erosion along Cache Creek. These levees do not provide full flood protection along a reach but can cause a local drop in the WSE that is beneficial from a flood-control standpoint. If future setback levees are constructed for erosion purposes, the design/alignment should also consider the potential flood control benefits.

4.1.4 Alternative 3 – Flood Control Storage Reservoir

As mentioned, the Cache Creek levees were constructed with the anticipation of Wilson Valley Dam and Reservoir being constructed for flood control upstream shortly after the levees were completed. However, the Wilson Valley Dam and Reservoir project was never constructed. Based on the anticipated reservoir construction, the design of the levees was minimized for a targeted flow of 30,000 cfs with 3-feet of freeboard. This design flow corresponds to a 10-percent annual chance flood. Construction of a flood control storage reservoir upstream was proposed as one of the alternatives to reduce flood risk.

4.1.5 Alternative 4 – Restore Left Bank of Cache Creek to USACE 1957 Design Profile

The community of Yolo is located directly adjacent to the upper 2.5-mile reach of a larger 10-mile segment of the Lower Cache Creek channel that is heavily incised and is subject to periodic

bank and levee erosion. Past performance records indicated that erosion of the levee slopes and the channel bank have occurred during past high-water events. Cache Creek levees have experienced overtopping and boils both upstream and downstream of the community. Animal burrows have been reported along the Cache Creek left bank levee near the community of Yolo and have led to through seepage that required flood fighting.

Alternative 4 includes restoring the Cache Creek left bank levee from Levee Mile 1.7 to 2.2 to the intended USACE 1957 design profile. This would include raising the levees to accommodate 3-feet of freeboard over 1957 USACE design profile along with repairing the levees for erosion along the left bank levee of Cache Creek directly adjacent to the community of Yolo between Interstate-5 on the west and to a distance about 600 feet downstream from the easterly extension of Washington Street on the east side of Yolo as shown in Figure 9.

Comparing the existing levee elevations from CVFED LiDAR to the DWR 1955/57 design profile, the levees are a foot below the design water surface and short of the required three feet of freeboard by three to four feet. To meet 1955/57 WSE freeboard requirements, these levees would need to be raised approximately 0 to 4 feet. Due to these freeboard deficiencies, the levees also do not meet their levee prism requirements for a 12-foot crest width at 3 feet above the WSE, 3H:1V waterside slopes, and 2H:1V landside slopes. Freeboard and geometry repairs would be required as part of these levee improvements.

To address erosion concerns that are prevalent along the heavily incised reach of Lower Cache Creek containing steep and erosive banks, it may be advisable to place Rock Slope Protection (RSP) or install other erosion-control measures on the existing levee system to minimize the threat of erosion failures directly adjacent to Yolo. RSP may be a necessity where the channel and parallel left bank levee system make a sizeable turn downstream in an easterly direction near the easterly extension of Washington Street at the east end of Yolo.

4.1.6 Alternative 5 – Levee Improvements for Left Bank of Cache Creek to Pass 100-year Flow

Alternative 5 includes restoring or repairing the Cache Creek left bank levee to the 100-year level of flood protection. The total 100-year peak flow or the flow with a 0.01annual exceedance probability (AEP) is estimated to be 58,300 cfs based on the 2014 CVHS which is nearly double the 10-year flow event, upstream of the Cache Creek levee system near the CR 94B crossing, located approximately 4.5 miles west and upstream along Cache Creek. Similar to the earlier alternative, Alternative 5 would include levee improvements (raise/repairs) along the left bank levee of Cache Creek directly adjacent to the community of Yolo between Interstate-5 on the west and to a distance about 600 feet downstream from the easterly extension of Washington Street on the east side of Yolo.

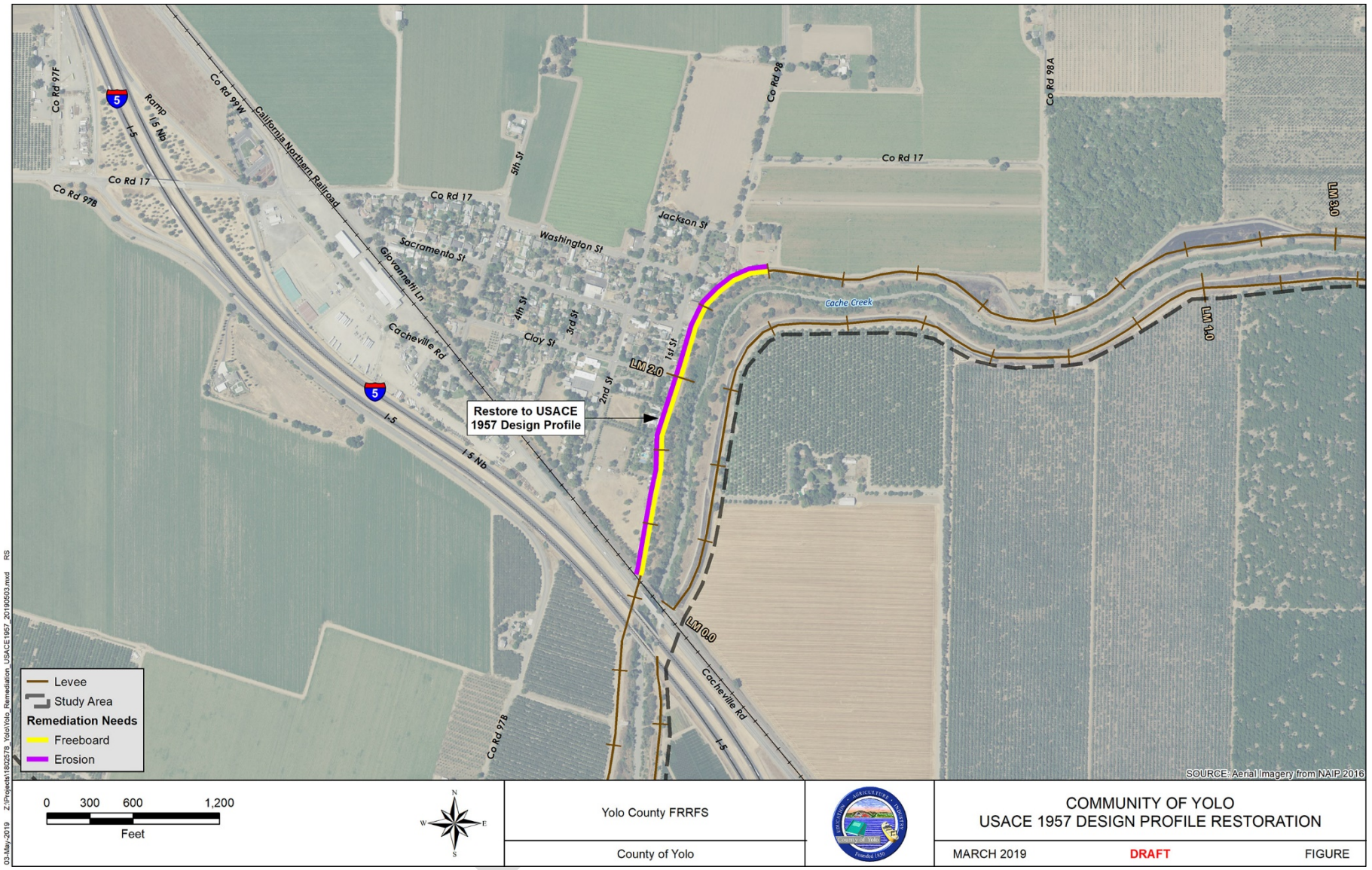

Figure 9: Alternative 4 – Restore left bank of Cache Creek to USACE 1957 Design Profile

Based on the hydraulic modeling and historical information available, the estimated peak flow of 58,300 cfs overtops levees and high ground at several locations upstream of Interstate-5. As a result, the resulting WSE in the channel downstream of Interstate-5 is approximately 0.8 feet to 1.4 feet lower than the corresponding USACE design profile. To accommodate this resulting WSE with 3 feet of freeboard, the levee crown on the left bank of Cache Creek would have to be raised as much as 0 to 3 feet above its current height and the levee widened at its base by as much as 10 to 15 feet in certain locations, particularly along the downstream easterly portion of the levee system. The largest levee raises and enlargement would take place along the left bank levee of Cache Creek on the furthest downstream easterly end of Yolo, east of Clay and Sacramento Streets.

Geotechnical subsurface exploration data was not available for the levee directly adjacent to the community of Yolo. However, there is Caltrans bridge data for the Interstate-5 bridges slightly upstream of the community. The data indicate there are areas of shallow sands in the levee foundations as well as deeper units of sand and gravel.

Recent DWR data for erosion repair sites both upstream and downstream were available along with 1958 explorations from USACE levee improvement work. The recent DWR explorations found gravels at the bottom limit of their explorations, as deep as about 60-feet below the ground surface. The bottom depth of these pervious zones is not known based on the available exploration information.

Based on this exploration information and the past performance of the levees adjacent and near the community of Yolo, it was concluded that the levees protecting the community of Yolo need repairs for underseepage, through seepage, and erosion in addition to the freeboard and geometry repairs as shown in Figure 10.

To estimate the costs and for further evaluation of these alternatives, levee remediations were proposed for these levee improvements. To address underseepage and through seepage, it is proposed that a cutoff wall would be practical for this project site as there is no adequate space at the landside levee toe for a berm solution. Based on the unknown depth of the underlying aquifer, a cutoff wall to a depth of 80-feet (the limit of conventional open trench wall construction) was assumed for this feasibility study. To address erosion, waterside rock slope protection for the levee slope and part of the channel bank is also recommended. In summary, the levees protecting the community of Yolo need repairs for underseepage, through seepage, and erosion and levee raises to safely pass 100-year flow.

4.1.7 Alternative 6 – Restore Left Bank of Cache Creek to USACE 1957 Design Profile and Levee Improvements to Pass 100-year Flow

Alternative 6 is a combination of Alternatives 4 and 5 described earlier. Alternative 6 includes restoring the left bank of Cache Creek from levee mile 1.7 to 2.2 to accommodate 3-feet of freeboard for USACE 1957 design profile along with applicable levee improvements for under seepage, through seepage, and erosion as shown in Figure 11.

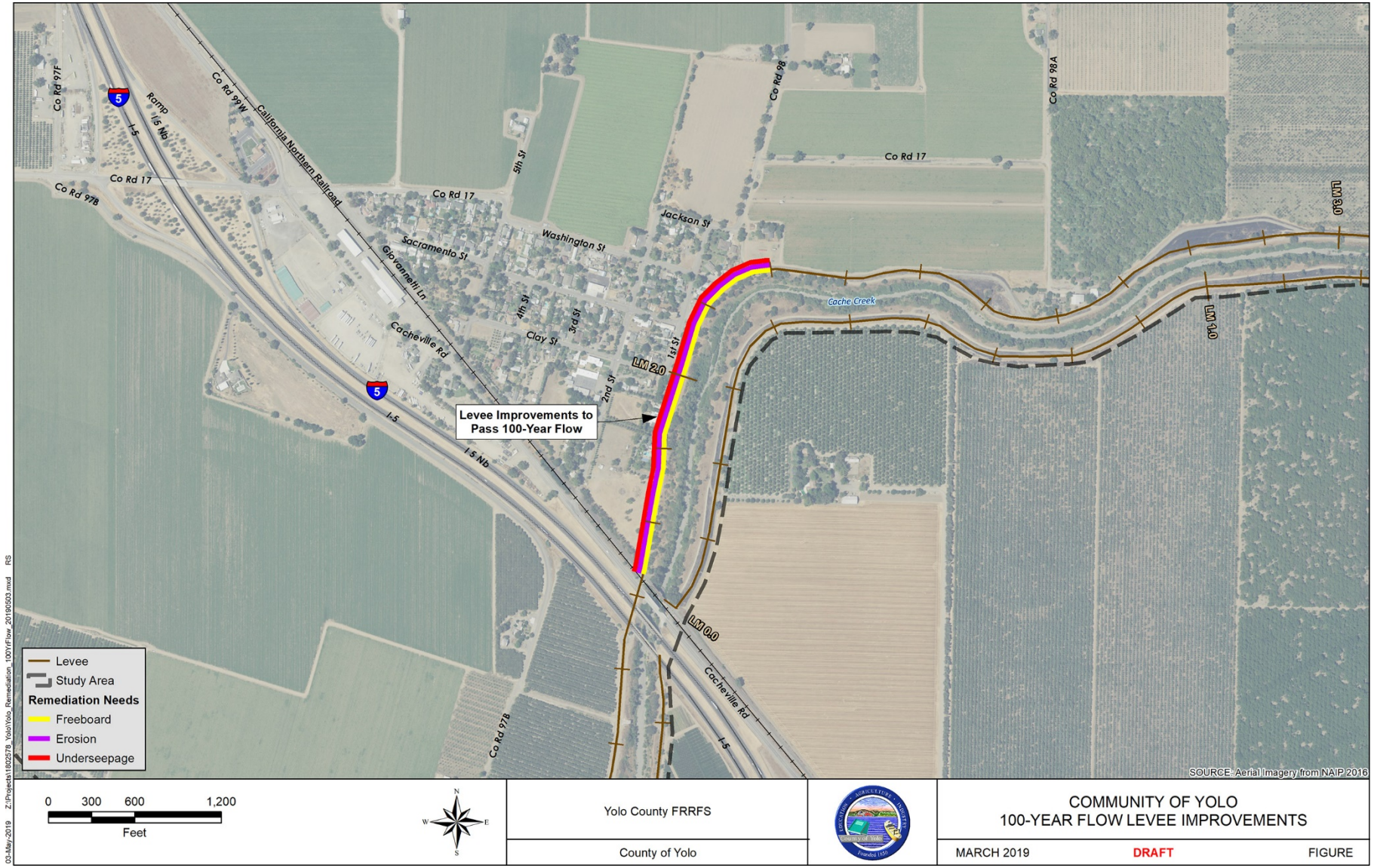

Figure 10: Alternative 5 – Levee improvements for left bank of Cache Creek to Pass 100-year flow

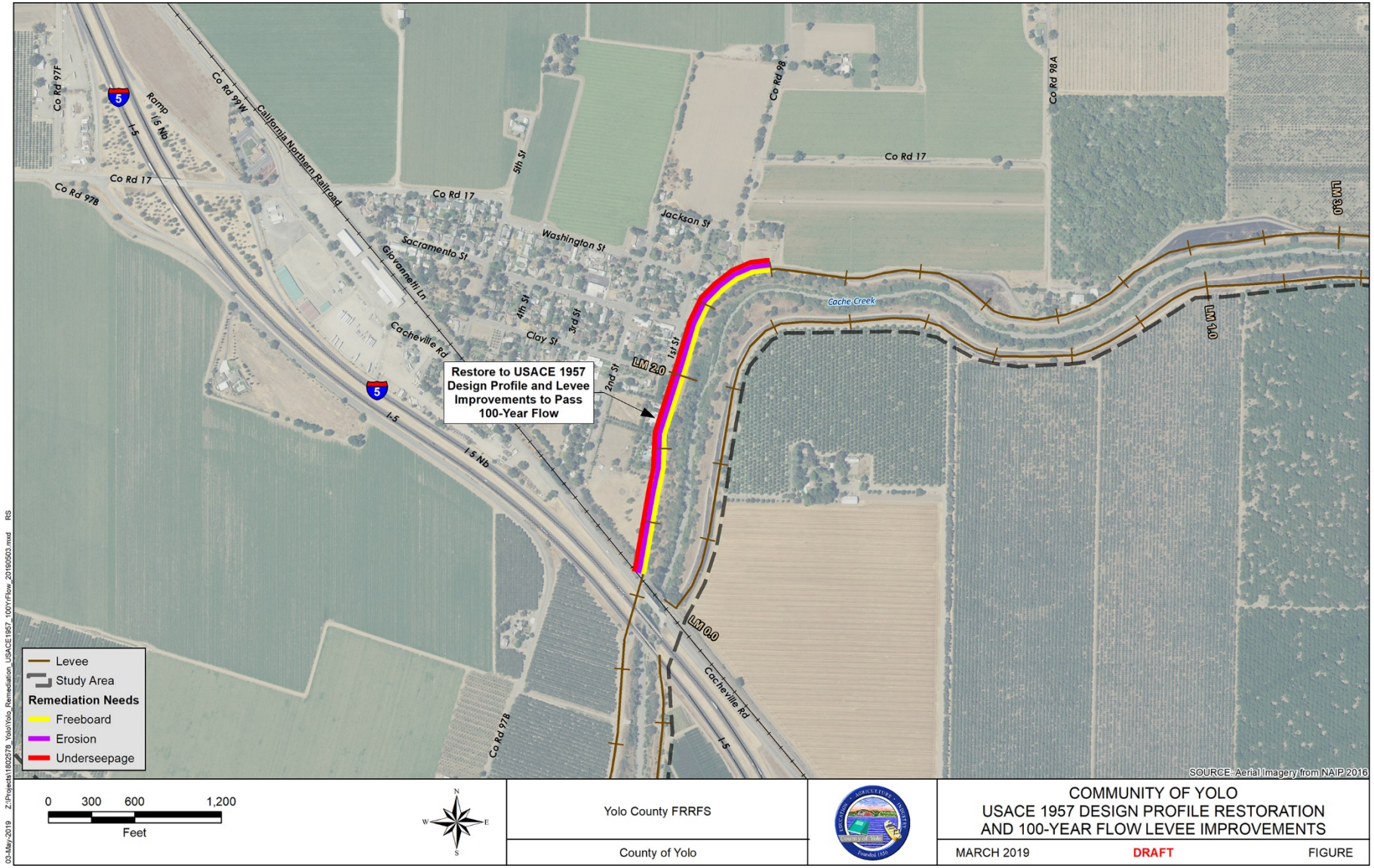

Figure 11: Alternative 6 – Restore left bank of Cache Creek to USACE Design Profile and levee improvements to pass 100-year flow

4.2 Preliminary Evaluation and Screening

As mentioned in Section 3.1, the primary objective of this feasibility study is to reduce the risks of flooding to life, property, and critical infrastructure and attain a 100-year level of flood protection for the community of Yolo. The alternatives mentioned above were evaluated and screened qualitatively based on constructability and achievement of feasibility study objective. Based on the available information, alternatives that provided a reduction in flood risk and/or alternatives that were considered implementable were carried forward for further evaluation.

4.2.1 Alternative 1 – Sediment Removal/Dredging

This alternative was evaluated using the available historic models for Cache Creek. This included the Comprehensive Study Model from 2001 and the CVFED HEC-RAS model for Cache Creek from 2012. Both models contain riverine cross sections that can be compared to determine if there has been sediment build-up over time. Comparing the channel inverts, both models have approximately the same channel profile between the Cache Creek Settling Basin and the upstream end of the SPFC levees at Huff's Corner. When looking at the cross sections, there are minor differences in storage between the 2001 and 2012 data sets. These minor differences are at the lower point of the channel that does not provide much conveyance area.

To evaluate the potential impact if sediment buildup was occurring, a potential dredging alternative was modeled to compare to the existing conditions. For this comparative analysis, the channel was lowered by 5-feet from the Cache Creek Settling Basin to the upstream portion of the Huff's Corner levee to approximate dredging. The results from this run were compared to the existing conditions and they showed no significant decrease in the resulting WSE. This is due to the low part of the channel having a relatively small conveyance area compared to the upper portions of the channel. Additionally, if dredging was to occur, it would exacerbate erosion and necessitate more bank protection.

In addition, the Cache Creek Settling Basin has been modified many times since 1938 to redistribute sediment settling patterns and increase sediment storage capacity. Based on the design of the Cache Creek Settling Basin, where sediment is deposited as the water ponds until it reaches the outlet weir elevation, it is unlikely that sedimentation is occurring in the channel upstream of the basin.

Based on the channel geometry comparison and the model results of a potential dredging alternative, Alternative 1 was not carried forward for additional evaluation.

4.2.2 Alternative 2 – Setback Levees

Currently, Cache Creek overtops upstream of Interstate-5 in the 1-percent annual chance event. During high flows, these structures result in significant head losses in Cache Creek, resulting in significantly higher water levels upstream that result in overtopping. A setback levee on the right bank of Cache Creek from downstream of Interstate-5 to the Cache Creek Settling Basin would provide protection for the town of Yolo from the 1-percent annual chance event but not provide

protection for the City of Woodland due to the culvert constriction that causes overtopping which results in floodwaters overtopping Interstate-5. Though the setback levee alternative is technically feasible to provide flood protection for the town of Yolo, it would impact existing agricultural lands, require State and local funding, and be cost prohibitive to build this long stretch of setback levee solely as a flood control measure.

The City of Woodland and the CVFPB are currently working with USACE on the LCCFS that is considering implementing structural flood control features in the right overbanks of Cache Creek to provide flood protection to Woodland. A potential setback levee along the right bank of Cache Creek could provide flood protection to the town of Yolo but would not provide protection to the City of Woodland. Without providing benefit to the City of Woodland, a potential setback levee would not be able to use any cost-sharing mechanisms with the proposed LCCFS project.

Land between the old levee and the new setback levee would remain undisturbed; however, this land would be isolated and potentially inaccessible for continued agricultural use. In addition, agricultural land would be lost due to the construction of the new setback levee. The loss of agricultural land would need to be addressed as related to Yolo County's General Plan and agricultural land preservation goals. In addition, a setback would increase the floodplain significantly, and require more land acquisition, and the relocation of some existing homes and other structures. This alternative would also involve the replacement of the railroad bridge, making this alternative economically unviable. Smaller segments of setback levee can be constructed to provide some flood protection by locally reducing the WSE, but these will not provide full protection from the 1-percent annual chance of flooding.

As a result, Alternative 2 was not carried forward for further evaluation.

4.2.3 Alternative 3 – Flood Control Storage Reservoir

The Wilson Valley site is on Cache Creek about 5 miles downstream from the confluence with the North Fork of Cache Creek. Flood storage on Cache Creek was evaluated by the USACE in 2003. USACE reconnaissance hydrologic analyses indicated that the peak discharge for the 1 in 100 chance flow at the town of Yolo would be decreased by 25 percent using a maximum storage volume of 37,000 acre-feet in the storage basin. The reduced peak discharge for the 1 in 50 chance flow event with the 37,000-acre-foot basin was found to be well above the estimated nondamaging channel capacity of lower Cache Creek. The analysis also indicated that weak foundation conditions limited the storage capacity to 37,000 acre-feet and this volume would be filled with sediment in 80 to 90 years. As a result, significant reductions in flood damages would not be achieved with the storage available at the Wilson Valley site and Alternative 3 was not carried forward for further evaluation by USACE 2003.

Since the 2003 evaluation, subsequent State legislation has precluded a dam at that site. The California Wild & Scenic Rivers Act (Public Resources Code § 5093.50 et seq.) was passed in 1972 and segments of Cache Creek were added in 2005:

> It is the policy of the State of California that certain rivers which possess extraordinary scenic, recreational, fishery, or wildlife values shall be preserved in their free-flowing state, together with their immediate environments, for the benefit and enjoyment of the people of the state. The Legislature declares that such use of these rivers is the highest and most beneficial use and is a reasonable and beneficial use of water within the meaning of Section 2 of Article X of the California Constitution.

Therefore, a change in legislation would be required in addition to addressing geotechnical and hydraulic constraints. Alternative 3 was not carried forward for further evaluation in this study.

4.2.4 Alternative 4 – Restore Left Bank of Cache Creek to USACE 1957 Design Flow

Restoring or repairing the Cache Creek left bank levee to the USACE 1957 design flow of 30,000 cfs would require levee improvements for approximately 2,550 feet of Cache Creek left bank levee directly adjacent to the community. The existing levees in this extent are approximately 4.5 to 7.5 feet tall on the landside. Higher ground is present along the upstream end of the levee, near the railroad and road embankments that run roughly perpendicular to the levee.

Based on the preliminary evaluation of past performance records, it was concluded that Alternative 4 will be carried forward for further evaluation that would include a detailed evaluation of past performance records.

4.2.5 Alternative 5 – Levee Improvements for Left Bank of Cache Creek to Pass 100-year Flow

Alternative 5 includes levee improvements for approximately 2,550 feet of Cache Creek left bank levee directly adjacent to the community to pass 100-year maximum flow of 58,300 cfs. This peak flow overtops levee and high ground upstream of the channel resulting in a WSE lower than 1957 design profile for the portion of the channel next to the community of Yolo. Based on the preliminary evaluation of past performance records, it was concluded that Alternative 5 will be carried forward for further evaluation that would include detailed evaluation of past performance records.

4.2.6 Alternative 6 – Restore Left Bank of Cache Creek to USACE 1957 Design Profile and Levee Improvements to Pass 100-year Flow

As explained previously, Alternative 6 is a combination of Alternatives 4 and 5 and subsequently, Alternative 6 was carried forward for further evaluation that would include detailed evaluation of past performance records

4.3 Preliminary Screening Summary

Table 1 below provides a summary of preliminary screening of alternatives.

Table 1: Summary of Preliminary Screening of Alternatives

Alternative	Alternatives	Further Evaluation
1	Sediment Removal/Dredging	No
2	Setback Levees	No
3	Flood Control Storage Reservoir	No
4	Restore Left Bank of Cache Creek to USACE 1957 Design Profile	Yes
5	Levee Improvements for Left Bank Cache Creek to Pass 100-year Flow	Yes
6	Restore Left Bank of Cache Creek to USACE 1957 Design Profile and Levee Improvements to Pass 100-year Flow	Yes

4.4 Capital Costs

As explained in Section 4.2, the three alternatives that are carried forward for final evaluation and screening (Alternatives 4, 5, and 6) include levee improvements to left bank of Cache Creek adjacent to the community of Yolo. Potential levee improvements for these alternatives were considered to prepare cost estimates for evaluation and comparison of the alternatives. Additional information regarding existing levee conditions and potential levee improvements are provided in Appendix B – Community of Yolo Geotechnical Assessment. Structural improvements to the levees include the following:

- Improvements to levee geometry to address freeboard deficiencies
- Construction of a cutoff wall to address underseepage and through seepage
- Rock slope protection to address erosion

The following section provides a summary of assumptions, methodology, and resulting cost estimates for proposed remediations for these structural improvements. Further description of the development of the capital costs can be found in Appendix C: Community of Yolo Structural Alternatives Cost Estimates. The design level of effort for these cost estimates is considered a feasibility-study level. A feasibility-study level is defined as a paper study depending on existing reports, site visits, aerial photography review, and engineering judgment. A cost estimate was developed for each of the structural improvements by applying unit costs to quantities based upon conceptual designs or previous studies. Unit costs were established for construction items included within the conceptual designs.

Capital costs consist of:

- Major construction item costs (unit costs)
- Other construction costs including:
  - Unallocated items in construction costs as a percentage of the major construction item costs (percentage)
  - Mobilization and demobilization of construction equipment as a percentage of the major construction item costs (percentage)

- Other Owner Costs including:
  - Environmental documentation and permitting as a percentage of all construction costs (percentage)
  - Design and engineering costs as a percentage of all construction costs (percentage)
  - Legal costs to implement project as a percentage of all construction costs (percentage)
  - Construction management as a percentage of all construction costs (percentage)
  - Real estate capital outlay and acquisition costs (unit costs)

4.4.1 Levee Improvements

Levee prism geometry was assumed to meet the minimum minor tributary levee standard based on *Barclays Official California Code of Regulations, Title 23. Waters, Division 1 Central Valley Flood Protection Board* (CVFPB, 2014). Levee heights vary between locations and levee crown elevations were established to meet freeboard requirements (three feet) above the 1955/57 and 100-year WSE depending on the alternative.

Table 2: Levee Geometry

	Levee Geometry
Crown Width	12 feet
Landside Slope	2:1
Waterside Slope	3:1
Freeboard	3 feet
Levee Patrol Road Width	10 feet

Existing levee profiles were developed every 500 feet along Cache Creek as part of the NULE. A total of six profiles were used to determine the existing levee geometry. Based on this assessment, it was determined that existing levee heights were between 0 and 2.8 feet deficient to pass the 100-year flow with 3 feet of freeboard and 0 to 4 feet deficient to pass the 1955/57 design flow. It was assumed that raising and improving the levee geometry may impact some of the existing structures which are immediately adjacent to the levee. To account for this, it was assumed that up to three structures and an existing storm drain system may need to be improved or relocated.

As discussed in Section 4.1.6, potential seepage remediations were analyzed by reviewing geotechnical borings along the Cache Creek levee. The bottom of the aquifer was not found within 65 feet of the ground surface, and due to the presence of a permeable aquifer, it was decided that a fix would be required for underseepage. Due to space limitations of structures directly adjacent to the levee, it was determined that a seepage berm would not be feasible, and a cutoff wall was assumed to be required to address underseepage. Because a confining layer was not found in the review of existing borings, it was assumed that cutoff walls would be constructed to 80 feet below ground elevation, the maximum depth allowed using conventional open trench construction techniques. Similar subsurface conditions were found along the entire levee extent and thus it is assumed that the entire length will require a cutoff wall.

Erosion has historically been a consistent problem for the levees protecting Yolo. The NULE program developed cost estimates for the Cache Creek North Bank Segment which includes the community of Yolo. The estimate assumes rock slope protection is installed for a slope length of 72 feet which includes the levee slope and a portion of the channel bank slope. The estimate for this improvement was scaled to only include the 2,550 feet in this study and was then escalated from 2011 dollars to 2018 dollars.

Construction Sequence

For the purposes of this cost estimate, it is assumed that all activities occur during a single construction season. Due to the physical space requirements for construction of the proposed cutoff walls, it is necessary to degrade the existing levee to provide at least a 35-foot-wide working surface for the equipment. Because of the relatively short height of the existing levees, the majority of the Cache Creek levee would need to be degraded to ground elevation to meet the space requirements. After the cutoff wall was constructed, suitable levee fill material would be brought on site to construct the levee to the required elevation. Rock slope protection would then be added to the waterside slope. A summary table for the levee improvements is included in Table 3 below.

Table 3: Community of Yolo Levee Improvements Cost Estimates

Activity		Alternative 4	Alternative 5	Alternative 6
Remove Existing levee			$140,732	$140,732
Prepare Existing Levee		$82,269		
Cutoff Wall Construction			$2,378,770	$2,378,770
Rebuild Levee to Design		$484,332	$516,988	$650,183
Relocations		$900,000	$700,000	$900,000
Major Construction Items Subtotal =		$1,466,601	$3,736,490	$4,069,684
Other Construction Costs**				
Unallocated Items in Construction Costs	15%	$219,990	$560,473	$610,453
Mobilization and Demobilization	5%	$73,330	$186,824	$203,484
Construction Total =		$1,759,921	$4,483,788	$4,883,621
Other Owner Costs***				
Environmental Documentation and Permitting	35%	$615,972	$1,569,326	$1,709,267
Design and Engineering Costs	15%	$263,988	$672,568	$732,543
Legal Costs	2%	$35,198	$89,676	$97,672
Engineering during Construction	2%	$35,198	$89,676	$97,672
Construction Management	15%	$263,988	$672,568	$732,543
Other Owner Costs Subtotal =		$1,214,346	$3,093,814	$3,369,698
Other Items				
Permanent Right-of-Way (fee Title)- Residential	0	$103,335	$56,221	$103,335
Erosion Protection Riprap	LF	$4,120,794	$4,120,794	$4,120,794
Total Site Baseline Cost =		$7,200,000	$11,800,000	$12,500,000
Contingency of 50%				
Expected Project Cost =		$8,700,000	$15,600,000	$16,700,000
NOTES:				

* Other Construction Costs are a percentage of the Major Construction Items Subtotal.

** Other Owner Costs are a percentage of the Construction Total.

*** Riprap already had contingency applied to it so riprap is not escalated.

4.5 Final Screening

The three structural alternatives (Alternatives 4, 5, and 6) that were retained after preliminary screening were further evaluated qualitatively to select the preferred structural alternative. Alternative 4 provides adequate freeboard to pass the 100-year flow, but it does not include levee improvements to fix the existing levee deficiencies. As a result, this alternative was eliminated.

Alternatives 5 and 6 not only provide adequate freeboard to pass the 100-year flow, but also include levee improvements to address existing levee deficiencies. Of this, Alternative 6 provides adequate freeboard for USACE 1957 profile which is higher than the 100-year WSE. Per California Water Code 8361, on behalf of the State, California Department of Water Resources shall maintain and operate certain portions of the Sacramento River Flood Control

Project. These portions include “The levees of Cache Creek and the easterly and westerly levees of CCSB”.

As Alternative 6 provides 100- year level of protection to the community of Yolo, which is the primary objective of this study, and also meets the California Water Code 8361 requirement, it was selected as the Preferred Structural Alternative.

4.6 Preferred Structural Alternative

The Preferred Structural Alternative, “Alternative 6 – Restore Left Bank of Cache Creek to USACE 1957 Design Profile and Levee Improvements to Pass 100-year Flow”, includes 0 to 4 feet of levee raise above its current height near the community of Yolo and the levee widened at is base by as much as 10 to 15 feet in certain locations, particularly along the downstream, easterly portion of the levee system. In addition to the levee raise, these levees protecting the community of Yolo would have improvements to address underseepage, through seepage, and erosion.

Since the elements of the Preferred Structural Alternative include all the elements for ‘Restore Left Bank of Cache Creek to USACE 1957 Design Profile’ which is the State’s responsibility, the State would pay for approximately $7.2 million to $8.7 million. The remaining $5.3 million to $8 million would be cost-shared between available funding sources and the community. A detailed discussion of implementation and cost-share of the Preferred Structural Alternative is provided in Chapter 7

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5 Non-structural Alternatives

Non-structural solutions can be considered and combined with structural alternatives. Non-structural flood risk management solutions include a wide range of measures which limit the risk of property damage and loss of life from flood water. These actions minimize damages primarily by reducing the exposure to flood waters rather than by confining those flood waters with hydraulic structures. These elements include raising structures so that they will be above anticipated flood levels; floodproofing structures to make them more resistant to flood waters; purchasing and relocating at-risk structures; limiting development in floodplains through zoning or through the acquisition of agricultural conservation easements, open space easements, regulatory constraints, and incentive programs; purchasing of flood insurance to mitigate damages; and/or developing robust emergency operations, evacuation, and flood warning systems to evacuate persons and property in advance of devastating flood water.

Below is a list of potential non-structural solutions under consideration for the community of Yolo:

- Voluntary flood proofing
- Improve NFIP CRS for Yolo County/community of Yolo
- Mapping of flood depths, timing, duration, and evacuation maps for community of Yolo
- BFE Study to share with community of Yolo and FEMA
- FIRO for Indian Valley reservoir releases
- Consolidation between, Yolo County at Huffs Corner and DWR for OMRR&R and improvements to Cache Creek SPFC levee system

5.1 Descriptions and Evaluations of Potential Non-Structural Solutions

5.1.1 Voluntary Flood Proofing

Damages to structures behind levees can be greatly reduced through effective flood proofing. Flood proofing can be cost effective for most structures where maximum depths of potential flooding are not expected to exceed five feet. However, agricultural-related structures have been known to be flood-proofed for flood depths much greater than five feet. There are two types of floodproofing. Wet floodproofing is where structures are constructed of flood resistant materials and have openings, or vents, to allow floodwaters to pass through the structure. Any mechanical or electrical equipment must be affixed above the flood elevation or waterproofed to prevent damage. Wet floodproofing is typically appropriate for agricultural shops and buildings but are not normally practical for residential or commercial structures. Dry floodproofing is where a

structure is designed to be watertight to keep flood water from entering the structure. Based on FEMA definition, dry flood proofing includes but is not limited to the following:

- Installation of watertight closures for doors and windows
- Reinforcement of walls to withstand floodwater pressures and impact forces generated by floating debris
- Use of membranes and other sealants to reduce seepage of floodwater through walls and wall penetrations
- Installation of pumps to control interior water levels
- Installation of check valves to prevent the entrance of floodwater or sewage flows through utilities
- Relocation of electrical, mechanical, utility, and other valuable damageable equipment and contents above the expected flood level

If the flood depth at a site is above the practical height limits of available flood proofing barriers, an alternative mitigation method, such as raising of structures, should be considered. However, hydrologic and hydraulic modeling of the community of Yolo and adjoining overflow areas both upstream and downstream along the north side of the Cache Creek levee system indicates that the structures in the community of Yolo are only subject to flood depths of 3.5 feet or less. This suggests that flood proofing for significant portions of Yolo may be feasible. Yolo County requests that if the State and federal agencies can secure funding, Yolo County is willing to cost share with willing landowners to pursue wet or dry floodproofing solutions. (See Section 5.1.5 below that addresses opportunities for floodproofing could also lead to an improved NFIP CRS for Yolo County and the community of Yolo that may in turn result in lower NFIP premium flood insurance rates).

Hydraulic analyses of the entire Cache Creek levee system, inclusive of simulated levee breach scenarios along the left bank levee upstream, downstream, and adjoining the community of Yolo, all indicate shallow flooding depths due to a breach and/or overtopping. In February of 2019, when overtopping within a mile downstream of Yolo on the left bank of Cache Creek, the overtopping flows did not necessarily pond but resulted in shallow overland flows. Recent and past overtopping, coupled with hydraulic modeling, all indicate shallow (typically less than 5 feet in depth) overland flows along the overflow areas adjoining the community of Yolo. As such, a relief cut in the left bank levee system of Cache Creek either upstream, downstream, or adjoining the community will not appreciably reduce potential flood depths nor duration of shallow flooding. Thus, a relief cut for the community of Yolo has been eliminated as a non-structural solution

5.1.2 Voluntary Raising of Structures

Raising of existing structures to an elevation which is at least equal to or greater than the computed WSEs resulting from a levee breach can be a common and effective way of

minimizing damage from floodwaters and is considered a key flood protection provision of the NFIP. The process in most cases consists of separating a building from its foundation by vertically lifting with hydraulic jacks and placing the structure onto a higher foundation of vertical walls. Structures can be elevated using various methods such as extended foundation walls, on piers, posts, piles, and columns and can be completed in a way to allow garage or storage space below the elevated structure. This non-structural measure is sustainable over the long term with minimal costs for operation, maintenance, repair, rehabilitation, and replacement. Hydraulics and hydrologic modeling of the community of Yolo indicates that there is not a threat of deep flooding, and maximum flood depths from a levee breach scenario on the left bank of Cache Creek directly adjacent to the community would likely result in shallow flood depths of only one to three feet in depth.

The cost to raise structures to heights of 3.5 feet or lower may not be the most cost-effective solution relative to wet or dry floodproofing structures as discussed in further detail below in Section 5.1.4. Although raising some structures by heights of 3.5 feet or less, these short heights may be feasible with federal and State participation but may not be desirable for the entire community as a whole. Elevating structures 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.

It is recommended that voluntary raising of structures not be carried forward as a non-structural solution for reducing flood risks in the community of Yolo, as flood proofing may be more cost effective for the community of Yolo that is subject to shallow flood depths of less than 3.5 feet.

5.1.3 Support to Continue to Improve NFIP CRS for Yolo County/Community of Yolo

Yolo County is an active participant/community of the NFIP. Through its County-wide Flood Protection Ordinance, the County strives to reduce flood risks throughout the unincorporated areas of Yolo County while also attempting to reduce NFIP premium policy rates. As described below, the current CRS score in Yolo County is based upon the collective rating score of all the unincorporated areas combined within the County, with the exception of incorporated cities within the County having City-specific CRS scores. As of April 1, 2017, Yolo County has retained a CRS credit score, (cT) of 1,394 which places Yolo in the NFIP Community Classification Class 8. The Class 8 designation yields a 10% reduction of NFIP insurance premiums for Special Flood Hazard Areas (SFHAs) within Yolo County, inclusive of the community of Yolo and adjoining outlying agricultural areas. Actions to increase the cT score would result in further reductions to insurance premiums within the County.

Yolo County's current cT score of 1,394 is based upon several FEMA-specific activities carried out by Yolo County as identified below with corresponding CRS Credits:

NFIP Activity	Activity Credit Score/Max Possible Score
310 - Elevation Certificates	32/116
320 - Map Information Service	70/90
330 - Outreach Projects	48/330
340 - Hazard Disclosure	15/80
350 - Flood Protection Information	57/125
420 - Open Space Preservation	620/2,870
430 - Higher Regulatory Standards	118/2,462
440 - Flood Data Maintenance	136/222
450 - Stormwater Management	141/755
502 - Repetitive Loss Category	0/n/a
510 - Floodplain Management Planning	120/622
630 – Dams (State Dam Safety Program Default Value)	37/37
710 County Growth Adjustment factor 1.07 applied to 400 Series/Activities	
Total cT Score	1,394

A review of the above table indicates how the cT is score is derived based upon the County's current CRS activities, and through State support and funding, there may be greater opportunities to increase its current cT score from 1,394 to 1,500 which would yield an additional 5% reduction of NFIP insurance premiums throughout the county SFHAs, inclusive for the community of Yolo.

5.1.4 Mapping of Flood Depths, Timing, Duration, & Evacuation Maps for Community of Yolo

To enhance flood emergency preparedness, response, and recovery plans for the community of Yolo it may be advantageous to develop flood mapping of the community and adjoining agricultural lands upstream and downstream of Yolo along the left bank of Cache Creek. Flood mapping would identify: (1) probable maximum flood depths; (2) timing of flood depths exceeding 1 foot, based on a few representative levee breach or overtopping scenarios; (3) the likely duration and depth of flooding that may occur from various levee breaches along the left bank of Cache Creek; and (4) evacuation maps identifying evacuation routes for various levee breach scenarios along Cache Creek. Flood mapping could further enhance flood response and recovery actions, and further reduce the risk of potential lives and properties lost during a catastrophic flooding event if one were to occur in or adjoining the community of Yolo. The

noted flood mapping could also assist the County and the community of Yolo with improving its CRS cT score above current levels.

The mapping of flood depths, timing, and duration can also be very useful in developing a community specific BFE study to share with FEMA for potentially reducing NFIP flood insurance rates for the community of Yolo.

5.1.5 BFE Study to Share with Yolo Community and FEMA

As noted above in Section 5.1.4, the mapping of flood depths, timing, and duration thereof may be of significant value in preparing a formal BFE study to share with FEMA with the intent to confirm that the community of Yolo is only subject to very shallow flooding depths between 0 to 3.5 feet. The BFE study can also be shared with FEMA to potentially reduce NFIP flood insurance rates for the community of Yolo.

A BFE study could be utilized by home and business owners in the community of Yolo to justify an actuary flood insurance rate (a reduced rate), which may be significantly lower than their present NFIP premium rate. Although there is no history of flooding within the community, homeowners reportedly may pay as much $10,000 per house to determine the likely flood depths for individual lots. A BFE study would be very beneficial to the community to establish the maximum flood depth for each of the existing lots within community of Yolo before and after any of the proposed structural solutions are implemented.

5.1.6 Forecast-Informed Reservoir Operations Plan for Indian Valley Reservoir Flood Releases

A formal Forecast-Informed Reservoir Operations Plan (FIROP) for Indian Valley Reservoir flood releases could be collectively developed by Yolo County, the Yolo County Flood Control and Water Conservation District (YCFC&WCD), and DWR to improve the scheduling and timing of flood releases from the Indian Valley Reservoir. The flood control releases from Indian Valley can have an impact on the peak flows in Cache Creek at the communities of both Yolo and Woodland. A greater understanding of the flood control releases from Indian Valley Reservoir could be beneficial to all flood control interests in the lower Cache Creek basin.

5.1.7 Consolidation between Yolo County at Huff's Corner and DWR for OMRR&R and Improvements to Cache Creek SPFC Levee System

Yolo County is responsible for operations and maintenance of the small 0.29-mile reach of the right bank levee system of Cache Creek immediately upstream of Interstate-5, commonly referred to as Huff 's Corner. DWRs Sacramento Maintenance Yard is responsible for over 14 miles of levees (over six miles along the right bank of Cache Creek downstream of Interstate-5, over eight miles along the left bank of Cache extending two miles upstream, and six miles downstream of Interstate-5).

In August of 2014, during the development of the LSDN RFMP, the University of California, Davis (UC Davis) Extension Collaboration Center conducted a Yolo County Flood Governance Study which identified a preference and need to improve local governance between the County, the City of Woodland, YCFC&WCD and DWR. The governance study indicates the County cannot afford and does not possess the expertise to meet its obligation to operate and maintain the levee to acceptable standards at Huff's Corner, along the right bank of Cache Creek just upstream and west of Interstate-5.

Following the recent highwater overtopping event occurring on February 27, 2019, along the left bank levee of Cache Creek downstream of Yolo, DWR indicated they will conduct investigations and develop a plan of action for repairing the freeboard deficiencies as well as address erosion concerns on the noted SPFC levee system along both banks of lower Cache Creek, adjoining the community of Yolo inclusive of agricultural areas upstream and downstream of Yolo.

In addition to improving operations and maintenance, the improved governance between the noted entities could also enhance capital improvement/repair assessments to restore the Cache Creek SPFC levee system to its original USACE 1957 Design Profile and potentially improve the left bank levee segment adjoining Yolo (the community's preferred structural alternative) to meet FEMA 100-year accreditation standards pursuant to 44 CFR Section 65.10. An early opportunity to improve governance or advance the governance discussions with DWR, YCFC&WCD, Yolo County (CSA #6), and City of Woodland interests may include: (1) the advancement of a formal FIROP identified above in Section 5.1.6 for Indian Valley Reservoir flood releases; or (2) further development of the USACE/City of Woodland Lower Cache Creek Feasibility Study to improve flood protection to the City of Woodland and improve long-term operations of the CCSB.

5.2 Recommendation of Non-Structural Solutions

As explained in the previous section, some of the non-structural solutions identified have been deemed infeasible or undesirable for the community of Yolo. However, the following solutions are recommended for inclusion to further reduce flood risks to the community and also provide opportunities to collectively improve the County's CRS cT score to further reduce NFIP flood insurance premiums. The non-structural solutions also include improving local governance to enhance the community's ability to sustain existing operations and maintenance obligations and enhance funding of any new levee improvements, inclusive of the community's preferred structural alternative to improve the SPFC levee segment adjoining the community to FEMA 100-year accreditation standards pursuant to 44 CFR Section 65.10, inclusive of any associated hydraulic mitigation measures in the Cache Creek SPFC levee system.

The following non-structural solutions have been identified and are highly recommended for implementation, some of which are already in the early stages of implementation:

- Voluntary flood proofing
- Improve NFIP CRS for Yolo County/community of Yolo

- Mapping of flood depths, timing, duration, & evacuation maps for community of Yolo
- BFE Study to Share with Community of Yolo and FEMA
- FIRO for Indian Valley reservoir releases
- Consolidation of Yolo County at Huffs Corner and DWR for OMRR&R and improvements to Cache Creek SPFC levee system

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6 Multi-Benefit Alternatives

6.1 Identification of Ecosystem Alternatives

The approach used to identify potential habitat restoration concepts for this report initially focused on what could possibly be implemented without regard for existing land use or infrastructure constraints. As an example, the geographic scope was not limited to the Yolo community in recognition of the high value habitats that are located directly outside of the basin, including specifically upstream along Cache Creek. This approach allowed the project team to initially identify opportunities with high restoration potential. Using this approach, the project team identified nine preliminary habitat restoration concepts and one groundwater recharge concept through the use of aerial maps, high-resolution topography, and local knowledge related to land-use, infrastructure, target species, and habitats. Target species included, but were not limited to, numerous avian species (e.g., Swainson's Hawk, Tri-colored Blackbird, Western Yellow-billed Cuckoo, least Bell's vireo), and reptiles (e.g., Giant Garter Snake).

6.2 Preliminary Screening of Ecosystem Alternatives

Following the identification of the preliminary concepts, the project team conducted a qualitative evaluation of each concept. This evaluation process included assessing each concept's ability to provide ecological uplift, to include or support recreational activities, cost to construct and operate, estimated permitting complexity, effects on agricultural sustainability, overall feasibility of implementing the improvements, and contribution to reducing flood risks. The review focused on identifying realistic and feasible restoration concepts that would merit more detailed review due to their potential ability to be planned and implemented in the near future in connection with the identified flood improvement alternatives. Categories were scored Low, Moderate, or High representing potential or relative values associated with each category.

Nine preliminary habitat restoration concepts and one groundwater recharge concept were narrowed through a screening process to the four with the highest potential to be implementable in connection with the flood risk reduction alternatives identified in this study (See Appendix D. Environmental Constraints Analysis). These four concepts include the Cache Creek Non-Native Species Control Concept (Concept 1), the Working Waterways Projects Implementation Concept (Concept 2), the Cache Creek Gravel Pit Restoration Concept (Concept 5), and the Cache Creek Gravel Pit Recharge Basin Concept (Concept 6).

6.3 Description of Final Array of Alternatives

6.3.1 Cache Creek Non-Native Species Control Concept

The Cache Creek Non-Native Species Control Concept (Concept 1) includes implementing a non-native species control effort within the Cache Creek watershed to control the spread of arundo and other invasive species. Healthy riparian systems in California are biologically diverse, supporting many species of plants, animals and insects as well as aquatic species. Arundo out-competes native plants within riparian habitats due to its ability to monopolize soil moisture, light, and space. Within the Cache Creek riparian corridor, arundo has successfully infested large areas of the stream bank. The California Invasive Plant Council has mapped 85.7 acres of arundo infestation in Cache Creek (Yolo RCD 2018). However, ongoing eradication efforts by the Cache Creek Conservancy through their Invasive Weed Control Program have improved conditions along lower Cache Creek over the last several years.

Arundo removal and subsequent replant with native species would restore the riparian ecosystem along Cache Creek that has been degraded by non-native species infestations. This would improve riparian function and enhance natural plant species recruitment. Dense monocultures also restrict movement of native fauna through and across the riparian corridor. Riparian zones are critical corridors across the landscape; enhancing their function benefits both wetlands and adjacent uplands. Replanting riparian habitat following arundo removal would also contribute to listed-species recovery and would support native species. Land would be opened up for elderberry shrub recruitment, which supports the Valley elderberry longhorn beetle, and for bank improvements and riparian planting, which supports Giant Garter Snakes, Western yellow-billed cuckoo, and least Bell's vireo (Yolo RCD 2018). Due to its rapid growth rate, arundo can also reduce flood conveyance capacity, reducing the creek's ability to pass large flood events.

The purpose of this concept is to partner with the Yolo Resource Conservation District to assist them in implementing their Arundo-control efforts. The implementation of flood system improvements in the community of Yolo could provide an opportunity to leverage multi-benefit funding to achieve the ecosystem benefits associated with arundo removal.

6.3.2 Working Waterways Projects Implementation Concept

The Yolo Resource Conservation District teamed with the Audubon Landowner Stewardship Program, the Solano Resource Conservation District, and the Solano Land Trust to pursue implementation of Working Waterways Projects. The Working Waterways Projects effort is focused on developing, installing, and maintaining ecosystem function improvements on working landscapes in Yolo, Solano, and Colusa counties. The project was funded by California Department of Fish and Wildlife from 2012 through 2014. The Working Waterways Projects partners implemented a range of environmental projects on farm properties along working waterways using conservation funds from State and federal agencies.

Working Waterways Projects include three types of conservation projects:

- Vegetating levees, ditches, and canals to slow water flow, filter out pesticides and sediments, and provide species habitat
- Restoring riparian habitat to stabilize stream banks and support species that provide pollination, biological control, and food
- Constructing habitat or sediment ponds to control sediment and floods, to enable water reuse, and to create habitat (Solano Land Trust 2014)

Farm edges along working waterways in the region surrounding the community of Yolo provide a range of ecosystem services. The region has a substantial amount of agricultural land with farm edges along working waterways such as streams, canals, and irrigation ditches. These waterways are often described in terms of the functions they can provide such as improved water quality and quantity, carbon storage, and wildlife habitat. The health of riparian areas along farm edges can affect the quality and quantity of water, which impacts community services such as water treatment and sediment removal, flood control, and the need to drill deeper wells to reach ground water. Some wetland soils and different types of vegetation can also sequester carbon, which keeps greenhouse gases out of the atmosphere. The presence of native habitat increases the availability of wildlife and enhances recreational pursuits such as hiking, bird watching, and photography.

The objective of this restoration concept (concept 2) is to identify how working waterways can be used to offset ecosystem impacts associated with flood system improvements. As a representative project, the Yolo Resource Conservation District and their partners implemented habitat restoration along Cottonwood Slough as part of this Working Waterways effort. Cottonwood Slough is located east of CR 89 and south of Madison in Yolo County. The restoration effort included enhancing the north and south banks of the slough with native riparian vegetation. The project's ecosystem benefits include increased water-carrying capacity, floodwater storage and peak flow attenuation, water quality improvement, wildlife and fish habitat, improved aesthetics, increased groundwater recharge, and carbon storage. This type of project could be integrated into flood planning and design improvements within the community of Yolo through a collaborative partnership with the Yolo Resource Conservation District.

6.3.3 Combined Cache Creek Gravel Pit Restoration and Recharge Basin Concepts

The Cache Creek Gravel Pit Restoration Concept (Concept 5) includes rehabilitating and restoring existing gravel pits located along Cache Creek upstream of Yolo. The Cache Creek Gravel Pit Recharge Basin Concept (Concept 6) includes creating groundwater recharge basins using these same gravel pits. Because these concepts would likely be complimentary and could be implemented concurrently, they have been combined into a single concept.

Some of the existing gravel pits would require only minor rehabilitation for habitat purposes whereas others would involve moderate to significant grading, terracing, and planting of native vegetation, including woody riparian and emergent marsh species. The terracing would help control soil erosion and stabilize existing berms. Natural inundation through existing or modified

topography would be recommended over operable water diversions from Cache Creek to inundate pits. For groundwater recharge, the best opportunities are located along the more unconfined channel reaches and within existing gravel operations (e.g., Teichert, Vulcan, Cemex).

With the understanding that groundwater recharge potential in the target reach is high, a detailed evaluation of LiDAR topography and aerial photographs led to numerous restoration and rehabilitation actions that could be taken to simultaneously improve habitat and groundwater recharge in this heavily mined reach of Cache Creek. These specific actions are identified in the Community of Yolo Multi-Benefit Opportunities Technical Memorandum (Appendix E).

6.4 Final Screening of Ecosystem Alternatives

The preliminary ecosystem concepts were narrowed to those that would have a high feasibility of implementation. Four of the ten concepts met this criterion. These included the Cache Creek Non-Native Species Control Concept (Concept 1), the Working Waterways Projects Implementation Concept (Concept 2), the Cache Creek Gravel Pit Restoration Concept (Concept 5), and the Cache Creek Gravel Pit Recharge Basin Concept (Concept 6). These concepts were identified as having the highest potential to be implementable in connection with the flood improvement alternatives identified in the Feasibility Study. This screening process is described in detail in Appendix E. The restoration concepts were not narrowed further because any one of these four concepts could be feasibly paired with the flood improvement alternatives identified in this report.

Although a more detailed review of the other six concepts was not included in this report, the analysis of these concepts was done at a relatively high planning level and should be considered preliminary. The analysis is not intended to preclude these concepts from being evaluated in greater detail in future planning studies or from ultimately being considered for implementation.

6.5 Recreation Alternatives

As described in Appendix E, the Cache Creek Parkway Plan (Parkway Plan) identifies a long-term vision for recreational opportunities that could be developed within the Cache Creek Area Plan. To optimize the recreational benefits for the community of Yolo associated with Parkway Plan implementation, it is recommended that any flood system planning and design improvements proposed within Yolo also consider the integration of the multi-benefit recreational opportunities identified in the Parkway Plan, particularly those east of CR 94B near the community of Yolo. In addition, if the Cache Creek Borrow Pit Restoration and Recharge Basin Ecosystem Concepts described above are implemented as a multi-benefit project associated with flood improvements in the community of Yolo, the recreational improvements identified in the Cache Creek Parkway Plan for that area are recommended to be integrated into these concepts.

The implementation of Class II bike path improvements between Yolo and Woodland are also recommended to be integrated into any flood system planning and design improvements proposed within Yolo.

6.6 Multi-Benefit Projects

6.6.1 Cache Creek Parkway Plan Recreational Components

The Parkway Plan identifies a number of recreational opportunities within relatively close proximity to the community of Yolo. These include the 98-acre Teichert Woodland Muller property, the Teichert Muller Bridge, the 7-acre County Borrow Pit, the 115-acre Granite Woodland Reiff property, the 30-acre Rodgers Property, and the 38.9-acre Correll Property. All of these current and former mining properties are located east of CR 94B along Cache Creek within a 10-minute drive from the community of Yolo. The potential recreational opportunities for these properties include the following:

- **Teichert Woodland Muller Property** – This property includes an existing conveyer bridge that could provide pedestrian access over the creek. It is also adjacent to the Granite Woodland Reiff property to the east and a Nature Preserve to the west, which would allow it to be developed as a recreational node and trail connection location.
- **Teichert Muller Bridge** – This existing bridge could be converted to a pedestrian crossing that would provide a future link to a trail on the south side of the creek connecting to the Rodgers and Correll properties.
- **County Borrow Pit** – The property is leased by Teichert, who would be responsible for reclamation at the end of the lease term.
- **Granite Woodland Reiff property** – This property provides excellent direct public access to Cache Creek and CR 95B with approximately 3,800 linear feet of creek frontage. It also provides a large active recreational opportunity and habitat restoration potential.
- **Rodgers Property** – This property provides passive recreational opportunities and good public access including potential parking.
- **Correll Property** – This property provides passive recreational and riparian vegetation restoration opportunities. It would anchor the east end of the Parkway and could include trail connections with the Rodgers property.

The Parkway Plan also identifies trail and creek channel connections that extend through the length of the Cache Creek. The Parkway Plan further identifies regional trail connections that extend east and west beyond the plan boundaries. For the regional trail extension to the east, it is proposed to follow the levees along the eastern length of Cache Creek extending through Yolo, continuing to the CCSB, and then extending along CR 22 to South River Road and the City of West Sacramento. Two extensions are proposed to extend south from this eastern alignment following CR 99 and CR 102, respectively.

6.6.2 Class II Bike Lane Between Yolo and Woodland

The community of Yolo is located approximately 3.5 miles north east of the City of Woodland, which represents a relatively short bicycling distance between the two communities. However, the local roads that would be used for bicycle commuting, including Cacheville Road, CR 18 and CR 99, have narrow shoulders consisting of a mix of pavement and gravel, and vehicle speeds on these straight rural roadways can be quite high. These conditions discourage bicycle use on these roadways due to safety concerns. However, the Circulation Element of the 2030 Countywide General Plan (County of Yolo 2009) identifies a proposed Class II bike lane alignment that would more safely connect the community of Yolo to the City of Woodland's existing bicycle circulation system.

A Class II bike lane is a paved edge of a street or road delineated as a bike lane by white stripes and stencils. Figure CI-3B in the Circulation Element identifies the proposed bike lane alignment as extending southeast from Yolo along Cacheville Road to the intersection with CR 18. The alignment would continue east along CR 18 to the CR 18/ CR 99 intersection, at which point it would extend south on CR 99 (West Street) to CR 20 (Kentucky Avenue), where it would connect to an existing Class II bike lane on CR 99 within the City of Woodland. This same Class II bike lane alignment is also identified in the County of Yolo Bicycle Transportation Plan (Yolo County Transportation Advisory Committee 2013, pg. A2-18). As identified in this plan, the project includes widening the existing 24-foot wide roadways by four feet to accommodate Class II bike lanes on each side of the roadway alignment.

6.6.2.1 *Water Supply Improvement Opportunities*

The 2017 CVFPP Update strongly supports and encourages the planning and implementation of projects that provide multiple benefits. These benefits are not solely limited to ecosystem or recreational enhancements; they also include improving water supply and water quality. Within Yolo, the main groundwater well was installed in the early 1970s and it has periodically failed. Approximately three to four years ago, the well failed for several months due to deficiencies in the well casing. The existing well currently produces approximately 1,000 gpm. However, the number of water supply connections are near the water supply system's existing capacity. Also, the system's delivery capacity is insufficient for the Yolo Fire Protection District's fire apparatus. The current fire apparatus pumps produce up to 1,250 gpm, which exceeds the production capacity of the existing well. During fire events, this results in the water system being quickly drawn down. Once drawn down, the negative pressure that results from continued apparatus pump operations can damage components of the water delivery system. This water system deficiency requires the Yolo Fire Protection District to carefully manage their use of water during fire events, which can affect their fire suppression effectiveness. When the backup water supply system is used in the community, it only produces 500 gpm. At this level, the Yolo Fire Protection District cannot draw water from the system during fires using their apparatus pumps (Tafoya, D. 2019).

The improvements necessary to enhance the water supply system such that it meets applicable standards would likely include the drilling of a new well, the installation of new pumps, and the construction of water storage facilities. The integration of these water system improvements should be considered in any levee improvement planning and/or design within the community of Yolo, consistent with the integrated water management approach advocated for in the 2017 CVFPP Update.

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7 Implementation

The preferred structural alternative was identified as 'Restore Left Bank of Cache Creek to USACE 1957 Design Profile and Levee Improvements to Pass 100-year Flow' (Alternative 6) as explained in Section 4.6. This preferred structural alternative includes Cache Creek left bank levee next to the community of Yolo raised to pass USACE 1957 design profile, levee improvements to address through seepage, under seepage, stability, and erosion.

7.1 Phased Implementation of Structural Alternatives

The total cost for the preferred structural levee improvements is estimated to be approximately $16.7 million. Since the elements of the preferred alternative includes all the elements for 'Restore Left Bank of Cache Creek to USACE 1957 Design Profile' which is primarily the State's responsibility per California Water Code 8362, the study indicates that State should pay for approximately $8.7 million. The remaining $8 million could be potentially cost-shared by the State, Yolo County, the community, and other available funding sources.

The community and DWR should collaboratively identify and potentially implement any of the multi-objective ecosystem and or recreation benefit concepts identified above in Section 6 that are compatible and may coincide with planned levee improvements proposed herein and others that may be identified by DWR for the adjoining SPFC levee system for lower Cache Creek.

The community of Yolo, which is an economically disadvantaged community, should consider the following phasing for implementation to reduce flood risks.

7.1.1 Levee Improvements

Repair all known levee performance deficiencies immediately adjacent to the community as identified in Section 4.1.6. These improvements would include levee remediations for underseepage, through seepage and erosion. The total cost for these improvements were estimated at $7 million including contingencies.

7.1.2 Levee Raise

This phase would include zero to four feet of levee raise above current height near the community of Yolo. By raising the levees, the SPFC levee system adjoining Yolo would provide 3-feet of freeboard to pass the USACE 1957 design profile which is higher than 100-year WSE, assuming levee overtopping can still occur upstream of Yolo. The total cost for these levee raises were estimated at $9.7 million including contingencies.

7.2 Other Recommendations

7.2.1 FEMA Accreditation of Cache Creek Left Bank Levee per 44 CFR Section 65.10

Beyond enlarging the existing levee system to accommodate higher water stages and water volumes associated the 100-year peak event, the community may consider having the improved levee system certified and accredited to meet 100-year FEMA certification pursuant to 44 CFR Section 65.10. Full FEMA accreditation for the community of Yolo to meet the NFIP requirements will also require establishing high ground or certification of the highway and/or railroad embankments west of Yolo as described in Section 7.2.2 below.

To attain certification and accreditation of an improved and enlarged levee system along the left bank of Cache Creek the certification and accreditation process must consider all the following key elements pursuant to 44 CFR Section 65.10 during the design, construction, and documentation processes:

1. At least 3 feet of freeboard must be provided against the residual 100-year WSE downstream and east of Interstate-5 for the 0.50-mile reach adjacent to the community of Yolo
2. Proper positive closure devices are in place for any pipe or gate openings in the levee system
3. Adequate erosion control/embankment protection measures are in place, where applicable
4. The levee embankment and foundation meet USACE stability requirements and required factors of safety, including through seepage and underseepage safety factors for exit gradients
5. A settlement analysis is conducted to show there will not be residual long-term settlement concerns, or how they can be addressed and accommodated in the future
6. An interior drainage analysis is conducted to ensure local drainage systems/pumps are in place to drain local water away from the interior basin protected by the levee system
7. Design criteria and encroachments meet current design standards, and there are updated operation and maintenance manuals

Review of the items above indicate there are several design and geotechnical standards that must be met for accreditation purposes beyond having the levee embankment of the correct geometry and height to meet freeboard standards.

7.2.2 FEMA Accreditation of Highway and/or Railway Embankment(s)

With or without Alternative 7.2.1 associated with certifying the left bank levee of Cache Creek adjoining Yolo, the community may want to reduce flood risks by confirming or establishing non-levee embankments on the west side of Yolo. The non-levee embankments on the west side

of Yolo appear to exist in the form of the Caltrans Interstate-5 south-bound and north-bound separate highway embankments, the County frontage road embankment – Hwy 99W, and the Union Pacific Railroad embankment east of the County frontage road – Hwy 99W. Although these embankments are not formal levees, they could independently or collectively be evaluated, accredited, and maintained to serve as an official barrier of overbank flows entering Yolo originating from Cache Creek at or upstream of Interstate-5.

A review of overtopping or overbank flow simulations with overland flows originating from Cache Creek upstream and west of Interstate-5 indicate that the collective north- and south-bound highway embankments deflect said flows to the north over a distance of approximately 0.65 miles and send all overland flows west and north of Yolo, as far north as the "Interstate-5 – Yolo Exit" interchange with CR 17, north of Yolo. The flow simulations indicate the overland flows just west of Interstate-5 have an overland gradient over the 0.65 miles that is highest just north of Cache Creek at an approximate Elevation of 78, decreasing to Elevation 75 near the Interstate-5 northbound off-ramp exit to Yolo (Road 17), and decreasing further to Elevation 70 just northwest of the Interstate-5 Yolo interchange.

7.2.3 Cache Creek SPFC Levee Improvements Contemplated by DWR

As the primary LMA, DWR is responsible for restoring the Cache Creek SPFC levee system to the 1957 USACE Design Profile. Restoration of the Cache Creek SPFC levee system includes DWR restoring freeboard levels to a minimum of three feet above the USACE 1957 Design Profile, addressing erosion concerns and reductions in channel capacity due to subsidence, sedimentation, and long-term accumulation of non-native of vegetation. The community of Yolo is also looking to DWR to address any hydraulic impacts on the right bank of the Cache Creek levee system that may be associated with the community restoring and raising the left bank levee system in advance of the DWR improving said Cache Creek SPFC levee system. The community of Yolo and DWR should also collaborate on advancing the multi-objective restoration and recreation concepts identified above in Section 6 into actual components that may be implemented concurrently or following structural levee improvements along the SPFC levee system for lower Cache Creek.

7.2.4 Non-Structural Solutions Proposed for Implementation

Concurrently with implementation of the structural phases of the preferred structural alternative, Yolo County and the community of Yolo are recommending implementation of the following non-structural solutions to further reduce residual flooding in the community of Yolo. All of the non-structural solutions for implementation are described in more detail in Sections 5.1.1 through 5.1.7 The following non-structural solutions are highly recommended for implementation, some of which are already in the early stages of implementation:

- Voluntary flood proofing
- Support for continued improvement to the NFIP CRS for Yolo County/community of Yolo

- Mapping of flood depths, timing, duration, & evacuation maps for community of Yolo
- FIRO for Indian Valley reservoir releases
- Consolidation of Yolo County's Huff's Corner and DWR for OMRR&R and improvements to Cache Creek SPFC levee system