American River Watershed Project

Post-Authorization Change Report
And Interim General Reevaluation Report

American River Watershed
Common Features Project
Natomas Basin
Sacramento and Sutter Counties, California

SAFCA
Sacramento Area Flood Control Agency

CENTRAL VALLEY FLOOD PROTECTION BOARD
PUBLIC SAFETY AND FLOOD MANAGEMENT
STATE OF CALIFORNIA

US Army Corps of Engineers ®
Sacramento District

Main Report

October 2010

AMERICAN RIVER COMMON FEATURES PROJECT, NATOMAS POST AUTHORIZATION CHANGE REPORT AND INTERIM GENERAL REEVALUATION REPORT

U.S. Army Corps of Engineers
Sacramento District

October 2010

AMERICAN RIVER COMMON FEATURES PROJECT, NATOMAS POST AUTHORIZATION CHANGE REPORT AND INTERIM GENERAL REEVALUATION REPORT

TABLE OF CONTENTS

LIST OF PLATES

LIST OF APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

AEP	Annual Exceedance Probability
Airport	Sacramento International Airport
Caltrans	California Department of Transportation
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
cfs	Cubic Feet per Second
Common Features Project	American River Common Features Project
Comprehensive Study	Sacramento-San Joaquin River Basins Comprehensive Study
Corps	U.S. Army Corps of Engineers
CVFPB	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
DWR	California Department of Water Resources
EIR/EIS	Environmental Impact Report/Environmental Impact Statement
EIS	Environmental Impact Statement
Elkhorn Canal	Elkhorn Main Irrigation Canal
EQ	Environmental Quality
FAA	Federal Aviation Administration
FRM	Flood Risk Management
FEMA	Federal Emergency Management Agency
GGS	Giant Garter Snake
MOA	Memorandum of Agreement
MSL	Mean Sea Level
NAT	Natomas sub-basin
NBHCP	Natomas Basin Habitat Conservation Plan
NCC	Natomas Cross Canal
NED	National Economic Development
NEMDC	Natomas East Main Drainage Canal
NEPA	National Environmental Policy Act
NLIP	Natomas Levee Improvement Program

OMRR&R	Operation, Maintenance, Repair, Rehabilitation, and Replacement
OSE	Other Social Effects
PAC	Post-Authorization Change
PED	Planning, Engineering, and Design
PGCC	Pleasant Grove Creek Canal
PPA	Project Partnership Agreement
Pumping Plant 2	Prichard Lake pumping facility
RD	Reclamation District
RED	Regional Economic Development
ROD	Record of Decision
SAFCA	Sacramento Area Flood Control Agency
SCAS	Sacramento County Airport System
SCB	soil-cement-bentonite
SIR	Supplemental Information Report
SR	State Route
SRA	Shaded Riverine Aquatic
SRFCP	Sacramento River Flood Control Project
State	California Department of Water Resources and the Central Valley Flood Protection Board
TNBC	The Natomas Basin Conservancy
USBR	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
WRDA	Water Resources Development Act

This page left intentionally blank.

AMERICAN RIVER COMMON FEATURES PROJECT, POST AUTHORIZATION CHANGE REPORT

1. INTRODUCTION

This post authorization change report was prepared as the result of an interim general reevaluation study of the American River Common Features project that specifically identified changes to the Natomas portion of the authorized project. The Natomas Basin is a separable element of the authorized Common Features Project. While other significant changes are expected in the future to reduce risks in areas subject to flooding from the Lower American and Sacramento rivers, only improvements to the Natomas Basin levees are the subject of proposed changes at this time.

The Sacramento Area Flood Control Agency (SAFCA), in cooperation with the California Department of Water Resources and the Central Valley Flood Protection Board (CVFPB), have initiated urgently needed improvements to the Federal project levee system protecting the Natomas Basin. These improvements address identified deficiencies in the levee system based on the recent recognition of seepage problems that has caused experts to significantly downgrade the system's performance capability. In July of 2006, the U.S. Army Corps of Engineers (Corps) withdrew the certification of the Natomas Levee System. In response, the Federal Emergency Management Agency (FEMA) withdrew the 100-year flood protection certification that was granted to the levee system only a decade ago. These events have created substantial public safety and economic challenges for the Sacramento Area, the State, and the Federal Government. A catastrophic failure of the levee system around the Natomas Basin would cause a loss of over $7 billion in residential, commercial, and industrial property damage, imperil the health and safety of 80,000 residents, and shut down Sacramento International Airport and two of California's most important interstate freeways. SAFCA and the State are addressing these challenges by moving aggressively forward with the Natomas Levee Improvement Program. The Program implements features from the several prior Congressional authorizations of the Common Features Project. SAFCA and the State anticipate that the early implementation project will be incorporated into the Federally-authorized American River Common Features Project.

2. DESCRIPTION OF AUTHORIZED PROJECT

a. Project Location. The American River Common Features project is being developed to provide flood risk management to the City of Sacramento, including the Natomas Basin and areas along the North and South banks of the American River. Plate 1 shows the project area.

b. Project Sponsor. The non-Federal sponsor for the project and general reevaluation study is the State of California CVFPB. SAFCA has a Local Cooperation Agreement with the CVFPB.

c. Authorized Project Features. The authorized project is a single purpose flood risk management project with an authorized total cost of $205,000,000 (2004). The project includes the following features:

- Approximately 24 miles of slurry wall in the levees along the lower American River.

- Approximately 12 miles of levee modifications along the east bank of the Sacramento River downstream from the Natomas Cross Canal.

- Three telemeter stream flow gauges upstream from the Folsom Reservoir.

- Modifications to the flood warning system along the Lower American River.

- Raising the left bank of the non-Federal levee upstream of the Mayhew Drain for a distance of 4,500 feet by an average of 2.5 feet.

- Raising the right bank of the American River levee from 1,500 feet upstream to 4,000 feet downstream of the Howe Avenue Bridge by an average of 1 foot.

- Modifying the south levee of the Natomas Cross Canal for a distance of 5 miles to ensure that the south levee is consistent with the level of protection provided by the authorized levee along the east bank of the Sacramento River.

- Modifying the north levee of the Natomas Cross Canal for a distance of 5 miles to ensure that the height of the levee is equivalent to the height of the south levee.

- Installing gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates.

- Installing a slurry wall in the north levee of the American River from the east levee of the Natomas east Main Drain upstream for a distance of approximately 1.2 miles.

- Installing a slurry wall in the north levee of the American River from 300 feet west of Jacob Lane north for a distance of approximately 1 mile to the end of the existing levee.

- Installing a total of 3.6 miles of discontinuous slurry wall at nine levee sites beginning at Levee Mile 2.9 and ending at Levee Mile 10.3 in the Pocket Area.

- Installing six relief wells and collector drains and appurtenant features and a landside berm on the levee toe in the Pioneer Reservoir area.

d. Authorized Local Cooperation Requirements. Authorized Local Cooperation includes requirements to:

- Provide lands, easements, and rights-of-way.

- Modify or relocate utilities, roads, bridges (except railroad bridges), and other facilities, where necessary for the construction of the project.

- Pay 20 percent of the costs allocated to flood control to bring the total non-Federal share of flood control costs to 25 percent, as determined under Section 103(m) of the Water Resources Development Act (WRDA) of 1996, as amended.

- Bear all costs of operation, maintenance, repair, rehabilitation and replacement of flood control facilities.

3. AUTHORIZATION

The Common Features Project was authorized in WRDA 1996, Pub. L. 104-303 (S 640), Sec. 101(a) (1), 110 STAT. 3658, 3662-3663 (1996), as amended by the Energy and Water Development and Related Agencies Appropriations Act of 2008, Pub. L. 110-161 (HR 2674), Sec. 130, 121 STAT. 1844, 1947 (2007). Additional authority was provided in WRDA 1999, Pub. L. 106-53 (S 507), Sec. 366, 113 STAT. 269, 319-320 (1999). Significant changes to the project were approved via the Supplemental Information Report of March 2002. Additionally, the Energy and Water Development Appropriations Act of 2004, Pub. L. 108-137 (HR 2754), Sec. 129, 117 STAT. 1827, 1839 (2003) increased the authorized total cost of the project to $205,000,000. The current estimated cost of the authorized project is $274,100,000. The allowable (Sec. 902) cost limit is $284,000,000 under WRDA 1986, Pub. L. 99-662 (HR 6), Sec. 902, 100 STAT. 4082 (1986).

4. FUNDING SINCE AUTHORIZATION

Since the authorization of the project as part of WRDA 96 and WRDA 99, portions of the project have been implemented. Table 1 lists the Common Features work sites and their status.

Table 1 - Common Features Project Work Sites and Status

Item	Feature	Authorization, Overview, and Status
1	24 miles of slurry wall in the American River levees	Authorization; WRDA 96. Overview; general seepage and stability remediation on the American River. Status; approximately 20 miles of seepage cutoff wall, 0.15 miles of jet grout, and 0.20 miles of seepage berm constructed on the American River. 16 windows in the seepage cutoff wall exist at utility or road crossings of the American River, which are in various phases of design and construction for remediation of seepage and stability deficiencies.
2	12 miles of levee improvements, Sac. River east levee in Natomas.	Authorization; WRDA 96. Overview; general seepage, stability, and height remediation on the Sacramento River east levee in the Natomas Basin. Status; on hold pending authorization from this study.
3	3 telemetry streamflow gages u/s of Folsom Dam	Authorization; WRDA 96. Overview; installation of 3 telemetry streamflow gages upstream of Folsom Dam and reservoir. Status; complete.

Item	Feature	Authorization, Overview, and Status
4	Modification of the existing flood warning system	Authorization; WRDA 96. Overview; modifications to the existing flood warning system for the City of Sacramento. Status; not yet complete.
5	Mayhew Levee upstream of the Mayhew Drain	Authorization; WRDA 99. Overview; general seepage, stability, and height remediation on the American River left bank levee upstream of Mayhew Drain and installation of a closure structure on the Mayhew Drain to prevent the American River from backing up into the drain. Status; complete.
6	North Levee Raise Upstream of Howe Avenue	Authorization; WRDA 99. Overview; general height remediation on the American River right bank levee in the vicinity of Howe Avenue. Status; design to be complete by December 2010 with construction to occur in 2011 and 2012.
7	5 miles of levee improvement, Natomas Cross Canal south levee in Natomas	Authorization; WRDA 99. Overview; general seepage, stability, and height remediation on the Natomas Cross Canal south levee in the Natomas Basin. Status; on hold pending authorization from this study.
8	5 miles of levee improvement, Natomas Cross Canal north levee in Natomas	Authorization; WRDA 99. Overview; general seepage, stability, and height remediation on the Natomas Cross Canal north levee opposite the Natomas Basin, intended to maintain parity. Status; on hold pending authorization from this study.
9	North Levee Strengthening between NEMDC and Business I-80	Authorization; WRDA 99. Overview; general seepage and stability remediation on the American River right bank levee upstream of NEMDC. Status; design to be complete in 2011 with construction to occur in 2012.
10	North Levee upstream of Watt Avenue (Jacobs Lane)	Authorization; WRDA 99. Overview; general seepage and stability remediation on the American River right bank levee in the vicinity of Jacobs Lane. Status; this project has been divided into three sections. Construction of Section A was completed in 2009 and Section B will be completed in July 2010. Construction of Section C will be determined after vegetation on levee issues have been addressed. The work consists of reshaping the levee in spots and increasing the height of the levee up to a foot.
11	Pocket Geotech Reaches 2 and 9, and Pioneer Reservoir	Authorization; 2004 Post-Authorization Change. Overview; general seepage and stability remediation at 3 sites on the Sacramento River east levee downstream of the American River. These sites include Pocket Geotechnical reaches 2 and 9 as well as the Pioneer Reservoir site. Status; complete.

A funding history, by fiscal year, is shown in Table 2, History of Federal Funding, indicating the category in which funds have been appropriated and the items of work (listed in Table 1) for which the funds have been utilized.

Table 2 - History of Federal Funding

Fiscal Year	General Investigation	Construction General	American Recovery and Reinvestment Act	Use of Funds (Items listed in Table 1)
1996	$864,000			Completion of feasibility study
1997	$1,662,000			PED for Item 1
1998	$125,000	$9,400,000		PED for Item1
1999		$15,000,000		PED and Construction for Item 1
2000		$17,000,000		PED and Construction for Item 1
2001		$10,000,000		PED and Construction for Item 1
2002		$14,000,000		PED and Construction for Item 1
2003		$22,280,000		PED and Construction for Item 1
2004		$4,000,000		PED for Items 1 and 11; Construction of Item 1
2005		$5,000,000		PED for Items 1, 5, and 11; Construction of Item 1
2006		$4,405,000		PED for Items 1 and 5; Construction of Items 1 and 11
2007		$19,400,000		PED for Items 1, 5, and 10; Construction of Items 1 and 5
2008		$7,872,000		PED for Items 1, 5, 6, 9, and 10; Construction of Items 1, 5, and 10
2009		$13,000,000	$3,900,000	PED for Items 1, 5, 6, 9, and 10; Construction of Items 1, 5, and 10
2010		$6,300,000	$9,800,000	PED for Items 1, 6, 9, and 10; Construction of Items 1 and 5

5. CHANGES IN SCOPE OF AUTHORIZED PROJECT

The recommended plan includes the constructed features of the authorized project along the lower American River and a more extensive plan for reducing flood risk to the Natomas Basin. The plan for the Natomas Basin includes features that are currently authorized for construction by Congress as part of the Common Features Project along with additional features to address identified deficiencies in the levee system based on the recent recognition of seepage problems that has caused experts to significantly downgrade the existing system's performance capability.

Table 3 – Changes in the Authorized Project

Location	Reach(es)	Authorized Features	Recommended New Features
Lower American River	I	Modify 12 miles of north bank levee on American River to reduce chance of seepage through the existing levee. (WRDA 96) Construct slurry wall down centerline of existing levee to better withstand hydraulic forces during higher water stages	Widen 1.8 miles of levee in place and install seepage cutoff wall through levee and foundation.
		Modify12 miles of south bank levee on American River to reduce chance of seepage through the existing levee. (WRDA 96) Construct slurry wall down centerline of existing levee to better withstand hydraulic forces during higher water stages	None
		Raise left bank of non-Federal levee upstream of Mayhew Drain for a distance of 4,500 feet by an average of 2.5 feet. (WRDA 99) Raise the right bank of the American River levee from 1,500 feet upstream to 4,000 feet downstream of the Howe Avenue Bridge by an average of 1 foot. (WRDA 99) Install gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates. (WRDA 99) Install a slurry wall on the in the north levee of the American River from the east levee of the Natomas East Main Drain upstream for a distance of approximately 1.2 miles. .(WRDA 99) Install a slurry wall in the north levee of the American River from 300 feet west of Jacob Lane north for a distance of approximately 1 mile to the end of the existing levee.(WRDA 99)	None
Natomas – Sacramento River	A, B, C	Modify 12 miles levee on east (left) bank of Sacramento River below Natomas Cross Canal. (WRDA 96)	Widen 18.3 miles of existing levee by construction of an adjacent levee, install 12.3 miles of deep seepage cutoff walls, and install 8.3 miles of seepage berm, all on east bank of Sacramento River below Natomas Cross Canal

Location	Reach(es)	Authorized Features	Recommended New Features
Natomas – Pleasant Grove Creek Canal	E		Widening of the existing levee in place and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet.
Natomas - Natomas East Main Drain	F, G, H		Widening of 12.8 miles of the existing levee and installation of 10.7 miles of soil bentonite cutoff wall.
Natomas – Natomas Cross Canal	D	Modify south levee of Natomas Cross Canal for 5 miles and ensure levee provides consistent level of protection as provided on east bank of Sacramento River. (WRDA 99)	Widening of 5.0 miles of existing levee using in-place construction and install deep seepage cutoff walls on south bank of Natomas Cross Canal.
		Modify north levee of Natomas Cross Canal for 5 miles in parity with south levee. (WRDA 99)	None
Pioneer Site – Sacramento River	N/A	At RM 58.5 – left bank of Sacramento River: Seepage berm 5 feet from ground level and 500 feet long with relief wells(a total of six) on both the north and south end of the berm (Chief's Discretionary Authority)	None
Pocket Area Sites – Sacramento River	N/A	Strengthen levee with slurry wall down centerline of levee at following sites: Pocket Site 2 – approx. 0.3 miles (RM 52.1-52.4) Pocket Site 9 – approx. 0.3 miles (RM 45.5-45.7) 1480 linear ft of 40' deep conventional slurry wall	None

6. CHANGES IN PROJECT PURPOSE

There are no changes in the project purpose. Flood risk management is the single project purpose for both the authorized project and the recommended plan.

7. CHANGES IN LOCAL COOPERATION REQUIREMENTS

As indicated above, the non-Federal sponsor for the project is the CVFBP. SAFCA has a Local Cooperation Agreement with the State.

The original project was authorized with cost sharing of 75% Federal and 25% Local specifically named in the legislation. Conventional cost sharing under the requirements of WRDA 1986 as amended for flood risk management projects is 65% Federal and 35% Local. The new project components recommended in this report will be cost-shared at 65% Federal and

35% Local. When the new components and old components of the project are combined, the resulting cost sharing is 66.3% Federal and 33.7% Local.

The State of California and SAFCA have expressed the desire for implementing the project and sponsoring project construction in accordance with the items of local cooperation that are set forth in the recommendations chapter of the supporting limited reevaluation report. The non-Federal sponsors have certified that they are financially capable of participating in the selected plan.

The California Legislature has approved State participation with funding made available through voter approval of the Infrastructure Improvement, Smart Growth, Economic Reinvestment and Emergency Preparedness Financing Act of 2006. Local participation is authorized under the provisions of the Sacramento Area Flood Control Agency Act of 1990 based on property owner approval of SAFCA's Consolidated Capital Assessment District in 2007.

8. CHANGE IN LOCATION OF PROJECT

The authorized project identified specific reaches for improvements that included features for flood risk management to the Natomas Basin. At the time of authorization, it was assumed that the authorized features would provide a high level of flood risk management to the Natomas Basin. This report recommends additional features around the perimeter of the Natomas Basin to address the same flood risk management objective as the authorized project. There is, therefore, no change in the project location.

9. DESIGN CHANGES

The authorization for the project does not specifically mention the design details of the project in the Natomas Basin, but does specify the extent of the remediation. The Chief's Report for the 1996 Supplemental Information Report specifies levee improvements to provide protection to a 400-year flood event. The 1996 authorizing language specified 12 miles of levee modification along the Sacramento River in Natomas, and was addressed in the Chief's Report. These modifications included levee raising and enlarging of a stability berm. The 1999 authorizing language specifies modifying the south levee of the Natomas Cross Canal for a distance of five miles to ensure that the south levee is consistent with the level of protection provided by the authorized levee along the east bank of the Sacramento River. These modifications included levee raising and strengthening.

The reasons for major changes in design are twofold. First, on the 12 miles of Sacramento River levee authorized in WRDA 96, and on the five miles of Natomas Cross Canal levee authorized in WRDA 99, the remediation necessary was much more extensive than was understood at the time of authorization. After the 1997 flood event, deep levee underseepage was observed in the Natomas Basin. For the first time, underseepage was identified as a serious threat to levee stability and performance. Therefore, it was necessary to change the design of shallow seepage cutoff walls that had been intended to control through-seepage to much deeper

seepage cutoff walls for control of underseepage. Second, further evaluations of the underseepage problem indicated that nearly all 42 miles of the perimeter levee system required remediation before the flood threat would be significantly reduced.

The combination of the expansion of the project to cover the entire perimeter of Natomas, the changes in design in Natomas, and the changes in the design of the constructed components of the Common Features project along the American River also increased project costs.

It is anticipated that there will also be changes in the Common Features project along the Sacramento River south of the American River. These changes will be addressed in the upcoming Common Features General Reevaluation Report. But improvements to the Natomas Basin are not dependent on other anticipated changes.

10. CHANGES IN TOTAL PROJECT FIRST COSTS

Table 4, Project First Cost, is a four-column comparison of the estimated cost for the project being recommended, the project as authorized by Congress, the authorized project updated to October 2010 price levels, and the project last presented to Congress.

Table 4 - Project First Cost ($000)

Construction Item	Natomas Features of Recommended Plan[1]	Authorized Cost[2]	Current Project Cost Estimate[3]	Recommended Plan[4]
Lands and Damages	223,830	5,750	17,173	241,003
Relocations	110,766	460	381	111,147
Fish & Wildlife Facilities	18,869	1,730	2,075	20,944
Levees & Floodwalls	388,083	153,760	169,497	557,580
Pumping Plants	56,135	0	0	56,135
Cultural Resources Preservation	6,578	750	1,190	7,768
Subtotal	804,261	162,450	0	804,261
Planning Engineering & Design (PED)	148,711	35,380	71,604	220,315
Construction Management	158,588	7,170	16,060	174,648
Total First Cost	1,111,560	205,000	277,980	1,389,540
Associated Costs	0	0	0	0
Total Costs	1,111,560	205,000	277,980	1,389,540

[1] Natomas Features of Recommended Plan includes work recommended by this report within the Natomas Basin.
[2] Authorized Cost is as reflected in the 2001 Limited Reevaluation Report, and authorized by Congress in 2002. This is the last authorization by Congress on the Common Features project. The Authorized Cost, adjusted for inflation to 2010 is $254,274,000.
[3] Current PCE is the current Project Cost Estimate for the authorized project as reflected in the most recent budgetary updates. The current Section 902 limit for this work is $295,274,000.
[4] Recommended Plan reflects the Natomas Features of Recommended Plan as reported in this document (totaling $1,111,560,000) plus the current Project Cost Estimate for the Authorized Project (totaling $277,980,000) for a total of $1,389,540,000.

11. CHANGES IN PROJECT BENEFITS

Table 5, Economic Summary, shows a comparison of the benefits given in the project document, the benefits last reported to Congress, and the benefits based on reevaluations that have been done to support the recommended changes to the project. The evaluation of benefits has been limited to those that would accrue to structures and contents and do not include other benefit categories at this time, such as savings in emergency costs. Table 5 shows a breakdown of first and annual costs and benefits of the recommended plan, along with net economic benefits and benefit-to-cost ratio.

Table 5 - Economic Summary ($000)

Item	Natomas Features of Recommended Plan[1]	Authorized Project		
		Authorized Cost/Benefits[2]	Reported to Congress[3]	Recommended Plan
Investment Cost				
First Cost	1,111,560	205,000	277,980	1,389,540
Interest During Construction (IDC)	158,591	49,570	17,998	176,589
Total	1,263,573	248,880	294,788	1,558,361
Annual Cost				
Interest and Amortization	62,644	16,066	14,615	77,259
OMRR&R	5,180	50	85	5,265
Subtotal	67,824	16,116	14,700	82,524
Annual Benefits				
Monetary (FRM)	443,000	42,300	59,500	502,500
Non-monetary	Not applicable	Not applicable	Not applicable	Not applicable
Net Annual FRM Benefits	375,176	26,184	44,800	419,976
FRM Benefit-Cost Ratio	6.5	2.6	4.0	6.1
FRM Benefit-Cost Ratio (@7%)	4.2	Not applicable	2.6	3.9

[1] First costs for Recommended Plan are cost estimates prepared using the Corps' Micro-Computer Aided Cost Estimating System (MCACES) and differ from the screening-level cost estimates used in the economic analysis; values in October 2010 prices using 4.375% interest rate, unless otherwise noted

[2] Authorized costs/benefits are in October 2001 prices using a 6.125% interest rate, unless otherwise noted; source of data is the American River Watershed Project (Common Features), CA, Second Addendum to the Supplemental Information Report (SIR); benefits include those pertaining to the Natomas Basin

[3] Current estimate of benefits for the Authorized Project does not include Natomas Basin; values are in October 2010 prices using a 4.375% interest rate, unless otherwise noted.

12. BENEFIT-COST RATIO

Estimated total annual costs and annual benefits are calculated at an interest rate of 4.375 percent, over a 50-year period of economic evaluation. Table 5 above shows the benefit-to-cost ratio. It also shows a comparison of the benefit-cost ratios for the project being recommended, the project as authorized by Congress, the authorized project updated to current price levels, and the project last presented to Congress. The benefit-cost ratio for the Natomas features is 6.5 and the benefit-cost ratio for the Common Features project is 6.1.

13. CHANGES IN COST ALLOCATION

There are no changes in cost allocation for the project. All costs are allocated to the flood risk management project purpose for both the Recommended and Authorized projects.

14. CHANGES IN COST APPORTIONMENT

Table 6, Cost Apportionment, shows the Federal and non-Federal costs of the authorized project at current price levels. Table 7, Cost Apportionment, shows the Federal and non-Federal costs of the recommended project at current price levels. For those areas along the lower American River, the authorized improvements cost share is 75% Federal and 25% non-Federal. For those improvements for the Natomas Basin, the cost share is 65% Federal and 35% non-Federal.

Table 6 - Cost Apportionment ($000)

Item	Authorized Project		
	Federal Cost	Non-Federal Cost	Total Cost
Existing Authorized Common Features Project			
PED	71,409	195	71,604
LERRD	2,227	15,327	17,554
Remaining FDR Work	188,811	11	188,822
Project Subtotal	262,447	15,533	277,980
Cash Requirement	-53,962	53,962	
Total Project	208,485	69,495	277,980
Natomas Features of Recommended Plan			
PED	129,097	19,614	148,711
LERRD	18,492	316,104	334,596
Remaining FDR Work	620,698	7,555	628,253
Project Subtotal	768,287	343,273	1,111,560
Cash Requirement	-45,773	45,733	
Total Project	722,514	389,046	1,111,560
Recommended Plan			
PED	200,506	19,809	220,315
LERRD	20,719	331,431	352,150
Remaining FDR Work	809,509	7,566	807,075
Project Subtotal	1,030,734	358,806	1,389,540
Cash Requirement	-99,735	99,735	
Total Project	930,999	458,541	1,389,540

October 2010 Price Levels
Does not account for Non-Federal cash contribution

Table 7 – Funding Requirements[1] ($000)

Fiscal Year	Federal Appropriations	Non-Federal Contributions	Total Requirements
FY 2010	3,308	1,782	5,090
FY 2011	4,633	2,494	7,127
FY 2012	24,135	29,912	54,047
FY 2013	164,343	88,355	252,698
FY 2014	115,873	64,546	180,419
FY 2015	99,474	119,408	218,882
FY 2016	37,007	23,597	60,604

1 – Recommended Plan for Natomas only without any non-Federal credit for past work assumed

15. ENVIRONMENTAL CONSIDERATIONS IN RECOMMENDED CHANGES

Improvements in the Natomas Basin have been the subject of several Environmental Impact Statements/Environmental Impact Reports (EIS/EIR). A final EIS/EIR for Reach 4b is published with and is an integral part of the interim general reevaluation report.

In the Natomas Basin, the plan will provide incidental environmental benefits by capitalizing on the geographic scope and volume of soil borrow material necessary to support the required levee improvements. The plan includes a variety of landscape features that will have the substantial effect of expanding, connecting and enhancing the aquatic and upland habitat preserves that have been created in the Natomas Basin as part of the Natomas Basin Habitat Conservation Plan: reducing wildlife hazards in the vicinity of the Airport through improved storm and surface water drainage; and promoting agricultural sustainability in the western portion of the Basin through improvements to the existing agricultural irrigation system.

Public comments on the Draft EIS/EIR were accepted during the 45-day public review period ending on August 16, 2010. The major public concerns are; tree removal, loss of habitat, disturbance to the residents during construction, transfer of risk of flooding. Federal Environmental Protection Agency also raised a concern with regards to exceeding Federal air quality standards, however, additional emission reduction requirements on construction equipment and construction phasing has brought the project into compliance.

In 2006, the Corps and local sponsor began coordination with the resource agencies for Section 7 Consultation under the Endangered Species Act. This coordination resulted in a Programmatic Biological Opinion (B.O.) for the Natomas Levee Improvement Project, which includes Phases 1, 2, 3, and 4a from Fish and Wildlife Service. The consultation for the Phase 4b project is still underway with a BO expected in the next several months. The continued coordination over the past several years has resulted in a Biological Assessment (BA) being prepared which accurately described the mitigation measures. As a result of this coordination the BO's received for the previous four phases have obtained mitigation measures similar to what was proposed in the BA. Therefore, no additional mitigation is anticipated beyond what is already presented as the preferred alternative for the Phase 4b Landside Improvement Project.

Coordination with National Marine Fisheries Service (NMFS) over the past several years has resulted in receiving a concurrence letter of "not likely to adversely affect" list species. The design for the 4b project has been fully coordinated with NMFS and a concurrence letter is expected for the Phase 4b project. NMFS participated in site visits to the location where trees will be removed for the project to assess the impacts and coordinate the mitigation site. Comments received on the DEIS/EIR from NMFS were minimal and no additional mitigation is anticipated beyond what is presented in the existing preferred alternative.

16. PUBLIC INVOLVEMENT

The USACE published an NOI to prepare the American River Common Features General Reevaluation Report (GRR) EIS in the Federal Register (Vol. 73, No. 41) on February 29, 2008 and a series of public meetings were held in March 2008. On November 5, 2009, SAFCA issued a NOP for the EIS/EIR and copies of the NOP were distributed to approximately 900 recipients and a notice was published in The Sacramento Bee on November 5, 2009. The NOP was circulated for a 30-day comment period, these comments are included in Chapter 7- Consultation and Coordination, of the DEIS/DEIR.

The Draft EIS/EIR for the American River Watershed Common Features Project (Common Features)/Natomas Levee Improvement Program (NLIP)/Phase 4b Landside Improvements Project (Phase 4b Project) was released for public and agency review and comment in accordance with NEPA and CEQA requirements. The review period began on July 2, 2010 and closed on August 16, 2010. During this time, four public meetings were held and written comments were received from the public and agencies.

These comments and the responses to them can be found in Appendix I- Public Involvement of the FEIS/FEIR.

17. HISTORY OF PROJECT

The history of the Sacramento River Flood Control Project (SRFCP) dates back to the mid 1800's with the initial construction of levees along the Sacramento, American, Feather, and Yuba rivers. The early history of the system was characterized by trial and error, with initial construction followed by a levee failure, followed by improvement (strengthening and/or raising), followed by another levee failure, etc. This continued until the California Legislature authorized a comprehensive plan for controlling the flood waters of the Sacramento River and its tributaries in the Flood Control Act of 1911. This plan, which included the Natomas levee system, was approved by Congress in the Flood Control Act of 1917, Pub. L. 64-367, which authorized Federal participation with the State of California in construction of the flood control system.

Historically, from the mid 1800's onward, most hydraulic engineers at the Federal, State and local level thought that the most effective way to control flood flows in the river system was to construct levees close to the main channel. This approach served two purposes. First it allowed reclamation of as much land as possible for agricultural purposes. Second it kept flows in the main channel and thus helped to flush out the hydraulic mining debris that clogged much

of the river system and impaired navigation. Similar thinking guided flood control efforts along the Mississippi River during this period.

The record floods of 1907 and 1909 forced a re-evaluation of this historic approach. It was clear from the size of these flood events in relation to existing channel capacities that major bypass systems were needed to control excess flood flows. These bypass systems, which are described below, were incorporated into the comprehensive plan adopted by the State Legislature and later approved by Congress.

Federal participation in the SRFCP began shortly after authorization in 1917 and continued for approximately 40 years. The completed flood control system was documented in 1957 in a design memorandum, which included design water surface profiles. To this day, these are the profiles, which govern the operation and maintenance requirements of the levee system.

The system is designed to keep all flows from floods up to a certain magnitude within the Sacramento River channel, and to divert flows into the bypass system once this magnitude is exceeded. Throughout the SRFCP, the frequency that flow starts to divert from the Sacramento River to the bypass system varies between a 3-year to 5-year flood event.

Locations where flow is allowed to spill from the Sacramento River into the bypass system include three overflow locations upstream of the project levees, Moulton Weir, Colusa Weir, and Tisdale Weir, and two overflow locations in the vicinity of the Natomas Basin, the Fremont Weir and the Sacramento Weir. Flow from these weirs (or overflow locations) enters the Butte Basin, the Sutter Bypass, or the Yolo Bypass. Flows from the Feather and American rivers are also diverted into the bypass system near where they intersect the Sacramento River, and the bypass systems directly receive outflows from many smaller tributaries.

The Fremont Weir is perhaps the most significant over flow location in the system. The Sacramento River crosses from the center of the Sacramento Valley toward the east near the north extent of the Natomas Basin. Because the river crosses the valley, the bypass system had to be constructed such that it crossed the river. The Fremont Weir forces flow up to the 3- to 5-year frequency event to stay in the river and allows flow to spill to the Yolo Bypass once this frequency is exceeded.

Folsom Dam and much of the north levee of the American River were authorized by Congress in the late 1940's. Folsom Dam was designed such that the flood control space would accommodate the Standard Project Flood (SPF), which did not have a specific frequency, but was estimated to be between the 250 and 500 year event. Construction of Folsom Dam was nearing completion in 1955 when a new flood of record was experienced. This flood event caused the objective release for Folsom Dam to occur. Afterward, hydrology for Folsom Dam was reassessed with the 1955 flood event included in the analysis. This assessment showed that the City of Sacramento downstream of Folsom Dam and adjacent to the American River had considerably less flood protection, even with Folsom Dam, than was previously realized. Discussion soon began about the need for additional storage upstream of Folsom Dam, which led to a proposal for flood control dam near the town of Auburn.

Auburn Dam was authorized by Congress in the 1960's. The Auburn Dam project included additional flood control space to restore the flood performance that Folsom Dam was originally thought to provide. Design efforts began soon afterward by the U.S. Bureau of Reclamation (USBR) with construction effort beginning in the early to mid 1970's. A diversion tunnel around the dam site, foundation preparation, and a cofferdam to divert flow to the diversion tunnel had been completed when in 1976, an earthquake occurred near the Oroville Dam location. Oroville Dam had been completed approximately five years before.

The earthquake, occurring so near a dam site, caused significant concerns about dam safety. Because of this, the U.S. Geologic Survey became involved investigating faults throughout California. This investigation discovered a fault near the location of the proposed Auburn Dam. The USBR design for Auburn Dam was a thin arch concrete dam, which, while being very strong, is susceptible to earthquake damage. All design concerns were resolved and it was determined that a safe dam could be constructed at the Auburn site using a different concrete dam design. Construction efforts were then put on hold pending a future decision on Auburn Dam. For a variety of other reasons the Auburn Dam project was not restarted.

No decision on Auburn Dam was made and the completed cofferdam and diversion tunnel sat unaltered until 1986. In 1986, a new flood of record occurred (which is currently the flood of record for the American River). The 1986 flood washed out the cofferdam. This flood very nearly caused catastrophic flooding of the City of Sacramento.

The objective release of Folsom Dam is 115,000 cubic feet per second (cfs) and the emergency release is 152,000 cfs. Since construction of Folsom Dam, the objective flow rate has been met in 1955, 1964, 1986, and 1997. Based on experience from the 1955 and 1964 flood events, the ability of the American River levees to convey flow in excess of 115,000 cfs was somewhat uncertain because of the considerable flood fight activity required to convey 115,000 cfs.

In the 1986 flood event, Folsom reservoir rapidly filled up. At the time, USBR, the Corps, and the California Department of Water Resources (DWR) all agreed that the release from Folsom Dam needed to be raised above 115,000 cfs to manage the risk of a dam failure. The release from Folsom Dam was increased to 134,000 cfs. This flow seriously stressed the American River levees and came dangerously close to causing levee failures into the City of Sacramento. In addition, conditions at Folsom Dam were such that the operator of the dam (USBR) was within one hour of having to open the emergency gates of Folsom Dam, which would have released considerably more than 152,000 cfs, and flooded the City of Sacramento. Fortunately the storm abated and the inflow reduced such that releases higher than 134,000 cfs did not have to be made.

After the flood of 1986, Congress directed the Corps to investigate the feasibility of reducing the flooding risk of the City of Sacramento. The Corps completed that feasibility study in 1991. The recommended plan in this study was a concrete gravity flood detention dam at the Auburn Dam location along with levee improvements downstream of Folsom Dam. Due to environmental and cost concerns, Congress chose not to authorize the detention dam and instead

directed the Corps to supplement the analysis of flood control options considered in the 1991 study. This supplemental study was completed in 1996.

While Congress chose not to authorize the detention dam in 1991, construction of improvements to the levees adjacent to the Natomas Basin was authorized in the Defense Appropriations Act of 1993 .Pub. L. 102-396. This authorization allowed the non-Federal interests to construct the improvements and receive reimbursement subject to approval from the Assistant Secretary of the Army (Civil Works). SAFCA constructed the authorized levee improvements between 1995 and 1998, and reimbursement has begun.

The additional analyses requested by Congress were presented in the Supplemental Information Report American River Watershed Project, California, dated March 1996. This report also recommended a concrete gravity flood detention dam at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam releases. These additional plans also included levee improvements downstream of Folsom Dam. Congress recognized that levee improvements were "common" to all candidate plans in the report and that there was a Federal interest in participating in these "common features." Thus, the American River Common Features Project was authorized and a decision on Auburn Dam was once again deferred to a later date.

In 1999, Congress decided not to authorize Auburn Dam but instead to authorize improvements for Folsom Dam. By doing this, improvements to levees downstream of Folsom Dam could be fine tuned to work closely with the Folsom Dam improvements being discussed by Congress. The improvements being discussed for Folsom Dam involved control of a 200-year flood event with a peak release of 160,000 cfs. Therefore, the Common Features project was modified by WRDA 99 to include additional necessary features for the American River so that it could safely convey an emergency release of 160,000 cfs. Also authorized in WRDA 99 was the Folsom Dam Modifications project (modifications of the existing outlets of Folsom Dam), which would allow for higher releases from Folsom Dam earlier in flood events. At the same time, Congress also directed the Corps to review additional modifications to the flood storage of Folsom Dam, indicating that Congress was looking at maximizing the use of Folsom Dam for flood damage reduction prior to consideration of any additional storage on the American River. The Folsom Dam Raise project was subsequently authorized by Congress in 2004.

Major construction components for Common Features in the WRDA 96 authorization include construction of seepage remediation along approximately 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas. Major construction components for Common Features in the WRDA 99 authorization include construction of seepage remediation and levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of Natomas Cross Canal levee in Natomas. Note that there are other construction components for both WRDA 96 and 99 that are not described here.

All American River features authorized in WRDA 96 and 99 have been constructed or are in design analysis for construction within a year or two. Natomas features have been deferred. The reason for this deferral is described in the following paragraphs.

Following the flood of 1986, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5 and on both the north and south bank of the American River. Seepage on the Sacramento River was so extensive that Congress soon after the 1986 flood event funded remediation in the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport. At the time, only seepage through the levees was considered to be the seepage problem affecting the City of Sacramento.

After construction of the Sac Urban project, geotechnical evaluation of levees in the vicinity of the City of Sacramento showed that deep underseepage was of concern. Shortly thereafter, the Sacramento Valley experienced a flood event in 1997. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was to be expected because remediation had yet to be constructed, but the occurrence of significant seepage on the Sacramento River in the reach remediated as part of the Sac Urban project was alarming and confirmed that deep underseepage was also of significant concern (this conclusion was also later confirmed by the levee seepage task force in 2003).

As a result of this conclusion, seepage remediation on the American River (then in the late 1990s in the design phase) would need to be designed to remediate both through- and deep underseepage. This additional effort led to considerable cost increases over what was originally authorized by Congress and has led to two increases in the authorized cost for the Common Features project. WRDA 99 increased the cost when it added components to $91.9 million from the original $56 million authorized in 1996. The Energy and Water Development Appropriations Act 2004 (PL 108-137) increased the authorized cost to $205 million. The report to Congress recommending this increase recognized that significant additional work was going to be needed in Natomas and would result in additional authorized cost increases which would be the subject of a future report.

Because of the considerable cost increase of seepage remediation on the American River, all funds appropriated by Congress throughout the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the Natomas Basin. Combining this with the recognition that all work in the Natomas Basin would also require significantly more effort than was anticipated at the time of authorization, it was decided in 2002 that a reevaluation study would be required for at least the Natomas Basin portion of the Common Features project. However, for a variety of reasons, this reevaluation was not begun until 2006.

At approximately the same time that the revaluation study was beginning for Common Features, the Folsom Dam Post Authorization Change report (PAC) was being completed by the Sacramento District. Results of this study, and the follow-on Economic Reevaluation Report (ERR) for Folsom Dam improvements, showed that additional levee improvements were needed

on the American River and on the Sacramento River below the American River in order to truly capture the benefits of the Folsom Dam projects. These levee deficiencies consisted primarily of erosion concerns on the American River and seepage, stability, erosion, and height deficiencies on the Sacramento River below the American River. However, the full extent of these levee deficiencies was not known. (With the construction of the Sac Urban project, it was thought that the seepage and stability problems had been addressed. However, the 1997 flood event proved otherwise.) Because of this, it was realized that additional reevaluation studies are also needed to include the additional two basins comprising the City of Sacramento, as well as the Natomas Basin.

AMERICAN RIVER COMMON FEATURES PROJECT, INTERIM GENERAL REEVALUATION REPORT

CHAPTER 1 - STUDY INFORMATION

This chapter provides basic background for the reevaluation of the Common Features Project. It also lists the steps in the Corps planning process and relates them to the organization of this report.

1-1. STUDY AUTHORITY

This report was prepared as an interim general reevaluation study of the American River Common Features Project. The Common Features Project was authorized in WRDA 1996, Pub. L. 104-303 (S 640), Sec. 101(a) (1), 110 STAT. 3658, 3662-3663 (1996), as amended by the Energy and Water Development and Related Agencies Appropriations Act of 2008, Pub. L. 110-161 (HR 2674), Sec. 130, 121 STAT. 1844, 1947 (2007). Additional authority was provided in WRDA 1999, Pub. L. 106-53 (S 507), Sec. 366, 113 STAT. 269, 319-320 (1999). Significant changes to the project were approved via the Supplemental Information Report of March 2002. Additionally, the Energy and Water Development Appropriations Act of 2004, Pub. L. 108-137 (HR 2754), Sec. 129, 117 STAT. 1827, 1839 (2003) increased the authorized total cost of the project to $205,000,000. The current estimated cost of the authorized project is $274,100,000. The allowable cost limit is $284,000,000 under Section 902 of WRDA 1986, Pub. L. 99-662 (HR 6), Sec. 902, 100 STAT. 4082 (1986). Pertinent sections of these Congressional authorizations are provided below:

a. Water Resources Development Act of 1996 (Pub. L. 104-303)

Sec. 101. Project Authorizations

(a) PROJECTS WITH CHIEF'S REPORTS. Except as provided in this subsection, the following projects for water resources development and conservation and other purposes are authorized to be carried out by the Secretary substantially in accordance with the plans, and subject to the conditions, described in the respective reports designated in this subsection:

(1) American River Watershed, California.

(A) IN GENERAL. The project for flood damage reduction, American and Sacramento Rivers, California: Report of the Chief of Engineers, dated June 27, 1996, at a total cost of $56,900,000, with an estimated Federal cost of $42,675,000 and an estimated non-Federal cost of $14,225,000, consisting of

(i) approximately 24 miles of slurry wall in the levees along the lower American River;

(ii) approximately 12 miles of levee modifications along the east bank of the Sacramento River downstream from the Natomas Cross Canal;

(iii) 3 telemeter stream flow gauges upstream from the Folsom Reservoir; and

(iv) modifications to the flood warning system along the Lower American River.

(B) CREDIT TOWARD NON-FEDERAL SHARE. The non-Federal interest shall receive credit toward the non-Federal share of project costs for expenses that the non-Federal interest incurs for design or construction of any authorized project feature, including credit for work commenced before the date of execution of a cooperation agreement for the affected feature. The amount of the credit shall be determined by the Secretary.

(D) OTHER COSTS. The non-Federal interest shall be responsible for

(i) all operation, maintenance, repair, replacement, and rehabilitation costs associated with the improvements carried out under this paragraph; and

b. Water Resources Development Act of 1999 (Pub. L. 106-53). Section 366 of WRDA 1999 includes further direction for the Common Features Project:

(a) IN GENERAL. The project for flood damage reduction, American and Sacramento Rivers, California, authorized by section 101(a)(1) of the Water Resources Development Act of 1996 (110 Stat. 3662-3663), is modified to direct the Secretary to include the following improvements as part of the overall project:

(1) Raising the left bank of the non-Federal levee upstream of the Mayhew Drain for a distance of 4,500 feet by an average of 2.5 feet.

(2) Raising the right bank of the American River levee from 1,500 feet upstream to 4,000 feet downstream of the Howe Avenue Bridge by an average of 1 foot.

(3) Modifying the south levee of the Natomas Cross Canal for a distance of 5 miles to ensure that the south levee is consistent with the level of protection provided by the authorized levee along the east bank of the Sacramento River.

(4) Modifying the north levee of the Natomas Cross Canal for a distance of 5 miles to ensure that the height of the levee is equivalent to the height of the south levee as authorized by paragraph (3).

(5) Installing gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates.

(6) Installing a slurry wall in the north levee of the American River from the east levee of the Natomas east Main Drain upstream for a distance of approximately 1.2 miles.

(7) Installing a slurry wall in the north levee of the American River from 300 feet west of Jacob Lane north for a distance of approximately 1 mile to the end of the existing levee.

(b) COST LIMITATIONS. Section 101(a)(1)(A) of the Water Resources Development Act of 1996 (110 Stat. 3662) is amended by striking "at a total cost of" and all that follows through "$14,225,000," and inserting the following: "at a total cost of $91,900,000, with an estimated Federal cost of $68,925,000 and an estimated non-Federal cost of $22,975,000,"

(c) COST SHARING. For the purposes of Section 103 of the Water Resources

Development Act of 1986 (33 U.S.C. 2213), the modifications authorized by this section shall be subject to the same cost sharing in affect for the project for flood damage reduction, American and Sacramento Rivers, California, authorized by Section 101(a)(1) of the Water Resources Development Act of 1996 (110 Stat. 3662).

c. Energy and Water Development Appropriations Act of 2004 (Pub. L. 108-137). Section 129 of the Energy and Water Development Appropriations Act of 2004 provided the following authorization:

The project for flood damage reduction, American and Sacramento Rivers, California, authorized by section 101(a)(1) of the Water Resources Development Act of 1996 (110 Stat.3662–3663) and modified by section 366 of the Water Resources Development Act of 1999 (113 Stat. 319–320), is further modified to direct the Secretary to carry out the project, at a total cost of $205,000,000.

d. Chief of Engineers' Discretionary Authority. In 2006, several features were authorized using the Chief of Engineers' discretionary authority. These features include installing a total of 3.6 miles of discontinuous slurry wall at nine levee sites beginning at Levee Mile 2.9 and ending at Levee Mile 10.3 in the Pocket Area and installing six relief wells and collector drains and appurtenant features and a landside berm on the levee toe in the Pioneer Reservoir area. The Pocket Area is between Interstate 5 and the East side of the Sacramento River, south of the Confluence with the American River, near the southern Boundary of the Common Features project area. It extends from river mile 53.6 to 45.3. The name reflects the shape of the area. The Pioneer Reservoir project area is located adjacent to the Sacramento River in the City of Sacramento; just upstream of the Pioneer Bridge that U.S. Highway 50 uses to cross the Sacramento River. The project runs in a north-south direction and is bounded on the north by Capitol Mall, on the south by U.S. Highway 50, on the east by Pioneer Reservoir, and on the west by the Sacramento River.

1-2. PURPOSE AND SCOPE

The purpose of this report is to present the findings of an interim general reevaluation study of the authorized American River Common Features Project. The study was conducted specifically to determine if there is a Federal interest in modifying the authorized project features for flood risk management in the Natomas Basin portion of the project area. While other significant changes are expected in the future to reduce risks in areas subject to flooding from the Lower American and Sacramento rivers, only improvements to the Natomas Basin levees are the subject of proposed changes at this time.

Because of the considerable cost increase of seepage remediation on the American River, all funds appropriated by Congress throughout the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts for the Natomas Basin. Combining this with the recognition that work in the Natomas Basin would also require significantly more effort than was anticipated at the time of authorization, it was decided

in 2002 that a reevaluation would be needed for the Natomas Basin portion of the Common Features project. However, for a variety of reasons, this reevaluation was not begun until 2006.

Upon the recognition of the underseepage problems in the Natomas levee system, the delay in the ability of the Corps to implement the authorized improvements and significant risk to residents in the Natomas Basin, the Sacramento Area Flood Control Agency (SAFCA) in cooperation with the California Department of Water Resources, and the Central Valley Flood Project Board (CVFPB), developed the Natomas Levee Improvement Program, Early Implementation Project (NLIP). Evaluations in support of this project were developed in a manner similar to a Corps reevaluation of the project with Corps review. Significant elements of this plan have been approved for construction under the Section 408 approval process and the Section 404 permitting process – determining that these improvements are in the public interest.

The focus of this interim general reevaluation study is to authorize immediate improvements to the levees surrounding the Natomas Basin while developing an overall GRR for the Common Features project, lessen risk in the Natomas Basin (regarded to be one of the most at-risk areas in the United States), to implement "no regrets" measures while developing the long-term strategy of flood risk management measures for the Sacramento metropolitan area, and to evaluate the Natomas Levee Improvement Plan to establish the degree of Federal financial participation in this plan, building upon the Section 408 approved features being implemented by SAFCA. To accomplish this determination, the study reanalyzes the problems and opportunities associated with reducing the risk of flooding in the Natomas Basin and expresses desired outcomes as planning objectives. Alternatives are then developed to address these objectives. These alternatives include a plan of no action and various combinations of structural and non-structural measures. The economic and environmental effects of the alternatives are then evaluated and a feasible plan is selected for comparison to the project currently being implemented. This report also presents details on the Corps and sponsor participation needed in order to implement the selected plan. This study is not a full reformulation of the authorized project, but it does include a new economic analysis. This report concludes with a recommendation for reauthorization of the American River Common Features Project.

1-3. LOCATION AND DESCRIPTION OF THE STUDY AREA

a. Location. The study area, which includes the Natomas Basin, also includes the Sacramento and American River Watersheds. The Sacramento River watershed covers approximately 26,000 square miles in central and northern California. Shasta Dam impounds the upper Sacramento River watershed. Major tributaries of the Sacramento River include the Feather, Yuba and American rivers. The American River Watershed covers about 2,100 square miles northeast of the City of Sacramento and includes portions of Placer, El Dorado, Alpine, and Sacramento counties. The American River watershed includes Folsom Dam and Reservoir; inflowing rivers and streams, including the North, South, and Middle forks of the American River; and the American River downstream to its confluence with the Sacramento River in the City of Sacramento. The Sacramento and American rivers, in the Sacramento area, form a flood plain covering roughly 110,000 acres at their confluence, approximately half of which comprises the Natomas Basin. The flood plain includes most of the developed portions of the City of

Sacramento and the Natomas Basin. Plate 2 shows the levees associated with the Natomas Basin. This report focuses on the Natomas Basin that is hydraulically separable and is a separable element of the authorized Common Features Project.

The Natomas Basin extends northward from the American River and includes portions of the City of Sacramento, the County of Sacramento, and the County of Sutter. In addition to the American and Sacramento rivers, the Natomas Basin is bordered on the north by the Natomas Cross Canal (NCC) and on the east by the Pleasant Grove Creek Canal (PGCC) and the Natomas East Main Drain Canal (NEMDC). The NCC is an engineered channel that diverts the runoff from a large watershed in western Placer and southern Sutter counties around the Natomas Basin and is a contributor to the flows in the upper reach of the Sacramento River channel in SAFCA's jurisdiction. The NEMDC is an engineered channel along the southeastern flank of the Natomas Basin. Tributaries to the Natomas East Main Drain Canal include Dry Creek, Arcade Creek, Rio Linda Creek, Robla Creek, and the Magpie Creek Diversion Channel. The Natomas Basin is protected from high flows in these water bodies and in the American and Sacramento rivers by an interconnected perimeter levee system. Figure 1-1 shows the study area. The Natomas Basin is shown in yellow.

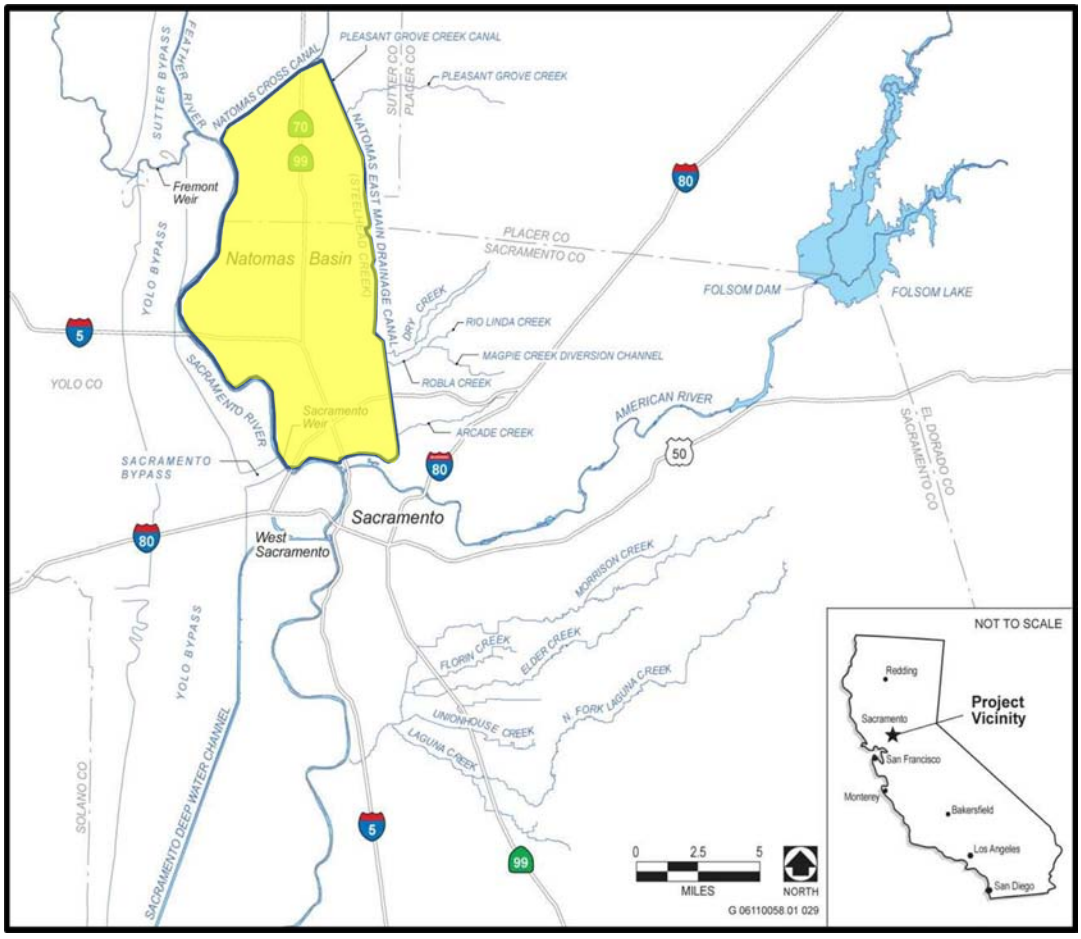


Figure 1-1. Study Area

b. Watershed Setting. The Natomas Basin is located in the Sacramento River Basin. The Sacramento River is the longest river entirely within the state of California. Starting at the confluence of the South Fork and Middle Fork of the Sacramento River, near Mount Shasta in the Cascade Range mountains, the Sacramento flows south for 447 miles through the northern Central Valley of California. The Sacramento River watershed covers an area of approximately 27,000 square miles. The Natomas Basin is located at the southern end of the watershed. Figure 1-2 shows the Sacramento River Basin and the location of the Natomas Basin (in red).

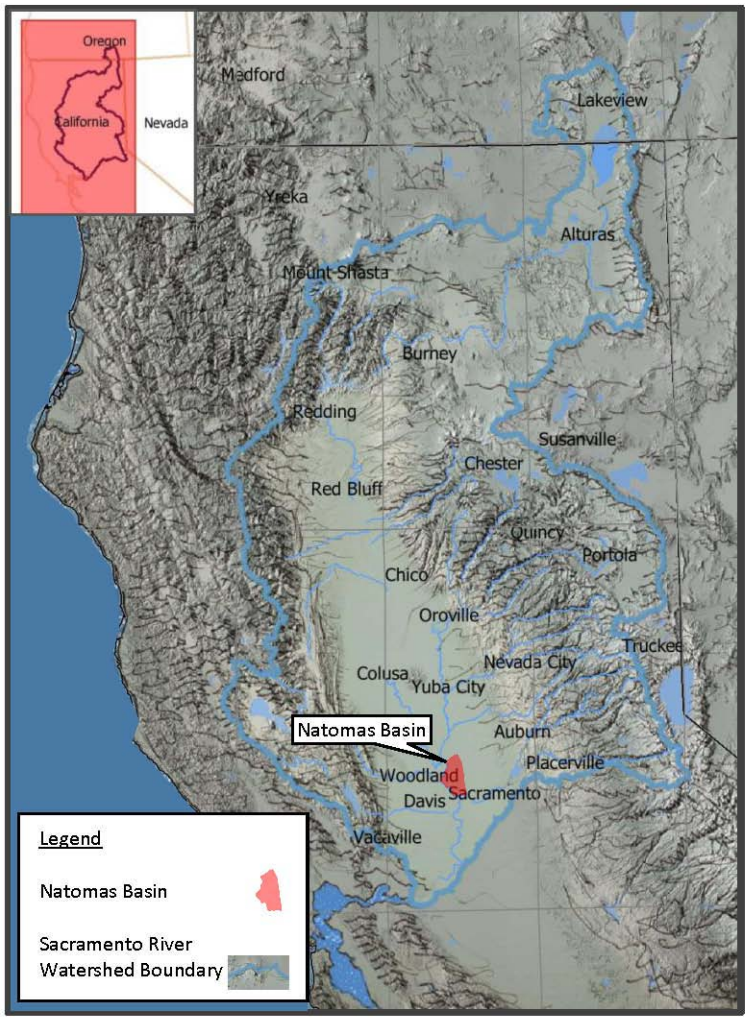


Figure 1-2. Sacramento River Watershed

Major tributaries to the Sacramento River relevant to the Natomas Basin are the Feather, Yuba, Bear, and American rivers. Figure 1-3 shows these basins and their relative locations to the Natomas Basin. And immediately to the east of the Natomas Basin are a number of smaller tributaries draining into the Natomas East Main Drain Canal, which forms the east boundary of the Natomas Basin. The watersheds of these small creeks are shown in Figure 1-4.

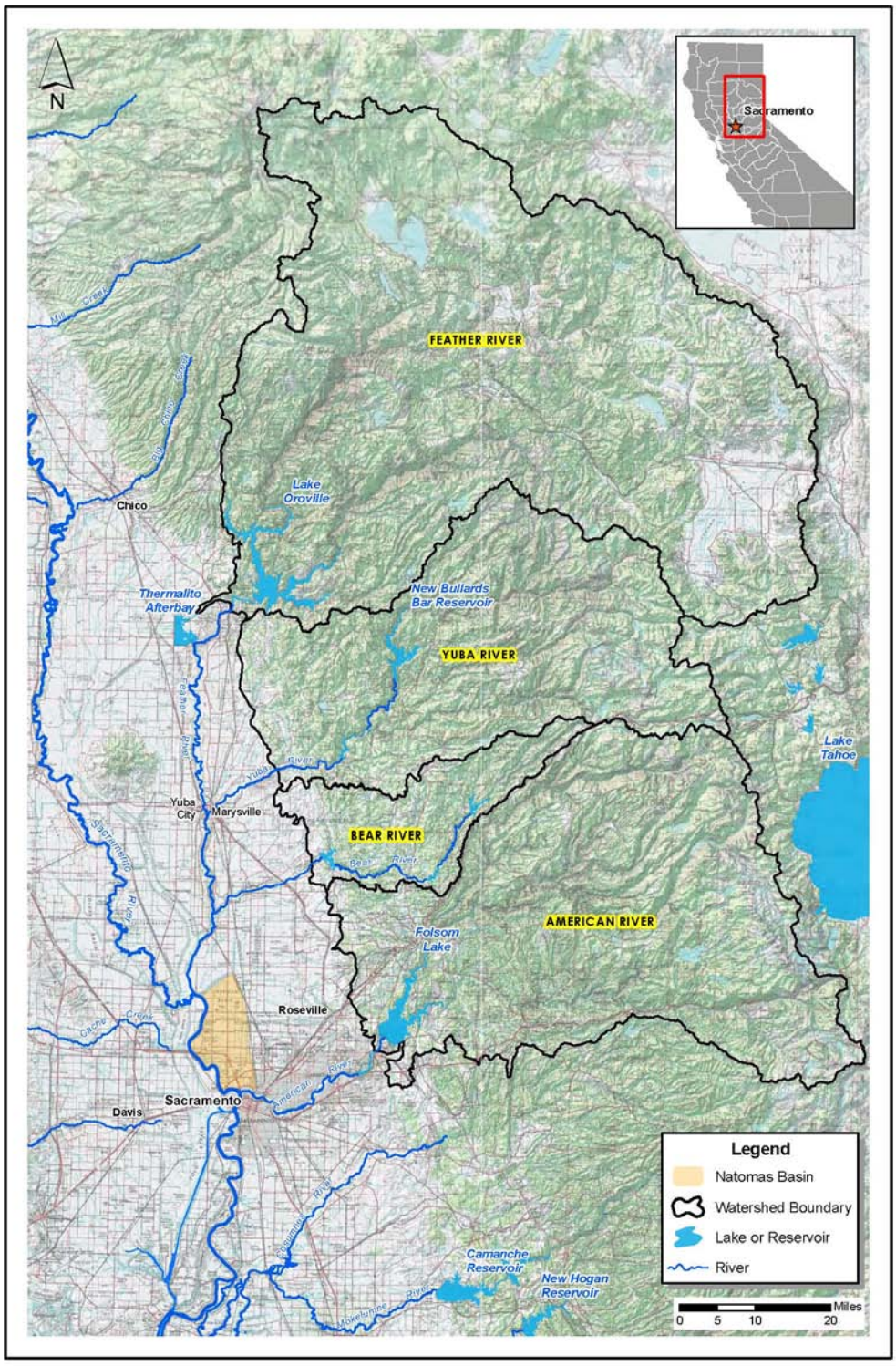


Figure 1-3. Major Watersheds Affecting Natomas Basin

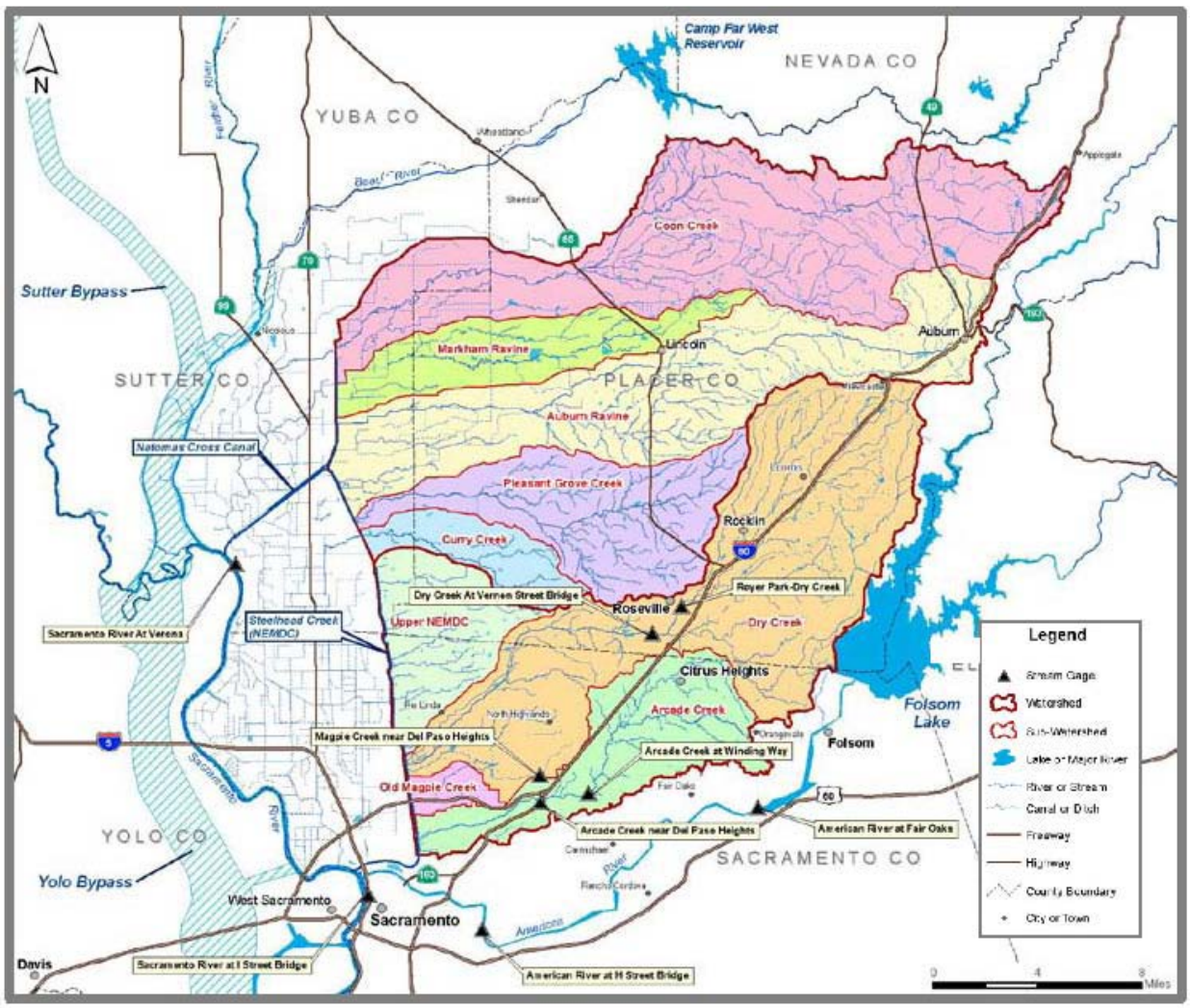


Figure 1-4. Watersheds on the East Side of Natomas Basin

c. Physical Setting. California winters are typically cool and wet, while the summers are typically hot and dry. In the valley portions of Sacramento County, about 85 percent of the annual rainfall occurs between October and March; about 95 percent falls between October and April. At Sacramento, average annual rainfall is approximately 18 inches. Mean annual temperature in Sacramento is 61ºF. January is generally the coldest month with a mean low temperature of 37.8 ºF and an average high temperature of 53.3 ºF. July is the hottest month with an average high temperature of 92.9 ºF and an average low of 58.2 ºF. High temperatures commonly exceed 100 ºF.

The study area is geologically part of the Great Valley geomorphic province of California. The valley is filled with materials eroded from the surrounding mountains and deposited by streams and rivers. Most of the soils are recent alluvial flood plain soils consisting of unconsolidated deposits of clay, silt, and sand that occurred as flood plain deposits. The elevation of the Common Features Project Area ranges from approximately 15 feet above mean sea level (MSL) near

Freeport to approximately 400 feet MSL near Folsom Dam. The majority of this area is less than 100 feet MSL.

d. Land Use and Development. The study area consists primarily of agriculture and urban land uses. The predominant urbanized area is the City of Sacramento. The City of Sacramento is the capital of California, and thus is the government center for the state. The suburban areas of Sacramento have undergone significant development in the past twenty years, in particular, the Natomas Basin.

The 53,000-acre Natomas Basin includes land north of the confluence of the American and Sacramento rivers and into adjacent Sutter County. The first residents of the area were Native Americans living in the oak woodlands, grasslands, and along the marshland banks. The gold rush brought miners and settlers to the area. Beginning early last century, much of the basin was drained for agriculture and levees were built for flood protection. Urban development began in the area when Sacramento Municipal Airport (now International Airport) was built in the 1960's.

The Natomas community is close to the state capital and bisected by two major freeways. The levee system around the Natomas Basin protects approximately 53,000 acres of improved agricultural, environmental, and urban lands. About 30 percent of the Basin is occupied by developed urban uses mostly located south of Elkhorn Boulevard. The urban area contains approximately 22,200 residential, 380 commercial, and 180 industrial structures and a population of approximately 80,000 people. Lands owned by Sacramento County and operated as part of Sacramento International Airport account for about 10 percent of the land in the Natomas Basin. Half of the Airport lands lie outside of the developed footprint of the Airport Operations Area and consist of “bufferlands” devoted to agricultural or open space use. In addition to the Airport, the Basin also contains three major public transportation facilities, Interstate 5, Interstate 80 and State Route 99/70 as well as numerous public facilities such as police stations, fire stations, libraries, schools and community centers which serve the Basin’s urban population. The Garden Highway parallels the Sacramento River on the western side of the Common Features Project area. Two mainline railroad tracks, Union Pacific Railroad and BNSF Railroad run through the Sacramento area.

e. Ecological Setting. Four habitat types have been defined as the dominant in the study area: wetlands, riparian forest, aquatic, and ruderal herbaceous and nonnative grassland. The North American River Basin Region supports an extensive network of freshwater forested/shrub and freshwater emergent wetlands habitat and vegetation. In addition, the American River Parkway provides a nearly continuous, narrow riparian woodland for several miles. Along the Sacramento River in the South American River Basin Region, the wetland vegetation is highly fragmented and limited by the extensive development of the Sacramento metropolitan area. Riparian vegetation occurs in narrow, fragmented expanses along the Sacramento and American rivers in this region. Within the study area, the Natomas Basin is a dynamic region with all habitat types represented.

The study area is encompassed by the Pacific Flyway migratory route, the westernmost of North America’s four flyways. The continuous stretch of riparian and wetland vegetation along the American River provides habitat for migratory birds and many resident species. The

wetlands habitats and the flooded rice fields throughout the Natomas Basin attract and support populations of migrant waterfowl. Many bird species use the pastures, harvested rice fields, and other croplands for foraging and shelter. The threat that substantial portions of this agricultural habitat will be lost over time as urban development occurs in the Basin has prompted local land use agencies to work with Federal and State wildlife management agencies to create the Natomas Basin Habitat Conservation Plan (NBHCP). As part of this conservation program, approximately 4,000 acres of aquatic and upland habitat preserves now exist in the northern, southern and eastern portions of the Basin under the management of The Natomas Basin Conservancy (TNBC). These preserves are expected to grow to approximately 15,000 acres over the next 30 years.

The major expanse of the City of Sacramento has constrained vegetation to limited areas and consequently has inhibited the diversity and range of wildlife in the region. Wildlife is restricted predominantly to the American River Parkway and the less-developed regions adjacent to the levees along the Sacramento River. In the Natomas Basin many wildlife species use the widely distributed agricultural fields and levee maintenance zones for foraging, nesting, and predator-avoidance habitat. Some species are restricted to the remnant patches of native vegetation and some use the fragmented system of irrigation/drainage ditches and canals.

The lower Sacramento and American rivers, NCC, and NEMDC/Steelhead Creek provide vital fish spawning, rearing, and/or migratory habitat for a diverse assemblage of native and nonnative species. Altered flow regimes, flood control, and bank protection efforts in these channels have reduced available shaded riverine aquatic (SRA) cover, sediment transport, channel migration and avulsion, and large woody debris recruitment and have isolated the channel from its floodplain. Historically, seasonal flooding covered basins throughout the Central Valley and provided important spawning and rearing habitat for many fish species, including Sacramento splittail, juvenile Chinook salmon, green sturgeon and steelhead. Levee construction has reduced the overall amount of seasonal flooding and shallow water habitat throughout the Sacramento River system.

Much of the study area has become urbanized which has resulted in fragmented habitat for many species. Because of the fragmentation, species continue to decline and have become listed under both the State and Federal Endangered Species Act.

1-4. HISTORY OF THE PROJECT

a. History of Sacramento River Flood Control Project. The history of the Sacramento River Flood Control Project (SRFCP) dates back to the mid 1800's with the initial construction of levees along the Sacramento, American, Feather, and Yuba rivers. The early history of the system was characterized by trial and error, with initial construction followed by a levee failure, followed by improvement (strengthening and/or raising), followed by another levee failure, etc. This continued until the California Legislature authorized a comprehensive plan for controlling the floodwaters of the Sacramento River and its tributaries in the Flood Control Act of 1911. This plan, which included the Natomas levee system, was approved by Congress in the Flood Control Act of 1917,Pub. L. 64-367,(HR 14777) , Chap. 144, Sec. 2, 39 STAT. 948, 949-

950 (1917); which authorized Federal participation with the State of California in construction of the flood control system.

Historically, from the mid 1800's onward, most hydraulic engineers at the Federal, State and local level thought that the most effective way to control flood flows in the river system was to construct levees close to the main channel. This approach served two purposes. First, it allowed reclamation of as much land as possible for agricultural purposes. Second, it kept flows in the main channel and thus helped to flush out hydraulic mining debris that clogged much of the river system and impaired navigation. Similar thinking guided flood control efforts along the Mississippi River during this period.

The record floods of 1907 and 1909 forced a re-evaluation of this historic approach. It was clear from the size of these flood events in relation to existing channel capacities that major bypass systems were needed to control excess flood flows. These bypass systems, which are described below, were incorporated into the comprehensive plan adopted by the State Legislature and later approved by Congress.

Federal participation in the SRFCP began shortly after authorization in 1917 and continued for approximately 40 years. The completed flood control system was documented in 1957 in a design memorandum, which included design water surface profiles. To this day, these are the profiles which govern the operation and maintenance requirements of the levee system. The completed flood control system is shown on Plate 3.

The system is designed to keep all flows from floods up to a certain magnitude within the river, and then to divert flow into the bypass system once this event is exceeded. Throughout the SRFCP, the frequency that flow starts to divert from the Sacramento River to the bypass system varies between a 3-year to 5-year flood event.

Locations where flow is allowed to spill from the Sacramento River into the bypass system include three overflow locations upstream of the project levees, Moulton Weir, Colusa Weir, and Tisdale Weir, and two overflow locations in the vicinity of the Natomas Basin, the Fremont Weir and the Sacramento Weir (Plate 3). Flow from these weirs (or overflow locations) enters the Butte Basin, the Sutter Bypass, or the Yolo Bypass. Flows from the Feather River and American River are also diverted into the bypass system near where they intersect the Sacramento River, and the bypass systems directly receive outflows from many smaller tributaries.

The Fremont Weir is perhaps the most significant over flow location in the system. The Sacramento River crosses from the center of the Sacramento Valley toward the east near the north extent of the Natomas Basin. Because the river crosses the valley, the bypass system had to be constructed such that it crossed the river. The Fremont Weir forces flow up to the 3- to 5-year frequency event to stay in the river and allows flow to spill to the Yolo Bypass once this frequency is exceeded.

b. History of the Common Features Project. Folsom Dam and much of the north levee of the American River were authorized by Congress in the late 1940's. Folsom Dam was

designed such that the flood control space would accommodate the Standard Project Flood (SPF), which did not have a specific frequency, but was estimated to be between the 250 and 500 year event. Construction of Folsom Dam was nearing completion in 1955 when a new flood of record was experienced. This flood event caused the objective release for Folsom Dam to occur. Afterward, hydrology for Folsom Dam was reassessed with the 1955 flood event included in the analysis. This assessment showed that the City of Sacramento downstream of Folsom Dam and adjacent to the American River had considerably less flood protection, even with Folsom Dam, than was previously realized. Discussion soon began about the need for additional storage upstream of Folsom Dam, which led to a proposal for a flood control dam near the town of Auburn.

Auburn Dam was authorized by Congress in the 1960s. The Auburn Dam project included additional flood control space to restore the flood performance that Folsom Dam was originally thought to provide. Design efforts began soon afterward by USBR with the construction effort beginning in the early to mid 1970s. A diversion tunnel around the dam site, foundation preparation, and a cofferdam to divert flow to the diversion tunnel had been completed when in 1976, an earthquake occurred near the Oroville Dam location. Oroville Dam had been completed approximately five years before.

The earthquake, occurring so near a dam site, caused significant concerns about dam safety. Because of this, the U.S. Geologic Survey became involved investigating faults throughout California. This investigation discovered a fault near the location of the proposed Auburn Dam. The USBR design for Auburn Dam was a thin arch concrete dam, which, while being very strong, is susceptible to earthquake damage. All design concerns were resolved and it was determined that a safe dam could be constructed at the Auburn site using a different concrete dam design. Construction efforts were then put on hold pending a future decision on Auburn Dam.

No decision on Auburn Dam was made and the completed cofferdam and diversion tunnel sat unaltered until 1986. In 1986, a new flood of record occurred (which is currently the flood of record for the American River). The 1986 flood washed out the cofferdam. This flood very nearly caused catastrophic flooding in the City of Sacramento.

The objective release of Folsom Dam is 115,000 cubic feet per second (cfs) and the emergency release is 152,000 cfs. Since construction of Folsom Dam, the objective flow rate has been met in 1955, 1964, 1986, and 1997. Based on experience from the 1955 and 1964 flood events, the ability of the American River levees to convey flow in excess of 115,000 cfs was somewhat uncertain because of the considerable flood fight activity required to convey 115,000 cfs.

In the 1986 flood event, Folsom reservoir rapidly filled up. At the time, the USBR, the Corps, and the California Department of Water Resources (DWR) all agreed that the release from Folsom Dam needed to be raised above 115,000 cfs to manage the risk of a dam failure. The release from Folsom Dam was increased to 134,000 cfs. This flow seriously stressed the American River levees and came dangerously close to causing levee failures in the City of Sacramento. In addition, conditions at Folsom Dam were such that the operator of the dam

(USBR) was within one hour of having to open the emergency gates of Folsom Dam which would have released considerably more than 152,000 cfs, and flooded the City of Sacramento. Fortunately the storm abated and the inflow reduced such that releases higher than 134,000 cfs did not have to be made.

After the flood of 1986, Congress directed the Corps to investigate the feasibility of reducing the flooding risk to the City of Sacramento. The Corps completed that feasibility study in 1991. The recommended plan in this study was a concrete gravity flood detention dam at the Auburn Dam location along with levee improvements downstream of Folsom Dam. Due to environmental and cost concerns, Congress chose not to authorize the detention dam and instead directed the Corps to supplement the analysis of flood control options considered in the 1991 study. This supplemental study was completed in 1996.

While Congress chose not to authorize the detention dam in 1991, construction of improvements to the levees adjacent to the Natomas Basin was authorized in the Defense Appropriations Act of 1993,Pub. L. 102-396, (HR 5504), Sec. 9159, 106 STAT. 1876, 1944-1946 (1992). This authorization allowed the non-Federal interests to construct the improvements and receive reimbursement subject to approval of the Assistant Secretary of the Army (Civil Works). SAFCA constructed the authorized levee improvements between 1995 and 1998, and reimbursement has begun.

The additional analyses requested by Congress were presented in the Supplemental Information Report American River Watershed Project, California, dated March 1996. This report also recommended a concrete gravity flood detention dam at the Auburn site along with levee improvements downstream of Folsom Dam. Other plans evaluated in the report were Folsom Dam improvements and a stepped release plan for Folsom Dam. These additional plans also included levee improvements downstream of Folsom Dam. Congress recognized that levee improvements were “common” to all candidate plans in the report and that there was a Federal interest in participating in these “common features”. Thus, the American River Common Features Project was authorized and a decision on Auburn Dam was once again deferred to a later date.

In 1999, Congress decided not to authorize Auburn Dam but instead to authorize improvements for Folsom Dam. By doing this, improvements to levees downstream of Folsom Dam could be fine tuned to work closely with the Folsom Dam improvements being discussed by Congress. The improvements being discussed for Folsom Dam involved control of a 200-year flood event with a peak release of 160,000 cfs. Therefore, the Common Features project was modified by WRDA 99 to include additional necessary features for the American River so that it could safely convey an emergency release of 160,000 cfs. Also authorized in WRDA 99 was the Folsom Dam Modifications project (modifications of the existing outlets of Folsom Dam) which would allow for higher releases from Folsom Dam earlier in flood events. At the same time, Congress also directed the Corps to review additional modifications to the flood storage of Folsom Dam, indicating that Congress was looking at maximizing the use of Folsom Dam for flood damage reduction prior to consideration of any additional storage on the American River. The Folsom Dam Raise project was subsequently authorized by Congress in 2004.

Major construction components for Common Features in the WRDA 96 authorization include construction of seepage remediation along approximately 22 miles of American River levees and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas. Major construction components for Common Features in the WRDA 99 authorization include construction of seepage remediation and levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of the NCC levee in Natomas. Note that there are other construction components for both WRDA 96 and 99 that are not described here.

All American River features authorized in WRDA 96 and 99 have been constructed or are in design analysis for construction within a year or two. Natomas features have been deferred. The reason for this deferral is described in the following paragraphs.

Following the flood of 1986, significant seepage was experienced on the Sacramento River from Verona (upstream end of Natomas) at River Mile (RM) 79 to Freeport at RM 45.5 and on both the north and south bank of the American River. Seepage on the Sacramento River was so extensive that soon after the 1986 flood event, Congress funded remediation in the Sacramento Urban Levee Improvement Project (Sac Urban). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas at approximately RM 64 down to Freeport. At the time, only seepage through the levees was considered to be the seepage problem affecting the City of Sacramento.

After construction of the Sac Urban project, geotechnical evaluation of levees in the vicinity of the City of Sacramento showed that deep underseepage was of concern. Shortly thereafter, the Sacramento Valley experienced a flood event in 1997. Considerable seepage occurred on the Sacramento River as well as on the American River. Seepage on the American River was to be expected because remediation had yet to be constructed, but the occurrence of significant seepage on the Sacramento River in the reach remediated as part of the Sac Urban project was alarming and confirmed that deep underseepage was also of significant concern (this conclusion was also later confirmed by the levee seepage task force in 2003.

As a result of this conclusion, seepage remediation on the American River (then in the late 1990s in the design phase) would need to be designed to remediate both through- and deep underseepage. This additional effort led to considerable cost increases over what was originally authorized by Congress and has led to two increases in the authorized cost for the Common Features project. WRDA 99 increased the cost when it added components to $91.9 million from the original $56 million authorized in 1996. The Energy and Water Development Appropriations Act of 2004.Pub. L. 108-137 increased the authorized cost to $205 million. The report to Congress recommending this increase recognized that significant additional work was going to be needed in Natomas and would result in additional authorized cost increases which would be the subject of a future report.

Because of the considerable cost increase of seepage remediation on the American River, all funds appropriated by Congress throughout the late 1990s and the early part of the 2000s were used for construction activities on the American River instead of for design efforts in the Natomas Basin. Combining this with the recognition that all work in the Natomas Basin would

also require significantly more effort than was anticipated at the time of authorization, it was decided in 2002 that a reevaluation study would be required for at least the Natomas Basin portion of the Common Features project. However, for a variety of reasons, this reevaluation was not begun until 2006.

At approximately the same time that the revaluation study was beginning for Common Features, the Folsom Dam Post Authorization Change report (PAC) was being completed by the Sacramento District. Results of this study, and the follow-on Economic Reevaluation Report (ERR) for Folsom Dam improvements, showed that additional levee improvements were needed on the American River and on the Sacramento River below the American River in order to truly capture the benefits of the Folsom Dam projects. These levee deficiencies consisted primarily of erosion concerns on the American River and seepage, stability, erosion, and height deficiencies on the Sacramento River below the American River. However, the full extent of these levee deficiencies was not known. (With the construction of the Sac Urban project, it was thought that the seepage and stability problems had been addressed. However, the 1997 flood event proved otherwise.) Because of this, it was realized that additional reevaluation studies are also needed to include the additional two basins comprising the City of Sacramento, as well as the Natomas Basin.

1-5. AUTHORIZED PROJECT

Project features, as they have evolved through subsequent authorizations, are presented in Table 1-1. Table 1-2 presents an economic summary of the authorized plan. Plate 4 shows the features of the authorized plan.

Table 1-1. Authorized Project Features.

1997 Authorization
Approximately 24 miles of slurry walls along the lower American River
Approximately 12 miles of levee modifications along the east bank of the Sacramento River downstream from the NCC
Three telemeter stream gauges upstream from Folsom Reservoir
Modification of the flood warning system on the American River
1999 Authorization
Raising the left bank of the non-Federal levee upstream of the Mayhew Drain for a distance of 4,500 feet by an average of 2.5 feet
Raising the right bank of the American River levee from 1,500 feet upstream to 4,000 feet downstream of the Howe Avenue Bridge by an average of 1 foot
Modifying the south levee of the NCC for a distance of 5 miles to ensure that the south levee is consistent with the level of protection provided by the authorized levee along the east bank of the Sacramento River.
Modifying the north levee of the NCC for a distance of 5 miles to ensure that the height of the levee is equivalent to the height of the south levee as authorized
Installing gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates
Installing a slurry wall in the north levee of the American River from the east levee of the NEMDC upstream for a distance of approximately 1.2 miles
Installing a slurry wall in the north levee of the American River from 300 feet west of Jacob Lane north for a distance of approximately 1 mile to the end of the existing levee

2006 Chief's Discretionary Authority
Installing a total of 3.6 miles of discontinuous slurry wall at nine levee sites beginning at Levee Mile 2.9 and ending at Levee Mile 10.3 in the Pocket Area
Installing six relief wells and collector drains and appurtenant features and a landside berm on the levee toe in the Pioneer Reservoir area

Table 1-2. Economic Summary of the Authorized Plan

ESTIMATE OF FIRST COSTS ($000)*			
ITEM	**FEDERAL**	**NON-FEDERAL**	**TOTAL**
Total First Cost	208,485	69,495	277,980
Interest During Construction	11,588	6,410	17,998
Total Investment Cost	218,883	75,905	294,788
Interest and Amortization	10,933	3,682	14,615
OMRR&R	0	85	85
Total Annual Costs	10,933	3,767	14,700
AVERAGE ANNUAL BENEFITS			
Flood Risk Management			59,500
Total Annual Benefits			59,500
NET ANNUAL BENEFITS			44,800
BENEFIT TO COST RATIO			4.0

* The source of the information in this table includes data and modeling from Economic Reevaluation Report (Feb 2009), American River Watershed Project, CA Folsom Dam Modification and Folsom Dam Raise Projects and the Common Features Economic Update (June 2010). Benefits reflect improvements along the American River and Sacramento River below the confluence. As Authorized, the Natomas features would provide no significant measurable benefits. All values are in October 2010 prices.

1-6. WATERSHED PLANNING

a. Past and Current Related Studies and Programs. The Common Features Project is one of several flood risk management projects authorized within the American River Watershed in Northern California. The project is also within the greater Sacramento River Watershed, and is part of an overall system in place in the Sacramento Valley since the early 1900s, the Sacramento River Flood Control Project.

The complexity of California water resource issues and solutions are escalating and require a strategic awareness with a vision for short, mid, and long term timeframes. This watershed or systems awareness begins with the communication, coordination, and cooperation of the various project teams and programs working in the American River and Sacramento River Watersheds.

Currently, within the Corps' efforts, there are over a dozen authorized projects being studied or implemented within the Sacramento River Watershed and tributaries. The complexity of the engineering, environmental, and political issues requires a systems and watershed approach for all associated efforts with other local, state, and Federal agencies. Plate 5 shows all of the efforts underway in the watershed.

The following are brief descriptions of some of the major programs and projects in Northern California and the Sacramento River Watershed that are directly influencing and in need of coordination with the Common Features Project efforts. While the Common Features Project consists of more than just Natomas, this interim GRR is confined to improving levee performance in the Natomas Basin. The Natomas Basin is an independent hydrologic unit within the Sacramento River Flood Control System. Levee failures upstream of Natomas have little effect on flood levels adjacent to Natomas. Conversely, a failure into the Natomas Basin would have little effect on the remainder of the Sacramento River Flood Control System. Its geographic location below the Fremont Weir, above the Sacramento Weir and the confluence with the American River, and having very little border along the American River means that actions in other parts of the watershed have minimal effect on water levels in Natomas.

(1) American River Watershed Program. Three authorized projects make up the American River Watershed Program. One of these is Common Features, the subject of this report. The other two are the Folsom Modification Project and Folsom Dam Raise Project. The Folsom Modification Project primarily includes features to improve the efficiency and effectiveness of the existing flood control outlet works at Folsom Dam and flood control storage in Folsom Reservoir. The Folsom Dam Raise Project was intended to be constructed following implementation of the Folsom Modification Project. The Folsom Dam Raise Project primarily includes enlarging the flood control storage space in Folsom Reservoir, features to meet USBR's objective of passing the Probable Maximum Flood, and features to help restore the ecosystem downstream from Folsom Dam. The Folsom Modification and Folsom Dam Raise projects, in combination with the authorized Common Features elements downstream from the dam are expected to reduce the flood risk to Sacramento. With the American River Watershed Program, there is an emphasis on considering the individual projects on a more integrated basis. The Energy and Water Development Appropriations Act of 2006 directed the Corps and USBR to collaborate on flood damage reduction and dam safety at Folsom Dam.

(2) Natomas Levee Improvement Program. SAFCA, in cooperation with the California Department of Water Resources and the Central Valley Flood Protection Board, have initiated urgently needed improvements to the Federal project levee system protecting the Natomas Basin. These improvements address identified deficiencies in the levee system based on recent recognition of seepage problems that has caused experts to significantly downgrade the system's performance capability. In response, FEMA has withdrawn the 100-year flood protection certification that was granted to the levee system only a decade ago. These events have created substantial public safety and economic challenges for the Sacramento Area, the State and the Federal Government. A catastrophic failure of the levee system around the Natomas Basin would imperil the health and safety of 80,000 residents, shut down Sacramento International Airport and two of California's most important interstate freeways, and cause a loss of over $7 billion in residential, commercial and industrial property damage. SAFCA and the State are addressing these challenges by moving aggressively forward with the NLIP. The Program builds upon the several prior Congressional authorizations of the Common Features Project. The current pace of this early implementation project is not sustainable without an early commitment of Federal cost sharing. The Program as a whole would achieve the flood risk reduction objectives that Congress has previously adopted for the Natomas Basin in a manner that is consistent with current Federal engineering and environmental standards.

To support the NLIP program, the following documents have been prepared:

- 2003 CESPK Levee Task Force, Recommendations for Seepage Design Criteria, Evaluation and Design Practices, prepared by the U.S. Army Corps of Engineers, Sacramento District, dated July 2003.

- Natomas Levee Evaluation Study – Final Report, Prepared for SAFCA by MBK Engineers, Kleinfelder, Northwest Hydraulics Consultants, Parson Brinckerhoff, EDAW, and Jones & Stokes Associates, dated July 14, 2006.

- Natomas Levee Improvement Program, Bank Protection Project, Draft Environmental Impact Report, Prepared for SAFCA by Jones and Stokes Associates, dated September 2007.

- Natomas Levee Improvement Program, Landside Improvements Project, Draft Environmental Impact Report, Prepared for SAFCA by EDAW/AECOM, dated September 2007.

- Natomas Levee Improvement Program, Landside Improvements Project, Final Environmental Impact Report, Prepared for SAFCA by EDAW/AECOM, dated November 2007.

- Evaluation of Potential Groundwater Impacts Due to Proposed Sacramento River East Levee Improvements with Emphasis on Reaches 2 and 3, prepared for Sacramento Area Flood Control Agency (SAFCA), prepared by: Luhdorff & Scalmanini, Consulting Engineers, dated February 21, 2008.

- 408 Permission and 404 Permit to Sacramento Area Flood Control Agency for the Natomas Levee Improvement Project, Sacramento, CA., Draft Environmental Impact Report, prepared for US Army Corps of Engineers, Sacramento District by EDAW, dated June 2008.

- 408 Permission and 404 Permit to Sacramento Area Flood Control Agency for the Natomas Levee Improvement Project, Final Environmental Impact Report, prepared for US Army Corps of Engineers, Sacramento District by EDAW, dated November 2008.

- Natomas Levee Improvement Program, Landside Improvements Project – Phase 2 Project, Public Draft, Supplement to the Environmental Impact Report prepared for SAFCA, prepared by EDAW, dated November 2008.

- Natomas Levee Improvement Program, Phase 3 Landside Improvement Project, Draft Environmental Impact Statement/Draft Environmental Impact Report, Prepared for Corps of Engineers and SAFCA, prepared by EDAW, dated February 2009.

- Natomas Levee Improvement Program, Early Implementation Project, Area Plan Formulation Report, prepared for Sacramento Area Flood Control Agency, by MBK Engineers, dated February 2009.

- NLIP, Landside Improvements Project, Draft Programmatic Long-Term Management Plan, prepared for SAFCA by EDAW, dated March 13, 2009.

- Mitigation and Monitoring Plan, Natomas Levee Improvement Program, Landside Improvements Project, prepared for SAFCA by EDAW, dated April 2009.

- NLIP Landside Improvements Project, Final Programmatic Long-Term Management Plan, prepared for SAFCA, by EDAW, dated April 2009.

- Natomas Levee Improvement Program, Phase 3 Landside Improvement Project, Final Environmental Impact Report, prepared for SAFCA by EDAW, dated May 11, 2009.

- Mitigation Monitoring and Reporting Program, Natomas Levee Improvement Program, Landside Improvements Project, prepared for SAFCA by EDAW, dated May 2009.

- Basis of Geometric Design for Relocated Irrigation and Drainage Canals, Natomas Levee Improvement Program, prepared by SAFCA dated July 8, 2009.

- Draft Assistance Relocation Plan for the Natomas Levee Improvement Program Prepared for SAFCA by Overland, Pacific & Cutler, Inc., dated July 10, 2009.

- Natomas Levee Improvement Program, Phase 3 Landside Improvement Project, Final Environmental Impact Statement, prepared for SAFCA by EDAW, dated August 21, 2009.

- Natomas Levee Improvement Program, Phase 4a Landside Improvement Project, Draft Environmental Impact Statement/ Environmental Impact Report, prepared for SAFCA by EDAW, dated August 28, 2009.

- Natomas Levee Improvement Program, Phase 4a Landside Improvement Project, Final Environmental Impact Statement/ Environmental Impact Report, prepared for SAFCA by EDAW, dated November 3, 2009

(3) Delta CALFED Program. The Sacramento-San Joaquin River Delta covers more than 1,300 square miles. It has more than 60 “islands,” and with its natural channels and sloughs, the Delta is the home to 750 species of plants and wildlife as well as 130 species of fish. The Delta is the hub of California’s water delivery system, taking runoff from over 40 percent of California’s landmass and moving that water to farms and more than two-thirds of the state’s population. By the 1990s, water quality issues rendered the Sacramento Delta no longer reliable as a water supply source and led to its failure as an ecosystem to sustain many species of concern. Stakeholders, regulators, and policymakers were unable to agree on a course of action for the Delta region. In June 1994, twenty-five State and Federal agencies with management and

regulatory responsibilities in the Delta signed a Framework Agreement and formed CALFED. This unique multi-agency team representing agricultural, environmental, urban, fishery, water supply and business interests is committed to adopting mutually acceptable water quality standards and to developing long-term strategies addressing fish and wildlife, water supply reliability, levee stability, and water quality needs.

The purpose of CALFED's three-phase program is to develop a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. Phase 1 was completed in September 1996, identifying three preliminary categories of solutions for Delta water conveyance. Phase II was completed with the publication of the Final Programmatic Environmental Impact Report/ Environmental Impact Statement (EIR/EIS) and signing of the Record of Decision (ROD) on August 28, 2000. The ROD was adopted as a joint Federal-State guiding document and defined the programmatic plan. The CALFED Program is now in Phase III, implementation of the preferred alternative.

CALFED determined that the Delta levee system is critical to all CALFED objectives and named the Corps as the Federal lead of the program.

(4) Sacramento River Flood Control Project. In 1917, the Federal government authorized the Sacramento River Flood Control Project, which adopted the system of locally built levees as Federal levees, and constructed additional levees, bypasses, overflow weirs, and pumping facilities. Currently, the Sacramento River Flood Control Project extends from the river's mouth near Collinsville in the Sacramento-San Joaquin Delta to near Chico Landing in the northern Sacramento Valley. Approximately 980 miles of levee construction were involved in the project, providing flood protection to roughly 800,000 acres of highly productive agricultural lands, the cities of Sacramento and Marysville, as well as numerous other small communities. Although the Sacramento River Flood Control Project levees were often constructed of poor foundation materials such as river dredge soils that would not meet today's engineering standards, the levees are relied upon today to provide flood protection during major storms to over 2 million people in approximately 50 communities with an estimated $37 billion in urban and agricultural development. Plate 3 shows the features of the Sacramento River Flood Control Project.

(5) Sacramento River Bank Protection Project. The erosive forces from flood events on the Sacramento River have weakened the 100 year-old levees. In response to requests from the State of California, Congress authorized the Sacramento River Bank Protection Project in two phases to maintain levee integrity and other flood control facilities associated with the Sacramento River Flood Control Project. Phase I of the Sacramento River Bank Protection Project started in 1960 and was completed in 1975 with the installation of 480,000 lineal feet of rock revetment bank protection. Phase II was authorized by Congress in 1975 and provided for an additional 405,000 lineal feet of bank protection. To date, approximately 390,000 lineal feet of Phase II have been completed with continued construction planned. Expanded authority has been authorized under WRDA 2007 to provide for an additional 80,000 lineal feet of bank protection before the completion of Phase II.

As time goes on and flood seasons pass, an increasing number of sites are requiring some type of maintenance and/or repair work to provide consistent adequate flood control capability. As of the last inspection in 2009 there are 154 sites in need of repair. Some of these sites are deemed "critical" and potentially subject to failure during a flood event. While these critical sites are being monitored to provide early warning for emergency response, emergency flood fighting may be required to prevent levee failure and subsequent flooding unless needed repairs are made prior to the next flood event. Funding for repairs does not meet the needs of the system.

(6) Sacramento and San Joaquin River Basins Comprehensive Study. The Sacramento and San Joaquin River Basins Comprehensive Study is a joint effort by the CVFPB and the Corps, in coordination with Federal, State, and local agencies, groups, organizations, and the people of the Central Valley. State and Federal legislation authorized the development of comprehensive plans for flood damage reduction and ecosystem restoration along the Sacramento and San Joaquin rivers following the disastrous floods that occurred in January 1997.

The Sacramento and San Joaquin rivers function as hydrologic systems, and ecosystem needs are tied to hydrologic processes. Accordingly, one must approach these rivers as complete systems when considering flood damage reduction and ecosystem restoration objectives. The fact that these rivers were not consistently treated as comprehensive systems in the past led to some of the problems that are experienced today. Focusing on flood management within limited reaches without full consideration of hydraulic effects in reaches both upstream and downstream has resulted in modifications to the system that has shifted local problems to other reaches. Likewise, the cumulative effects of modifications to the system have contributed to a general decline in the health of the ecosystem. The cumulative effects of habitat restoration projects can also reduce flood conveyance. It is important to ensure that the integrity and continuity of the system is maintained and enhanced to allow the river system to function in a manner where flood management and the ecosystem are compatible.

An interim report produced in December 2002 contained several important findings about the flood management system. Some of these findings included:

- The system cannot safely convey the flows that it was formerly considered capable of accommodating.
- If levee reliability were improved system-wide, substantial increases in flood storage capacity would be necessary to avoid transferring increased flood risks to downstream areas.
- A comprehensive solution to improve public safety, reduce flood damages, and restore degraded ecosystems will require a combination of measures that increase conveyance capacity, increase flood storage, and improve floodplain management.

What evolved from these planning efforts is a process to develop future projects to meet the system's comprehensive public safety, flood damage reduction and ecosystem restoration objectives. This process consists of guiding principles for integrating flood damage reduction and ecosystem restoration in future changes to the flood management system.

In 2008, the State asked the Corps to integrate the next phase of the Comprehensive Study into the development of the Central Valley Flood Protection Plan (CVFPP).

(7) FloodSAFE California. FloodSAFE California is a strategic initiative of the State of California to improve flood protection and public safety. FloodSAFE California's vision is:

> *A sustainable integrated flood management and emergency response system throughout California that improves public safety, protects and enhances environmental and cultural resources, and supports economic growth by reducing the probability of destructive floods, promoting beneficial floodplain processes, and lowering the damages caused by flooding.*

The FloodSAFE program is a collaborative statewide effort designed to accomplish five broad goals:

- Reduce the chance of flooding;
- Reduce the consequences of flooding;
- Sustain economic growth;
- Protect and enhance ecosystems; and,
- Promote sustainability.

DWR is leading FloodSAFE. Success of the FloodSAFE program depends on active participation from many key partners, such as Governor's Office of Emergency Services, CVFPB, California Department of Fish and Game (CDFG), the Corps, the Federal Emergency Management Agency (FEMA), U.S. Fish and Wildlife Service (USFWS), the National Oceanic Atmospheric Administration, tribal entities, and many local sponsors and other stakeholders.

(8) SAFCA Development Impact Fee. On May 15, 2008, SAFCA approved a Development Impact Fee on all new development within the 200-year flood plain to offset potential increases in expected annual damage as a result of a flood. The fee anticipates additional risk with new development, and offsets that risk with enhanced flood protection. SAFCA has the authority to impose the fee due to the Sacramento Area Flood Control Act of 1990, but the collecting agencies must have approved collection of the fee. (Collecting agencies include the City of Sacramento, County of Sacramento and County of Sutter). SAFCA projects that the fee will raise $148 million. Fee collection will begin January 1, 2009.

The objective of this program is to avoid any substantial increase in the expected damage of an uncontrolled flood as new development proceeds in the floodplain. The revenue generated by the fee program will be used to finance a continuing flood risk reduction program for the Natomas Basin and the Lower American and Sacramento rivers that will consist of the following measures.

a) Waterside Levee Strengthening. This measure will consist of a long-term program of waterside bank and levee protection improvements along the Lower American and Sacramento rivers, including the Natomas area, designed to arrest retreat of the upper bank,

preserve waterside berm width, and reduce the potential for destabilization of the adjacent levee foundation due to erosion or ground shaking. In addition, this measure will minimize the long-term loss of mature trees and vegetation located along the affected berms and will provide opportunities for expansion of the Central Valley's remnant riparian forest while enhancing the public safety purposes of the levee system.

b) Landside Levee Strengthening. This measure will focus on improvements to the crown and landside slope of critical segments of the levee system along the NCC and the Lower American and Sacramento rivers to increase the resistance of these levees to overtopping and extended elevated river stages. These improvements will involve hardening the crown and landside slope of portions of the NCC south levee in Natomas and American River north and south levees between Howe Avenue and Watt Avenue.

c) Acquisition of Agricultural Easements. This measure will focus on acquiring agricultural conservation easements from willing landowners occupying the levee-protected floodplains upstream and immediately downstream of the Fremont Weir. The purpose of these easements will be to compensate the participating landowners for abandoning the development rights associated with their property. These easements will remove the incentive to improve the levees protecting the property beyond the minimum design requirements of the Sacramento River Flood Control Project and will thus ensure that these levees are not raised above the "1957 profile" that governs the design of the SRFCP. This will reinforce the 200-year design of the early implementation project and the Natomas Levee Improvement Program as a whole, which assumes that upstream levees are improved to the 1957 profile and overtop without failing when water surface elevations exceed this profile. It is assumed that SAFCA's development fee revenue will constitute only a portion of the revenue devoted to this measure, with the balance coming from the State and Federal governments as part of a comprehensive update of the plan of flood protection for the Sacramento Valley.

d) Improved System Operations. This measure will focus on opportunities to improve the operation of the Sacramento River Flood Control Project to reduce water surface elevations in the Lower American and Sacramento rivers and in the drainage channels around the Natomas Basin. These opportunities may include implementing weather forecast based operations at Folsom Dam and Reservoir and improving the conveyance capacity of the Yolo and Sacramento Bypass systems. It is assumed that SAFCA's development fee revenue will constitute only a portion of the revenue devoted to this measure, with the balance coming from the State and Federal governments as part of a comprehensive update of the plan of flood protection for the Sacramento Valley.

(9) Central Valley Flood Protection Plan (CVFPP). The State of California, through the CVFPB, has initiated the CVFPP, as a multi-faceted and phased process to reduce risks of flooding and improve public safety, while seeking to preserve riparian habitat along river corridors. The State of California expects to fully identify the long-term components of the Plan by 2012.

California Senate Bill 5, signed into law in October, 2007, provides the commitment for the long-term plan. The legislation establishes the minimum standard for urban areas at a 200-

year level of flood protection. It also establishes a deadline of 2025 to achieve 200-year flood protection if the urban area is protected by State-Federal project levees. After 2015, urban areas that cannot demonstrate adequate progress to achieve the 200-year level of protection will face potential limitations in approving new development in potential floodplains.

Development of the CVFPP will involve three major elements: (1) mapping of the 100-year and 200-year floodplains based on information from the Sacramento-San Joaquin River Basins Comprehensive Study and revised hydrologic and levee evaluations; (2) identification of the existing and proposed performance standards for all facilities within the system; and, (3) proposals for additional structural and nonstructural facilities that may become part of the flood management system, including:

- Bypasses;
- Floodway corridors;
- Flood plain storage; and,
- Other projects that:
  - Expand the capacity of the system;
  - Increase and improve the quantity, diversity, and connectivity of riparian, wetland, flood plain, and shaded riverine aquatic habitats, including the agricultural and ecological values of these lands;
  - Minimize the flood management system operation and maintenance requirements; and,
  - Promote the recovery and stability of native species populations and overall biotic community diversity.

Partnerships with the Corps are expected to be an integral part in the planning and development of the CVFPP. The Development Impact Fee is expected to help provide funding for the plan. And, the State and SAFCA consider the American River Common Features Project as an early implementation project of the plan.

(10) California's Public Law 84-99 Eligibility Retention and Flood System Improvement Framework. In the aftermath of Hurricane Katrina, the Corps began to place heightened emphasis in the removal of vegetation from flood control works. In Central California, the situation is unique in that dry conditions make it nearly impossible to maintain a sod cover on most levees. Because of this, many levees have brush and trees that were maintained in an effort to provide erosion protection for the levees. Additionally, the vegetation on the levees provide important habitat.

The Corps' levee maintenance standards are primarily derived from 33 C.F.R. §208.10(b)(1) and require that measures be taken to promote the growth of sod on the levees, while generally keeping them free of wild growth, trees, and other vegetation. Some vegetation is allowed, specifically, "brush and small trees" to be retained "on the waterward slope where desirable for the prevention of erosion and wave wash."

Levee vegetation guidance was issued in 2009, with the release of Engineering Technical Letter (ETL) 1110-2-571, Guidelines for Landscape Planting and Vegetation Management at

Levees, Floodwalls, Embankment Dams, and Appurtenant Structures, dated 10 April 2009. This ETL defines a vegetation-free zone for levees, calling for a zone wide enough and tall enough to accommodate all likely access requirements. The ETL also allows the local sponsor to request a variance from the standard vegetation guidelines set forth in this ETL under certain circumstances. Variances may be requested to preserve, protect and enhance natural resources and/or protect the rights and cultural resources of Native Americans.

The State of California developed a framework to address vegetation issues in the context of its ongoing activities to reduce flood risk in the Central Valley. A short-term framework includes actions that will be implemented before 2012. At that time, the CVFPP will be completed. That document will lay out strategies for implementing more comprehensive system-wide improvements over time.

The short-term strategy consists of removal of and trimming of vegetation to facilitate inspection and flood fighting, according to revised inspection criteria recently developed by DWR. The criteria used during this short term are considered interim, and will transition to the Corps standard, to be implemented as part of the Central Valley Flood Protection Plan after 2012. The State anticipates a "life-cycle management" approach to the vegetation remaining in this interim period after the short-term plan is implemented. This "life-cycle management" will consist of:

- Monitoring the health and condition of trees and woody vegetation;
- Removal of trees as they deteriorate, either through age, disease, or damage, before they can fall and cause harm to the levees; and,
- Adequate repair and replacement of levee materials lost when trees are removed.

b. Summary. The vegetation framework, the implementation of the projects at Folsom Dam, and other studies in the area all must be considered to establish the future without project condition. Additionally, the ongoing efforts toward a comprehensive plan of flood risk management in the Central Valley make it all the more important that the Common Features Project not adversely affect the development of the comprehensive CVFPP. It is assumed that the American River Common Features Project would be an early implementation project of the overall State plan.

1-7. PLANNING PROCESS AND REPORT ORGANIZATION

The purpose of the plan formulation in this report is to determine the degree of Federal participation in the locally developed plan of improvements to provide flood risk management to the Natomas Basin. To accomplish this determination, this interim general reevaluation study evaluates an array of alternatives to establish the limit on Federal cost sharing through the Corps planning process.

The planning process consists of six major steps: (1) Specification of water and related land resources problems and opportunities; (2) Inventory, forecast and analysis of water and related land resources conditions within the study area; (3) Formulation of alternative plans; (4)

Evaluation of the effects of the alternative plans; (5) Comparison of the alternative plans; and, (6) Selection of the recommended plan based upon the comparison of the alternative plans.

The chapters of this report relate to the six steps of the planning process as follows:

- The second chapter of this report, Problem Identification, covers the first step in the planning process (Specification of water and related land resources problems and opportunities). It also covers the second step of the planning process (Inventory and Forecast). It concludes with a focus on the Natomas Basin portion of the authorized project by reach and then establishes planning objectives for the reevaluation of the Natomas portion of the project.

- The third chapter of this report, Alternatives, is the heart of the report and also focuses on the Natomas Basin portion of the authorized project. It covers the third step in the planning process (Formulation of alternatives). It also covers the fourth step in the planning process (Evaluation), the fifth step in the planning process (Comparison), and the sixth step of the planning process (Selection).

- The fourth chapter of this report, The Selected Plan for the Natomas Basin, describes the selected plan resulting from the evaluation of alternatives.

- The fifth chapter of this report, Changes to the Common Features Project, integrates the revaluated Natomas Basin portion of the Common Features Project with the other previously authorized and constructed portions of the project to describe proposed changes to the authorized Common Features Project.

- The sixth chapter of this report, Public Involvement, Review, and Consultation, covers the public and agency review of the report.

- The seventh chapter of this report, Recommendations, provides the recommendation for project reauthorization.

CHAPTER 2 - PROBLEM IDENTIFICATION

This chapter presents the results of the first step of the planning process, the specification of water and related land resources problems and opportunities in the study area. The chapter concludes with the establishment of planning objectives and planning constraints, which are the basis for the formulation of alternative plans. This chapter focuses on the Natomas Basin portion of the authorized Common Features Project.

2-1. NATIONAL OBJECTIVE

The National or Federal objective of water and related land resources planning is to contribute to national economic development consistent with protecting the nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. Contributions to national economic development (NED) are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the nation. The National objective is not specific enough for the development of a water resource project. The formulation of alternative plans requires the identification of study specific planning objectives.

Benefits from plans for reducing flood hazards accrue primarily through the reduction in actual or potential damages to affected land uses. There are three primary benefit categories, reflecting three different responses to a flood hazard reduction plan. Inundation reduction benefits are the increases in net income generated by the affected land uses when the same land use pattern and intensity of use is assumed for with- and without-project conditions. Intensification benefits are increases in net income generated by intensified floodplain activities when the floodplain use is the same with and without the project but an activity (or activities) is more intense with the project. The third category of benefits is location benefits. If an activity is added to the floodplain because of a plan, the location benefit is the difference between aggregate net incomes (including economic rent) in the economically affected area with and without the project. In general, the NED Plan will be formulated to protect existing development and vacant property that is interspersed with existing development.

2-2. PUBLIC CONCERNS

A number of public concerns have been identified during the course of the study. Input was received through coordination with the sponsors, coordination with other agencies, and through public workshops. A discussion of public involvement is included in Chapter 6, Public Involvement, Review and Consultation, Appendix A, Public Involvement, and Appendix I of the FEIS/EIR. The public concerns that are related to the establishment of planning objectives and planning constraints are:

- The Corps should look at the most cost-effective solutions, utilize previous levee improvements, and maintain as much vegetation as feasible while ensuring adequate flood control.

- In addition to evaluating all methods of levee raising and strengthening, it is suggested that an evaluation of diverting excess water through the Yolo bypass corridor be conducted.

2-3. PROBLEMS AND OPPORTUNITIES

The evaluation of public concerns reflects a range of needs, which are perceived by the public. This section describes these needs in the context of problems and opportunities that can be addressed through water and related land resource management to reduce flood risk in the Natomas Basin and system performance. The problems and opportunities, relating to flood risk management and system performance factors, that have been identified are:

- Seepage and Underseepage
- Levee Erosion
- Levee Stability
- Levee Overtopping
- Vegetation and Encroachments
- Releases from Folsom Dam
- Floodplains

A description of the history and flooding risk follow, along with discussions of each of the above problems and opportunities.

a. History and General Description of Flooding Risk. The climate and geography of the Sacramento Valley combine to produce an area where regular flooding is natural. Sacramento is a semi-arid region with an annual rainfall of approximately eighteen inches. There are two distinct annual seasons, a dry summer and a wet winter. Approximately 80 percent of the annual rainfall occurs in five months, October to March. Just to the east of the region lies the Sierra Nevada mountain range. Some areas in these mountains receive one hundred inches of precipitation annually. The snow pack in some regions can reach 300 inches, with the resulting runoff causing flooding problems in the Central Valley, including Sacramento. Before human intervention, runoff from the mountains would expand over the natural flood plain from Sacramento to what is now Davis, 20 miles to the west. Under natural conditions, the Sacramento River channel in the valley area had insufficient capacity to carry the heavy winter and spring flows generated by precipitation and snowmelt. Once flow exceeded channel capacity, channels overflowed into the surrounding countryside.

The problem was complicated by the initiation of hydraulic gold mining in the California gold fields in 1853. In the first five years of the California Gold Rush, most of the easily accessible gold had been extracted from the gravel beds in streams. Hydraulic mining developed in an effort to extract gold from ancient gold-bearing gravel beds in hillsides and bluffs. Water at high pressure was directed through a nozzle at the hillsides. This high-pressure stream was used to wash entire hillsides into massive sluices, where the gold would settle to the bottom. The resulting streams of water and gravel were delivered into mountain streams that fed rivers flowing into the Sacramento Valley. Once the rivers reached the relatively flat valley, the

sediment was deposited in the floodplains and river beds. This caused the river beds to be higher, and the rivers to shift to new channels and overflow their banks. The filling of the river channels caused major flooding, especially during periods of spring runoff. Cities and towns in the Sacramento Valley experienced an increasing number of devastating floods. Hydraulic mining was discontinued in 1884.

Figure 2-1. Hydraulic Mining during the California Gold Rush.

Sacramento built its first levee to protect itself from the American and Sacramento rivers in 1850. Unfortunately, the levee was less than adequate, and flooding continued to occur. In the flood of the winter of 1861-62, the levee was overtopped, and the city was in a "lake" of its own creation. To relieve the water levels inside the levee, a cut in the levee was made to drain the "lake." Unfortunately, houses were swept away in the current through the cut in the levee.

Once agricultural development began in the area, the need for flood control became apparent. Landowners built private levees to protect specific tracts of land. The levees were not engineered and often were made of inadequate materials dredged from the river. These levees tended to increase depths of floodwater in other areas, which were further increased by the millions of cubic yards of hydraulic mining debris washed into valley streams between 1853 and 1884.

After the flood of 1861-62, the City embarked on a decade-long project to raise the central business district of Sacramento to a level believed to be safe. Streets east of the Sacramento River to about 12th Street were raised as much as 14 feet.

The levees on the Sacramento River in the vicinity of Natomas and Sacramento were originally built to reclaim land for agriculture. Suction and clamshell dredges were used to build the levees with material from the river. Levees were not built to modern day standards. This photograph shows how the levees were constructed from material dredged from the river.

Figure 2-2. Levee Construction in Natomas.

The U.S. Geological Survey kept gauged records of discharge during major flooding in March 1907 and January 1909. The 1907 flood was considered the "greatest experienced since the flood of 1862." In 1911, the California Legislature approved an integrated, comprehensive flood control project for the Sacramento Valley. This project, the Sacramento River Flood Control Project, was authorized by Congress in 1917. It consists of a system of levees, weirs, and bypass channels to carry major flood flows away from existing population centers. The design of this flood control system was based primarily upon the 1907 flood. Successful operation of this system as a whole depends on the successful operation of its individual parts.

The Natomas Basin is protected by 42 miles of perimeter levees that are part of the Sacramento River Flood Control System. The levees are configured such that they prevent the various rivers and channels that completely surround the basin from overflowing into the basin. Therefore, the 42 miles of levee protecting the basin form a ring levee protecting the basin. In addition to the basin being protected by a ring levee, it is also a single hydrologic unit. Depending on the magnitude of a flood event, a levee failure anywhere on the perimeter of the basin would cause damages to the densely populated southern end of the basin. For certain reaches, it takes a larger flood event to cause serious flooding as compared to other reaches; but, for all reaches, it is possible to have serious flooding with a certain level flood event, making it a single hydrologic unit as well as a system.

While the Natomas levees and the Sacramento River Flood Control System provided positive benefits to Sacramento, the area was still not free from flooding. In the 1930's, California would plan and build the Central Valley Project, with Shasta Dam at the upper end of the Sacramento Valley. The Central Valley Project extends from the Cascade Range in the north to the Kern River in the south and was primarily built to protect the Central Valley from crippling water shortages and menacing floods. Folsom Dam was authorized in 1944, and completed by the Corps in 1956. Though engineers had estimated that it would take a year to fill the reservoir, a record storm filled the lake in a week, and saved Sacramento from flooding. Another project, the "California State Water Project," was completed with the building of Oroville Dam in 1967. The California State Water Project is a water storage and delivery system of reservoirs, aqueducts, power plants and pumping plants. Its main purpose is to store water and distribute it to 29 urban and agricultural water suppliers in Northern California, the San Francisco Bay Area, the San Joaquin Valley, the Central Coast, and Southern California.

Newspaper accounts and anecdotal evidence mention at least nine major floods prior to 1900. Large floods since the operation of Folsom Dam on the American River became effective occurred in 1955, 1964, 1969, 1970, 1982, 1986, 1997, and 2006. The 1986 flood is the flood of record.

(1) February 1986 Flood. In February 1986, a series of storms struck California, resulting in severe flooding in central and northern California. Precipitation from the 10-day storm was more than half of the normal yearly rainfall for much of California. The Sacramento region was in the center of the path of storms that originated in the Pacific Ocean, pushing the flood control system to its capacity and beyond.

The Sacramento River flood control system was overloaded. Reservoirs in the system were filled beyond their design capacity. Record flow releases from the reservoirs produced river flows that made theretofore unseen demands on the downstream system of levees, beyond their design boundaries. Water came within inches of overtopping levees protecting Sacramento. At the runoff peak, an estimated 650,000 cfs flowed past the Sacramento metropolitan area and out to the Delta.

In Natomas, emergency levee work and flood fighting prevented catastrophic flooding. However, the extended high water caused numerous problems with Natomas Basin levees. Boils, slips, sloughing, seepage, flood flow erosion and wave erosion required emergency work to minimize or prevent further damage during the flood. The following figures show typical problems encountered during the 1986 flood.

Figure 2-3. Slope Failures on the Landside of the Levee and Seepage Exiting at the Levee Toe on the Garden Highway in Natomas During the 1986 Flood.

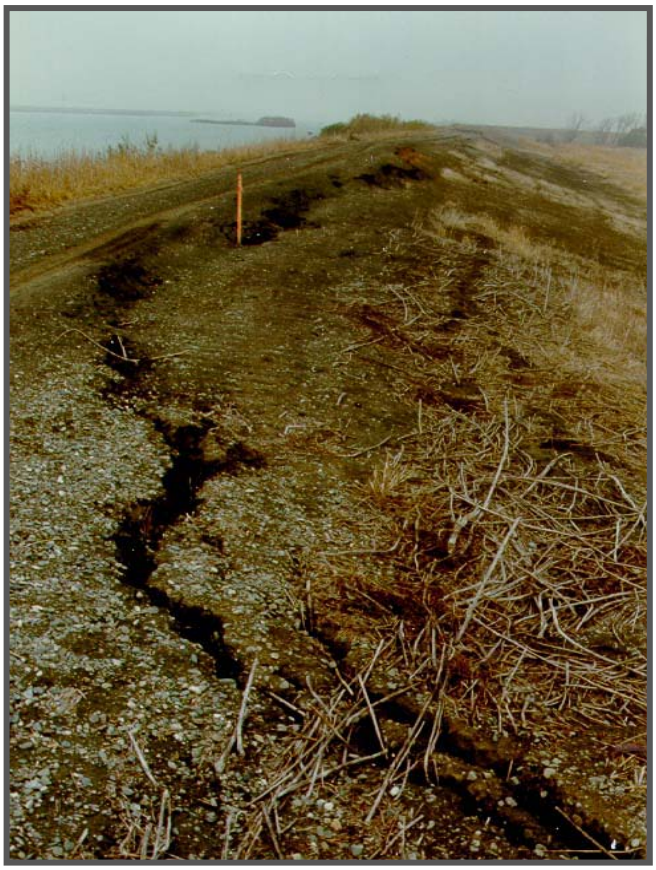


Figure 2-4.
Slope Stability Failure on the Natomas Levee during the 1986 Flood.

In spite of diligent levee patrolling and emergency levee work, several levees upstream from Sacramento failed in the 1986 flood. At the conclusion of the storm, the Governor had declared emergencies in 39 counties, with damages totaling more than a half billion dollars. Sacramento County had damages estimated at 49 million dollars.

(2) January 1997 Flood. Events leading up to the January 1997 flood began Christmas Week of 1996, when snowfall ranging from seven to ten feet fell in the Sierra Nevada Mountains. Rain began to fall on December 26, and from December 31 to January 3, a "Pineapple Express" pounded Northern California with more than half the rain it would receive in a normal year. The website of the National Weather Service's Spokane, Washington Forecast Office describes a "Pineapple Express" in this manner:

> *Pineapple Express is another descriptive term that is used frequently in the media and is linked with heavy rain and flooding. Actually, it develops during a relatively common weather pattern with a ridge over the West Coast and a low pressure in the Eastern Pacific. Southwest winds ahead of the low pressure drive warm, moist air over the ridge into the Pacific Northwest and California. This leads to widespread cloud cover, persistent rain and unseasonably warm temperatures. The flow of warm air can melt the snow pack in the mountains, while periods of heavy rain occur when the warm moist air is forced over the mountainous terrain. Rapid snow melt paired with heavy rain leads to extensive flooding. Forecasters often refer to this warm, moist air flow as the Pineapple Express because it originates from the subtropical waters around Hawaii where pineapples are typically grown.*

In addition to the rainfall, 50 degree temperatures and rain in the High Sierra melted the snowpack below 6,000 feet. The combination of record snowfall and record rain resulted in another close call for Sacramento. The Sacramento River peaked within half a foot of the 1986 record level. Folsom Reservoir was barely able to keep releases within the objective release of 115,000 cfs. Upstream from Sacramento, levees on the Feather River at Olivehurst and on the Sutter Bypass were breached.

b. Natomas Levee Performance History.

(1) Sacramento River Levee. The flood of 1986 exposed significant deficiencies in the sandy levees along the Sacramento River channel. Many days of high flow in the river saturated the sandy interior of the levee section, causing the landside slope to slough in several Garden Highway locations, nearly triggering a catastrophic levee failure. Thereafter, between 1990 and 1993, the levee was strengthened through the installation of stability berms along the landside toe of the levee for approximately 12 miles from the Natomas Cross Canal to Powerline Road. From there to the American River confluence, seepage cutoff walls were installed through the levee and its foundation to a depth of up to 30 feet. These repairs functioned well during the flood of 1997. However, subsequent analysis of foundation conditions, including at locations occupied by pumping facilities and drainage canals, revealed unacceptable vulnerability to underseepage. At RD 1000's Pumping Plant No. 2 near RM 75, this vulnerability was considered particularly unacceptable. Accordingly, in 2006, SAFCA, RD 1000, and CVFPB

initiated an emergency repair project at this site. As part of this project, several hundred feet of the levee were excavated to allow removal of an impaired discharge pipe, the levee was reconstructed, and the pumping facility was set back from the levee to allow a portion of the drainage canal to be filled and to accommodate the footprint of a new raised adjacent levee at this location.

(2) American River Levee. The American River levee has experienced many high water events in the 95 years since its completion, including in 1928, 1951, 1956, 1964, 1986, and 1997. The performance history of the levee was reviewed in February 2006 as part of a problem identification report (PIR) prepared for SAFCA. The PIR referenced historic documents from the State Department of Water Resources (1967) and a map issued by RD 1000 and RD 1400 (1938) showing areas affected by high water conditions in the Sacramento River during spring 1938. This event subjected the levee to high water for its entire length; however, it is unclear from DWR's and RDs' maps whether the seepage observed on the north side of the levee at several locations east of what is now Interstate 5 resulted from levee or foundation seepage, or from interior canal overflows. The PIR notes that during the 1986 flood a slip was observed near the levee crown at Station 78+00. After the flood, the performance of the American River levee was evaluated. Despite anecdotal reports of "notorious" leakage at several locations along the levee, the no problem sites were identified. Finally, the PIR indicates that in 1995, seepage and pin boils were observed near Station 88+00. No other indications of distress were identified in the PIR.

(3) Natomas East Main Drain Canal. The lower NEMDC west levee has experienced many high water events in the 95 years since its completion, including in 1928, 1951, 1956, 1964, 1986, and 1997. The performance history of the levee was reviewed in June 2009 as part of a PIR prepared for SAFCA. The report notes that of all of these flood events, the 1986 flood was the most significant. High flows in the American River (up 134,000 cfs) combined with high flows in the tributary streams discharging to the NEMDC produced record high water stages in the lower NEMDC channel. High water marks measured south of Dry/Robla Creek are equivalent to the elevation of the current 100-year flow being used for levee design purposes. After the flood, the performance of the lower NEMDC levee during the flood was evaluated. There was evidence of seepage through the levee, and foundation and internal erosion (or piping) of sandy materials through the levee by the presence of sand boils, and deposits at the landside toe of the levee in the general vicinity of the abandoned Arcade Creek streambed. A depression, or possible slump, was observed at about the midpoint of the waterside slope directly opposite the landside toe sand deposit, possibly indicating internal erosion. Despite anecdotal reports of "notorious" leakage at other locations along the lower NEMDC west levee particularly downstream of Arcade Creek, no other problem sites were identified.

(4) Natomas Cross Canal. The historic performance of the NCC south levee was reviewed as part of a PIR prepared for SAFCA in March 2006. Historical documents and maps were reviewed to evaluate the past performance of the NCC south levee, including maps produced by DWR in 1967 and the Natomas Company in 1938. These maps indicate that as many as 6,810 acres on the landside of the NCC south levee were inundated during a high water event in May 1938. It is not clear from the maps, however, whether the conditions observed in these areas were produced by seepage through or under the levee, or by collected surface water

at that location. In addition to the observations recorded on the maps described above, it was also noted that:

- During high water in 1997, a small pencil boil was observed near the confluence of the NCC south levee and the Sacramento River levee.
- A slide that occurred "approximately 3,500 feet southwest of Highway 99" was repaired in 1993.
- A slide also occurred in 1986, approximately 2,000 feet west of Highway 99, and longitudinal cracks indicative of slope instability were observed in the levee crown approximately 400 feet southwest of the highway. No clearly defined slide planes were observed, and the slide did not involve the crown. Investigators concluded that seepage forces resulting from spring flooding may have initiated the slide movement; however, these soil conditions were not encountered during the 1987 field investigation, and the instability that led to the slide could not be explained. A repair was performed in 1987, encompassing approximately 300 linear feet of levee slope.

c. Natomas Flood Risk Reduction Performance Factors.

(1) Seepage and Underseepage. The poor construction of most of the levees in the Sacramento area leads them to have problems with seepage through them. The levees were constructed of material dredged from the river and placed in a trench excavated in the natural ground between two starter dikes obtained from excavation placed along each side of the trench. Because of this, the embankment material consists of pervious sands and gravels that transmit water under flood conditions. This leads to the development of floodwater seepage through the levee embankment and eventually to damages of the levee. Internal erosion can cause piping of levee material from the embankment and landside slope failure. In addition, the area protected by the levee could be affected by excessive seepage of water from the river. During the 1986 floods, numerous areas of seepage through the levee leading to landside slope failures were observed. Figure 2-3 shows the consequences of seepage under and through the levee.

In addition to seepage through the levees, these levees are also subject to underseepage through permeable layers in the levee foundation that may compromise levee integrity. Geomorphologic and geotechnical studies have identified features along the American and Sacramento rivers that are former river channels, meanders, oxbows, and current and former point bars. This means that there are deposits of permeable sand and gravel beneath the levees protecting the Sacramento area that readily transmit water. Under high water stages the protected area may be flooded due to underseepage through these highly permeable layers. These layers are easily erodible, and may cause the levee to collapse due to internal erosion, or piping. If the permeable sand layers in the foundation are covered by an impervious blanket, water pressure can develop at the base of the impervious blanket, resulting in collapse of the levee embankment due to piping of the foundation soil, if the impervious blanket is not thick enough or is cracked. Sand boils were observed in the Natomas levees after the 1986, 1997, and 2006 floods. The sand boils resulted when the seepage beneath the levee moved swiftly enough to bring sand particles with it, creating piping through the levee foundation. This is a kind of internal erosion that can undermine a levee and cause serious instability and failure. Figure 2-5

shows a sand boil being treated with a sandbag ring during the 2006 flood. This flood was a 10-year frequency flood.

Figure 2-5. Sandbag Ring on Sand Boil on the Natomas Levee during the 2006 Flood.

After the 1997 flood event, the Corps, in conjunction with SAFCA and the State, put together a task force to extensively study the seepage problems. Based on the recommendations of the task force, studies of Natomas were finalized in 2005 and then thoroughly reviewed. On the basis of those results, in June 2006, the Corps stated that, primarily because of underseepage, the Natomas levees were no longer certifiable for the flood event that has a 1% chance of occurrence in any year, or the 100-yr event.

In December 2006, FEMA notified the City and County of Sacramento and Sutter County that they planned to revise the community's existing Flood Insurance Rate Map resulting in the entire Natomas Basin being placed within a regulatory Special Flood Hazard Area.

The map in Plate 7 shows areas where conditions are such that seepage under and through the levee could cause significant problems.

(2) Levee Stability. Stability problems were observed during high water stages on both on the landside and waterside slopes. The materials used to construct the levees were not selected for their suitability, merely their availability, and dredged from the riverbed. The construction methods were also not adequate, the levee material not being compacted but constructed with clamshells or dredged with assorted objects indiscriminately buried in the levee embankments, such as dead trees. Seepage through the levee embankment and underseepage through its foundation would raise the water pore pressure at the landside levee toe leading to sloughing and sliding of the landside levee slope. Landside slope failures have been observed during high river stages in areas where impervious soils cover the sandy and gravelly layers in the levee foundation due to high gradients at the levee toe. These slope failures have also been

observed in areas where water was seeping through the levee embankment above the toe of the levee.

There are no active faults running through the project area. There are, however, faults that run along the foothills east of Folsom Dam and near Vacaville and Dixon (outside of the project area). Potential of liquefaction of the saturated sandy material in the foundation of levees is also a concern, but considering the very low probability that an earthquake may occur during high river stages, the levees are not designed to resist a seismic loading. However, the liquefaction assessment is included in the Geotechnical Appendix, and it is considered that the damages on the levee may be repaired to a temporary condition to assure a protection for a minimum flood event of 25 years. The map on Plate 7 shows areas where levee stability is a concern.

(3) Levee Erosion. Because of the deposits of hydraulic mining debris that washed into the American and Sacramento River valleys, early levee builders constructed the flood control works by dredging material from the river beds and placing it on the bank near the river. This served several purposes. First, the resulting levee provided a degree of protection from flooding. Second, it removed material from the river bed, causing it to convey more water. And finally, by placing the levees close to the river's edge, the river flow was confined, speeding its flow, and causing it to erode away the material that had been deposited by hydraulic mining, further increasing the river's flow capacity.

The levees continue to confine the flow into a relatively narrow channel, still eroding and degrading the river channel. However, by now, most of the sediment deposited in the river channels has been depleted. Both the Sacramento River and the American River are confined by levees and are sediment hungry. Additionally, on the American River, Folsom Dam blocks sedimentation from upstream sources. Therefore, the energy of the flow tends to erode riverbanks and levees. This channel erosion and degradation could have detrimental effects on the levees by undercutting the foundation materials beneath the levees, particularly if the riverbank consists of easily erodible materials. The erosion of the riverbank adjacent to levee embankments may increase the underseepage through the foundation soils. It can also reduce the stability of the levee slopes by undermining the levee embankment and eroding the levees themselves. Significant erosion can lead to the failure of the levee.

Empirical evidence and prototype experience indicate that stream bank erosion in the area can be gradual or episodic. That is to say, some erosion occurs almost every year. Significant amounts of erosion during large floods have not been reported in the Natomas area, but have been observed in other streams in the region. This is primarily due to the fact that materials have been placed on the banks by landowners in an effort to halt erosion. These materials are generally random materials, placed without regard to engineering standards. The Sacramento District is currently evaluating erosion trends as part of the WRDA 2007 authorization for Sacramento River Bank Protection Project (Sac Bank).

The map on Plate 7 shows areas where erosion is a concern to the integrity of the levees. Under the Sac Bank program, the levees along the Sacramento River are inspected annually to monitor erosion and rank erosion sites for priority. Approximately 10 sites along the water side

of the Sacramento River east levee are subject to bank erosion in the form of bed or toe scour and wave wash that threatens the stability of the adjacent levee. These sites are listed in Table 2-1.

Table 2-1. Sacramento River Risk Priorities for Erosion Sites*

River Mile	Initially Estimated Site Length (feet)
78.2	640
74.4	1,360
70.3	480
70.0	400
69.8	690
69.4	1,170
69.1	660
68.5	1,390
67.8	370

**Status as of March 2010*

The NCC is also inspected annually under the Sac Bank program, and no sites on the left bank were identified.

The PGCC and the NEMDEC were recently inspected to identify erosion sites for this study. Seven erosion sites were identified. All of the locations are at the confluences of tributary streams where the channel of PGCC or NEMDC has migrated to the west and threatens or has damages the right levee. The locations are shown in Table 2-2.

Table 2-2. Erosion Sites on Pleasant Grove Creek Canal and Natomas East Main Drain Canal

Main Stream	Tributary Stream
PGCC	Curry Creek
PGCC	Pleasant Grove Creek
PGCC	Howlsley Road Bridge
PGCC	Pierce-Roberts Drain
NEMDC	Dry Creek North Channel (downstream of the City of Sacramento Pump Station No. 157)
NEMDC	Dry Creek North Channel
NEMDC	Arcade Creek

(4) Levee Overtopping. Fortunately, the levees in the Sacramento area have not been overtopped in recent flood events, although several floods have come close. However, it is possible that a large enough flood event could occur that would overtop the Sacramento levees. In past flooding, levees upstream have failed, relieving some of the pressure on the Sacramento area. But as repairs to these levees are made, it increases the flood risk to Sacramento as project levees could face the full brunt of the flood event. Because these levees were not built to modern

engineering standards and levee failures upstream are assumed not to occur, levee overtopping would potentially lead to failure of the levee and cause devastating flooding.

The State has established a preliminary draft of a standard for urban flood protection in California. This standard would require levees to have a top elevation equal to the mean 200-year water surface profile, plus three feet of freeboard, plus an allowance for wave run-up, plus one foot to account for climate change.

The map on Plate 7 shows areas where levee overtopping is a concern, in accordance with the proposed State standard.

It has been determined that in formulating a plan to address levee performance in Natomas, raising levees will not be a part of the selected plan because of the uncertainty in the hydraulic model being used for this analysis. Hydraulic modeling for the Common Features Project continues to be under refinement. The model was developed using the NGVD '29 datum rather than the NAVD '88 datum. This results in additional uncertainty in the stage/frequency relationship. The topography from the Comprehensive Study is being used as the basis for the current hydraulic model. Review of recent ground control elevations has determined that the ground control for the Comprehensive Study topography is not exactly based upon the NGVD'29, as was originally thought. This is mainly due to the use of obsolete ground control elevations in areas of ground subsidence. Because of this, one cannot simply convert the Comprehensive Study topography from NGVD'29 to NAVD'88 using Vertcon (a National Geodetic Survey software tool for datum conversion) because the data was not relative to the NGVD'29 datum to begin with. Without a hydraulic model that is fully corrected for the NAVD'88 datum, refinements of the model could potentially affect the optimization of benefits associated with levee raising. Therefore, this levee raising cannot be confirmed to be in the Federal interest without additional hydraulic modeling efforts.

(5) Vegetation and Encroachments. In many locations in the study area, vegetation and encroachments exist on or near the levees. Various types of vegetation exist on the levees, including native vegetation, landscaping, and gardens. Additionally, many types of encroachments exist on or near these levees. These include houses, utilities, stairs, fences, outbuildings, retaining walls, and swimming pools. These are not isolated cases on the levees, but represent a large-scale, nearly ubiquitous condition.

Most California levees were built close together after the Gold Rush to make the rivers run faster to scour out debris in the channel from hydraulic mining. As a result, trees and shrubs on levees now provide the only waterside habitat that remains for many sensitive wildlife species. In some cases, the levee slopes contain brush and trees that are the last remnants of a vast riparian forest, which once extended across the valley floor adjacent to the Sacramento River. Extensive destruction of California's Central Valley riparian forests has occurred during the last 150 years due to agricultural and urban development. According to some estimates, riparian forests in the Central Valley have declined by as much as 89 percent during that time period.

Many of the encroachments were granted permits for construction in the past, while some were built without any prior knowledge or approval from any governing agency.

Issues with vegetation on levees are summarized as follows:

- Levee Visibility – riparian vegetation can cause a reduction in visibility of the levee, particularly in very dense areas of vegetation. Levee visibility is important for maintenance and inspection crews to identify problems in levee integrity such as the presence of burrowing animals, cracks, slumping, and seepage.

- Accessibility – vegetation can block access to the levee crest or landside of the levee for flood fight requirements and maintenance access purposes.

- Through-levee seepage – riparian vegetation roots can cause seepage problems through levees and affect the general integrity of the levee.

- Windthrow – risk to levee integrity can be caused during storms as a result of windthrow. The root balls of felled trees during storms can displace relatively large amounts of earth which can affect the strength of the levee, or if on the waterside, increase the risk of scour.

- Slope stability – riparian vegetation can cause slope stability problems, particularly on the waterside of levees. Tree roots extending in the river flow can cause erosion problems near the toe of the levee, a particularly critical part of the levee in terms of slope stability.

- Burrowing animals – riparian vegetation may encourage the development of animal burrows detrimental to the levee or may reduce visibility of burrows.

Because of its composition and proximity to the Sacramento River channel, the Sacramento River East Levee proved to be vulnerable to erosion. This vulnerability was addressed through the construction of rock groins, bank armoring, and maintenance of a vegetative veneer on the waterside berms and the waterside slope of the levee. Over time, the root structure of this vegetation has reinforced the materials encasing the levee created a kind of protective shell around the sandy materials in the levee that stabilizes the waterside slope and berm of the levee and offers resistance to erosion caused by high flows in the river and wind and boat driven waves.

The Corps' levee maintenance standards are primarily derived from 33 C.F.R. §208.10(b)(1) and require that measures be taken to promote the growth of sod on the levees, while generally keeping them free of wild growth, trees, and other vegetation. These standards are not practical in the California Central Valley's climate.

The Standard Operation and Maintenance (O&M) Manual for the Sacramento River Flood Control Project on file at SPK was last amended in 1955. The purpose of the manual is to "present general information for use by local interests who maintain and operate the various geographical units comprising [the project]." It points out that all local interests must give satisfactory assurances that they will maintain and operate the federal structures consistent with existing Corps' regulations.

The manual then describes the various maintenance standards for the Project's different flood control structures. The Corps' levee maintenance standards, which deal with vegetation management, were changed in the manual to better reflect issues unique to California levees. That provision allows for "brush and small trees" to be retained "on the waterward slope where desirable for the prevention of erosion and wave wash." The purpose of the California-specific provisions is to provide better flood protection.

The Standard O&M Manual for the Sacramento River Flood Control Project is supplemented by 69 "Supplemental O&M Manuals." These Supplemental Manuals provide more specific O&M standards for various units of the Sacramento River Flood Control Project. Some of the Supplemental Manuals contain provisions that require the preservation of vegetation. For the Natomas Basin, the Supplemental Manual for Unit 124 (North Levee of American River from Natomas East Canal to the Sacramento River and East Levee of the Sacramento River from NCC to American River) of the Sacramento Flood Control Project provides:

> *Vegetation left during construction on the waterside berm or slope above the bank protection shall not be removed under normal maintenance. Dead trees with wildlife value will be retained except where they constitute a hazard to project works.*

In April 2009, the Corps issued Engineering Technical Letter (ETL) 1110-2-571, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures. This guidance calls for the removal of wild growth, trees, and other vegetation, which might impair levee integrity or flood-fighting access in order to reduce the risk of flood damage. In certain instances, to further enhance environmental values or to meet state or federal laws and/or regulations, the local sponsor may request a variance from the standard vegetation guidelines set forth in this ETL.

In March 2009, the Central Valley Flood System Improvement Framework (Framework) was completed based on an earlier draft of the ETL. The Framework was developed collaboratively by the California Levees Roundtable, a partnership of Federal, State, and local agencies formed in 2007 to address vegetation issues affecting the State-Federal levee system in California's Central Valley. The Roundtable included senior level officials representing the Corps Headquarters, South Pacific Division, and the Sacramento District; the CVFPB; DWR; National Marine Fisheries Service (NMFS); USFWS; CDFG; FEMA; Reclamation District (RD) No. 2068; and SAFCA. The Roundtable agencies agreed to work together to draft a phased system-wide levee vegetation plan, with short and long-term elements. The vegetation plan transitioned into the recently adopted Framework. The Roundtable recognized that vegetation management is only one of many issues that threaten levees and broadened its scope to address many threats to levee integrity. The Framework is an interim document that expires in 2012. At that time, the Central Valley Flood Protection Plan will contain new levee guidance.

SAFCA prepared a plan to manage the risks posed by vegetation on Sacramento levees in conformance with the Framework. Criteria will be used to identify trees for phased removal,

assuring levee security, while allowing time to achieve full compliance with the Corps' levee vegetation policy. This approach is being described as life cycle management (LCM) of levee vegetation. Vegetation risks would be actively managed in the context of other system repairs such as seepage and erosion control (i.e. if a vegetated slope is over-steep, it is assumed that will be fixed first and the vegetation issues will be addressed in the context of the repaired slope).

The LCM plan that SAFCA proposes would comply with the vegetation provision of the Supplemental Manual for Unit 124 in that it would remove vegetation as necessary for levee inspection and flood fighting and would monitor the remaining vegetation for indications that the levee is being threatened by the vegetation. If the vegetation appears to be causing levee distress, then it would be removed.

This study assumes that the LCM plan for vegetation management will be part of the without-project condition and forms the basis for the formulation of modifications to the Federal project that may be required to address the new requirements of the Corps ETL. The District Levee Safety Officer reviewed the LCM plan and found it to be consistent with the Framework. For the future without-project condition, the expectation is that SAFCA's LCM plan and the Framework will slowly bring levees in compliance with the ETL. For the purposes of formulating a project, the ETL will be taken into consideration, and its requirements factored into any alternatives.

(6) Floodplains. Flood flows from the north are split between the Sacramento River and the Yolo Bypass. Under the current design of the Sacramento River Flood Control Project, diversions to the Yolo Bypass at the Fremont Weir account for 70% of the Sacramento River flow at Verona. The Sacramento River downstream of the Fremont Weir has a channel capacity of 110,000 cfs and this will not change with the implementation of authorized improvements to the American River Common Features Project. The channel could see flows as much as 138,000 cfs, depending on the operation of the Fremont Weir.

For some of the perimeter of the Natomas Basin, the probability of a levee failure occurring and inundating the entire basin is very high. The levees in the Natomas Basin were divided into reaches based upon similar problems, similar geometry, the applicability of similar potential management measures, or reasons of convenience. Figure 2-6 below and Plate 7 show how the study team divided the study area into reaches.

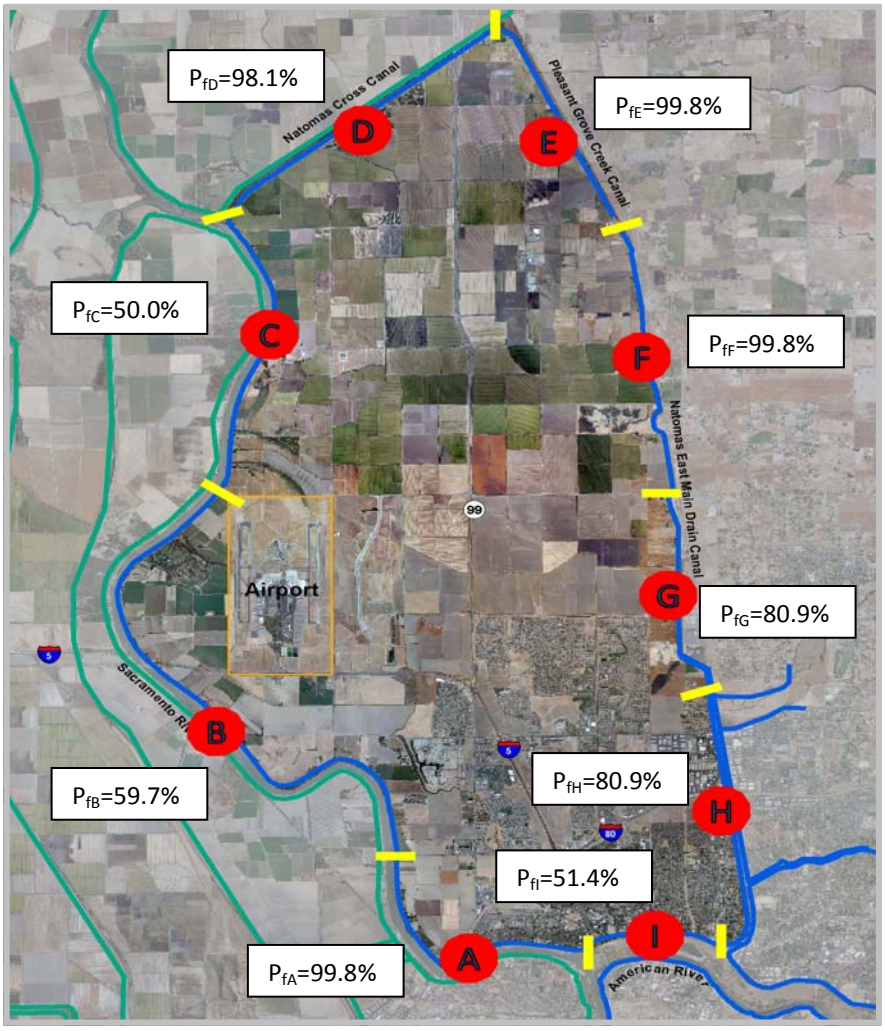


Figure 2-6. Natomas Reaches (p_f is the probability of failure with water at the top of the levee)

The Sacramento River and the Natomas Cross Canal (Reaches A through D) have between a 1 in 5 and a 1 in 25 chance of having a levee failure in any given year. A failure occurring here would inundate the entire basin. The Pleasant Grove Creek Canal and the American River (Reaches E and I, respectively) also inundate the entire basin, with the Pleasant Grove Creek Canal having a 1 in 6 chance and the American River having a 1 in 67 year chance of having a levee failure in any given year. The lowest portion of the Natomas East Main Drainage Canal (Reach H) does not cause flooding of the entire basin. However, it has very high damages because it floods nearly the entire developed portion of the basin. Additionally, it has a high probability of a levee failure occurring in any given year, with a 1 in 25 chance. The remaining segments of levee surrounding the basin are adjacent to the upper portion of the Natomas East Main Drainage Canal (Reaches F and G). These two reaches have a very high frequency chance of failure in any given year, with between a 1 in 3 and 1 in 5 chance. However, because of the limited volume of water available tributary to this stretch of the Natomas East Main Drainage Canal, the floodplains caused are not as large, relative to the floodplains caused by failures in other locations around Natomas, nor are the depths as great. Figure 2-6 shows the probability of failure for each reach. (The probability of failure is based upon water at the top of the levee.) Figure 2-7 below shows the floodplain, depth of flooding,

and the frequency flood event for each reach of the levee, where flood depths of five feet or more begin to occur in the urban region of the basin. Information about the development of the floodplains can be found in Appendix C, Hydraulics.

Evaluation and determination of the extent of flood damages due to levee overtopping and/or levee failure were performed with numerical floodplain models using FLO-2D. Table 2-3 shows the area inundated for the Natomas Basin for single events without the implementation of authorized improvements of the American River Common Features project. The without project evaluations all assume that authorized projects in the watershed, other than the Common Features project, are in place.

Table 2-3. Floodplains in the Natomas Basin

Area of Inundation (acres)		
500-year	**200-year**	**100-year**
53,500	53,500	53,500

The analysis is also based upon the assumption that levees upstream of the project area will be overtopped, but not breached. This, therefore, represents a worst-case flooding condition for the Natomas Basin. A sensitivity analysis indicates that assuming that levee breaches would occur does not significantly change the areas inundated or the damages. The inundated areas shown in the table represent the areas that would likely be inundated for a given frequency flood if a levee break were to occur. It does not, however, represent any type of probability of the levee break itself. The levees were assumed to break at "weak link" locations, with a trigger where there is little or no chance of levee failure. If the water surface elevation for a given flood event does not reach the trigger elevation, then there is no potential for levee failure at that location.

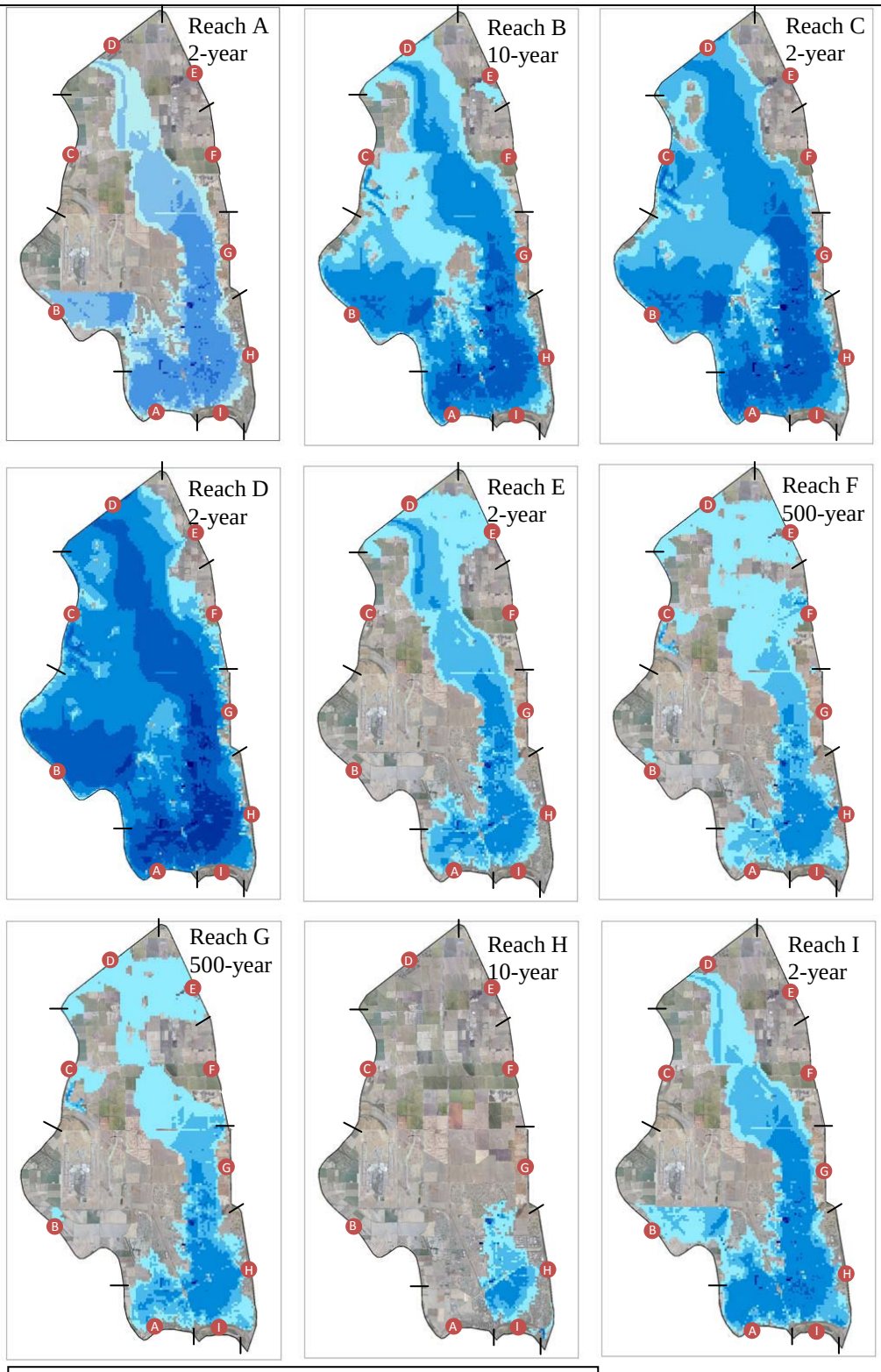


Figure 2-7. Floodplain, Depth of Flooding, and Frequency Event

b. Consequences of Natomas Flooding.

(1) Flood Damages. Damageable property in the Natomas Basin flood plains consists of commercial, industrial, residential, and public buildings. Many businesses would be forced to close, at least temporarily, during flooding and cleanup, resulting in lost revenues and wages. Physical damages caused by inundation losses or flood fighting preparation costs are the main types of flood damages within the flood plain. Physical damages include damages to, or loss of, buildings and their contents, raw materials, goods in process, and finished products awaiting distribution. Other physical damages include damages to lot improvements such as damages to roads, utilities, bridges, and cleanup costs. Additional costs are incurred during flood emergencies for evacuation and reoccupation, flood fighting, and disaster relief. Loss of life or impairment of health and living conditions are intangible damages that cannot be evaluated in monetary terms and have not been included in this analysis.

Within the Natomas Basin, a major flood would affect more than 70,000 to 80,000 people directly and approximately 23,000 structures, with the total value of structures ($5.7 billion) and contents ($2.9 billion) potentially at risk for over $8.6 billion. Details about the damage analysis are contained in Appendix H, Economics.

(2) Critical Infrastructure. A significant amount of critical infrastructure is located within the Natomas Basin. Critical infrastructure is a term used by governments to describe assets that are essential for the functioning of a society and economy. Most commonly associated with the term are facilities for:

- electricity generation, transmission and distribution
- gas production, transport and distribution
- oil and oil products production, transport and distribution
- telecommunication
- water supply and wastewater
- agriculture, food production and distribution
- heating
- public health (hospitals, ambulances)
- transportation systems (fuel supply, railway network, airports, harbors, inland shipping)
- financial services (banking, clearing)
- security services (police, military)

Figure 2-8 shows the critical infrastructure located in Natomas.

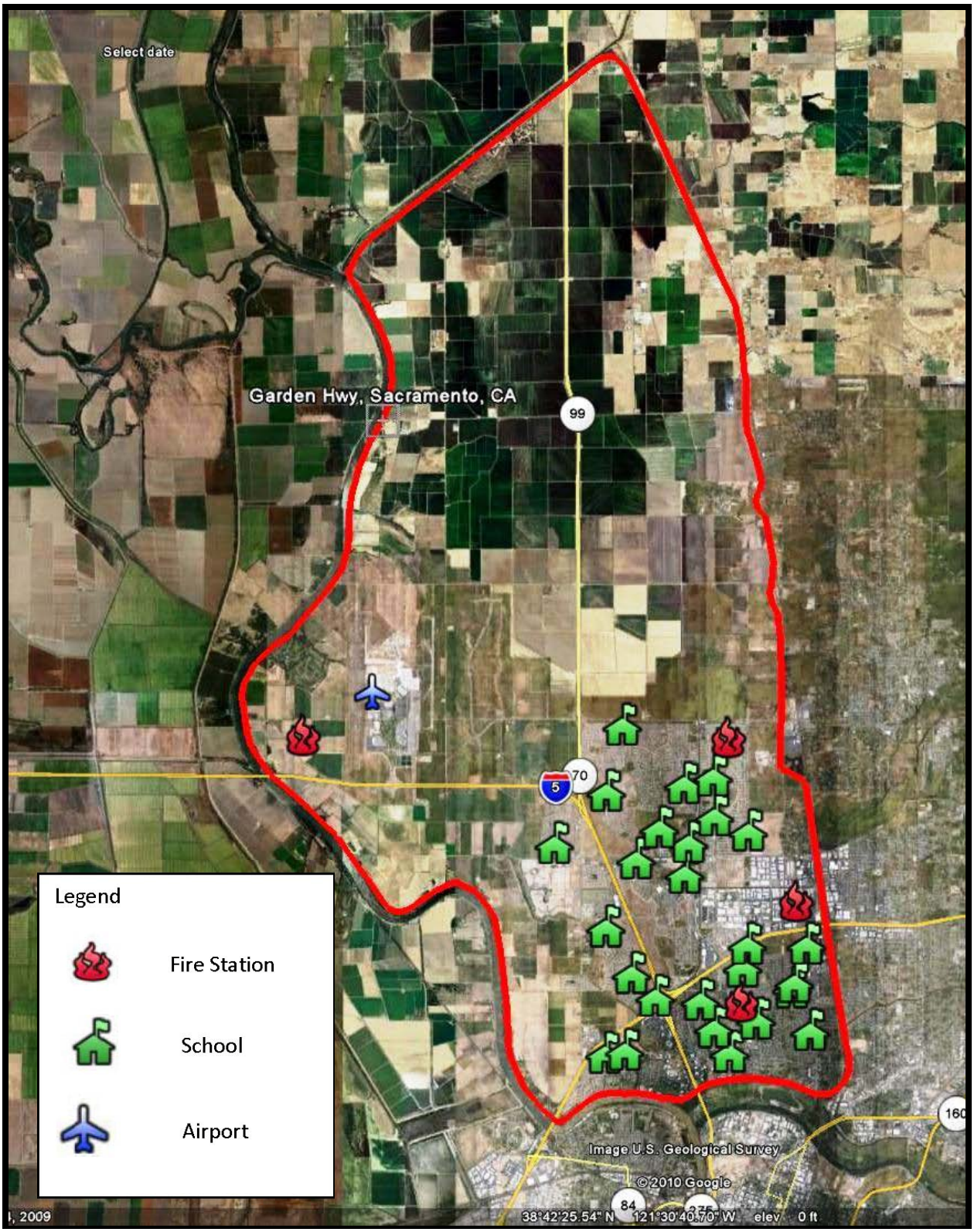


Figure 2-8. Critical Infrastructure in Natomas Basin.

Two interstate highways, I-80 and I-5 traverse the Basin. These are vital evacuation routes for the residents of Natomas in the event of a flood. While the evacuation distance is not far, generally under 10 miles, routes are limited.

Another piece of critical transportation infrastructure located in the Natomas Basin is the Sacramento International Airport. This is a major transportation hub for Northern California. During its busiest hour, the airport handles up to 29 flights. In a typical month, 800,000 passengers arrive at or depart from the airport. If a flood were to occur, passenger travel would be disrupted, and those stranded in the airport would have to be evacuated to higher ground. Mail and freight transit through the airport would also be interrupted. Data was obtained for the period from 2005 to 2009 on the quantities of passengers, mail, and freight that are moved through the airport during the typical rainy season from November through March. Table 2-4 shows this data.

Table 2-4. Sacramento International Airport Rainy Season Statistics (November through March)

Total Passengers					
	2005-2006	**2006-2007**	**2007-2008**	**2008-2009**	**Average**
Nov	844,049	871,952	867,507	727,397	827,726
Dec	822,455	859,015	848,107	738,563	817,035
Jan	741,265	785,255	760,810	640,007	731,834
Feb	713,008	743,038	752,961	615,782	706,197
Mar	849,165	895,879	891,598	727,175	840,954
Air Mail (pounds)					
	2005-2006	**2006-2007**	**2007-2008**	**2008-2009**	**Average**
Nov	1,405,406	386,569	310,797	219,385	580,539
Dec	1,750,004	315,622	239,678	225,727	632,758
Jan	1,773,028	371,751	419,919	168,370	683,267
Feb	1,307,708	331,222	337,352	155,094	532,844
Mar	1,442,429	335,109	150,563	175,591	525,923
Air Freight (pounds)					
	2005-2006	**2006-2007**	**2007-2008**	**2008-2009**	**Average**
Nov	10,637,674	10,637,674	14,529,821	11,504,845	11,827,504
Dec	12,920,861	12,870,055	14,726,250	13,401,438	13,479,651
Jan	9,783,013	12,230,114	14,605,171	12,325,612	12,235,978
Feb	9,764,605	11,268,345	13,849,463	11,365,817	11,562,058
Mar	11,763,117	14,513,389	13,925,438	12,048,871	13,062,704

Seventeen public schools are located in the Natomas Basin, along with several private schools. The 17 public schools serve approximately 12,000 students, kindergarten through high school. All of these schools are in areas that would require evacuation in the event of a flood. Should an evacuation be required during school hours, summoning the transportation needed for evacuating 12,000 students, plus teachers and staff, in addition to notifying families of the evacuees of the logistics of the evacuation, would present a serious challenge to school officials.

There are four City of Sacramento Fire Stations located in the Natomas Basin. The station addresses are as follows:

- Station 3 - 7208 W. Elkhorn Boulevard
- Station 15 - 1591 Newborough Drive
- Station 18 - 746 N. Market Boulevard
- Station 30 - 1901 Club Center Drive

All of the fire stations are located in areas that would be evacuated in the event of a failure along any of the levees protecting the Natomas Basin.

(3) Health and Safety. Flooding in urban areas can cause serious health and safety problems for the affected population. The most obvious threat to health and safety is the danger of drowning in flood waters. Swiftly flowing flood waters can easily overcome even good swimmers. If flooding occurs suddenly, people may become trapped in their homes, and drown. Additionally, when people attempt to drive through flood waters, their vehicles can be swept away in as little as two feet of water.

With much of the area within the 100-year flood plain, Sacramento County and the City of Sacramento have developed a comprehensive flood warning system and evacuation plan. The City and County monitor weather conditions and stream levels to determine the level of severity and evacuation triggers of potential flood events. Emergency evacuation routes have been established throughout the county. Evacuation areas, evacuation routes, and rescue areas for Natomas have been established for five different levee breach locations. Hypothetical flood depth and rescue and evacuation area maps have been developed by the City/County of Sacramento for five hypothetical levee failure locations in the Natomas Basin as part of the Flood Emergency Evacuation Plan. The hypothetical flood depth maps depict both the maximum flood depths and the elapsed time from levee failure until an area is inundated with floodwaters to a depth of 1 foot for five different levee failure locations on the levees surrounding Natomas. Depending on the levee failure location the elapsed time to get to 1 foot flood depths can range from 6 minutes to 200 hours.

Portions of the Gateway Oaks community in southern Natomas are the most quickly inundated area. A levee failure on the Sacramento River levee near Discovery Park would cause flood water to reach a depth of 1 foot in portions of Gateway Oaks in six minutes; flood water depths could reach 6 feet in a portion of Gateway Oaks in one hour and twenty minutes. A levee failure on the American River in the Truxel area of southern Natomas would cause flood water to reach a depth of 1 foot in approximately 20 minutes in portions of the Truxel area; depths could reach four feet in these areas within three hours.

A rescue area is defined as an area where the water has the potential of reaching a depth of at least one foot after 2 hours from the time of levee failure, depending on the location of the failure. Evacuation areas are defined as areas that, after 10 days from the time of levee failure, water depth will range from 15 feet at the deepest point to one foot at the flood boundary. Figures 2-9 and 2-10 show in red the rescue areas for Truxel resulting from levee breaks on the NEMDC and the American River. Figure 2-11 shows a satellite view of the area in which the density of development in Truxel can be seen.

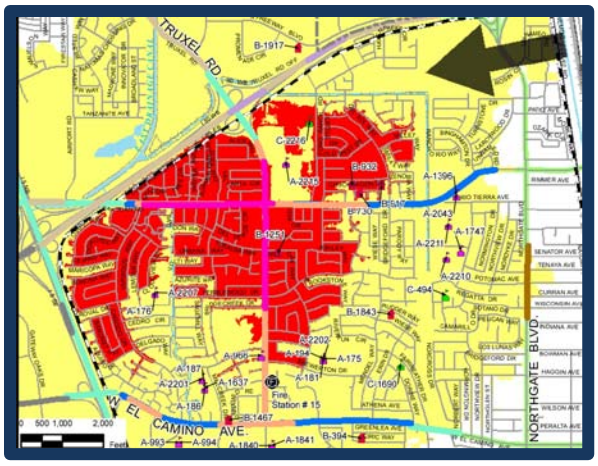


Figure 2-9. Rescue Area for Truxel Resulting from a Levee Break on the NEMDC

Figure 2-10. Rescure Area for Truxel Resulting from a Levee Break on the American River

Figure 2-11. Satellite Photo of Truxel Area

Estimates of potential loss of life were made for this study for the areas identified as rescue areas and for the areas identified as evacuation areas. These estimates are based upon the actual loss of life ratios experienced in 2005 by the population in New Orleans during the Hurricane Katrina levee failures. An article entitled "Loss of Life caused by the Flooding of New Orleans after Hurricane Katrina: A Preliminary Analysis of the Relationship between Flood Characteristics and Mortality," by SN Jonkman, B. Maaskant, E. Boyd, and M. Levithan, presented at the 4th International Symposium on Flood Defense, Managing Flood Risk, Reliability and Vulnerability, Toronto Canada May 6-8, 2008 was used to formulate these estimates. Jonkman,et.al. assumed that of the inhabitants in a flooded area, 80% evacuated and 10% found shelter in a special facility (such as the Superdome or high school), leaving approximately 10% of the population in a flooded area exposed to the flood event. Based on actual fatalities in New Orleans a mortality rate of 1.18% was determined for the population exposed to the flood event.

As indicated in Table 2-5 below, application of the Katrina ratio to the approximately 16,000 population within the Truxel rescue area associated with an American River levee failure

results in the potential loss of 19 lives, to the approximately 11,000 people in the Truxel rescue area associated with a NEMDC failure results in the potential loss of 13 lives, and to the approximately 8,000 people who live in the Gateway Oaks rescue area associated with a Sacramento River levee failure results in the potential loss of 9 lives.

Table 2-5. Estimated Loss of Life in Rescue Areas

Impacted Area	Population in Rescue Area*	Exposed Population (10%)	Mortality Rate	Potential Loss of Life
Truxel – American River	16,000	1,600	1.18%	19
Truxel – NEMDC	11,000	1,100	1.18%	13
Gateway Oaks – Sacramento River	8,000	800	1.18%	9

**Population data based on 2009 estimates and does not include workforce.*

The table below presents the results of applying the Katrina ratio to the population that lives within the evacuation area associated with various levee failure locations. A population of approximately 88,000 live within the evacuation area associated with an American River levee failure near Truxel results in the potential loss of 104 lives, to the approximately 68,000 in the Natomas evacuation area associated with a NEMDC levee failure near Truxel results in the potential loss of 80 lives, and to the approximately 96,000 people who live in the evacuation area associated with a Sacramento River levee failure near Gateway Oaks results in the potential loss of 113 lives. Table 2-6 shows the estimated loss of life in the evacuation area.

Table 2-6. Estimated Loss of Life in Evacuation Area

Hypothetical Levee Failure Location	Population in Evacuation Area*	Exposed Population (10%)	Mortality Rate	Potential Loss of Life
Truxel – American River	88,000	8,800	1.18%	104
Truxel - NEMDC	68,000	6,800	1.18%	80
Gateway Oaks – Sacramento River	96,000	9,600	1.18%	113

**Population data based on 2009 estimates and does not include workforce.*

Note that these are preliminary values; a study will be conducted as part of the Other Social Effects analyses for the American River Common Features GRR. Many factors will influence the mortality rate from a flooding disaster, including timing of the breach (day or night), population located near the breach, and availability of flood warning and evacuation routes. The preliminary analysis provides an indication of the loss of life levels that might be expected.

In the California Central Valley, the risk of a large flood is seasonal. The majority of rainfall occurs in the November through March rainy season, making the area most vulnerable to winter floods. The temperature range in the rainy months is shown in the Table 2-7.

Table 2-7. Average Temperature Range in the Rainy Season

Month	Low (Degrees F)	High (Degrees F)
November	42.8	63.7
December	37.7	53.9
January	38.8	53.8
February	41.9	60.5
March	44.2	64.7

Standing or working in water which is cooler than 75 °F (24 °C) will remove body heat more rapidly than it can be replaced, resulting in hypothermia. Cold water removes heat from the body 25 times faster than cold air. About 50% of that heat loss occurs through the head. Physical activity such as swimming or other struggling in the water increases heat loss. Hypothermia (decreased body temperature) develops more slowly than the immediate effects of cold shock. Survival curves show that an adult dressed in average clothing may remain conscious for an hour at 40 °F and perhaps 2-3 hours at 50 °F (water temp.). Any movement in the water accelerates heat loss. Survival time can be reduced to minutes. Hands rapidly become numb and useless. Without thermal protection, swimming is not possible. The victim, though conscious, is soon helpless. Without a life jacket, drowning is unavoidable.

During a flood, local water systems may become contaminated, either through the loss of power to a public water supply or if a private well is flooded. A variety of sources of contamination include animal and human waste, dead and decaying animals, or chemicals accidentally released during flooding. Water supply contamination can lead to a number of waterborne illnesses. Food exposed to floodwaters or stored without refrigeration during extended loss of power during flooding can lead to food-borne illnesses.

Wild animals and insects can become displaced from their natural habitats during flooding. Encounters with raccoons, possums, and squirrels can result in bites that require medical attention or may lead to rabies. Dead animals can sometimes be found in homes after a flood, leading to odor and excessive flies. These carcasses can serve as reservoirs for disease-causing organisms. Bees, wasps, and hornets may have their nests disturbed by wind, rain, or flood waters. These insects can be very aggressive. Snakes will also have their nests disturbed by flooding, and are prone to seek shelter in abandoned homes, vehicles, furniture, and equipment.

Liquefied petroleum gas tanks and underground storage tanks can break away from their supports and float in flood waters, causing hazards from their released contents. Floods can damage fire protection systems, delay response times of emergency responders, and disrupt water distribution systems. All of these factors lead to increased danger from fires.

Buildings damaged by flooding can become contaminated with mold and fungi if they do not dry out quickly enough. These molds and fungi can pose serious health risks.

Workers who respond to flooded areas are at the most risk of illness, injury, or death. These workers include utility workers, law enforcement, emergency medical personnel, firefighters, and military and government personnel. According to the Occupational Safety and

Health Administration, some of the hazards associated with working in flooded or recently flooded areas include:

- Electrical hazards
- Carbon monoxide
- Burns from fires caused by energized line contact or equipment failure
- Structural instability
- Hazardous materials
- Musculoskeletal hazards
- Heavy equipment operation
- Drowning
- Hypothermia
- Falls from heights
- Fire
- Exhaustion
- Dehydration
- Biohazards

(4) Connection of the Community to the River. The levees along the Sacramento and American rivers effectively cut off public access to the rivers and their environmental and recreation amenities in many areas. This project offers an opportunity to reestablish connections to the river. Opportunities within the Natomas Basin are limited. Along with providing features that reduce flood risk, there is an opportunity to incorporate a bicycle trail on the levee system.

2-4. SUMMARY OF PROBLEMS AND OPPORTUNITIES: NATOMAS PLANNING OBJECTIVES

The national objective is a general statement and, as indicated above, is not specific enough for direct use in plan formulation. The water and related land resource problems and opportunities identified in this study are refined and stated as specific planning objectives to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes in the without project conditions. The planning objectives, specific to the Natomas Basin are specified as follows:

1. Reduce flood risk to public health, safety, and property in the Natomas Basin associated with under- and through-seepage.

2. Reduce flood risk to public health, safety, and property in the Natomas Basin due to levee erosion.

3. Reduce flood risk to public health, safety, and property in the Natomas Basin due to levee instability.

4. Reduce flood risk to public health, safety, and property in the Natomas Basin associated with vegetation and encroachments on the levees.

5. Reduce flood risk to public health, safety, and property in the Natomas Basin associated with levee overtopping.

6. Educate the public about ongoing residual risk.

7. Provide opportunities to connect the community to the river.

2-5. PLANNING CONSTRAINTS

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that are important to various stakeholders. Some of the constraints are absolute and represent restrictions that should not be violated. Other constraints are more flexible and can be incorporated into the tradeoff analysis. The planning constraints identified in this study, along with their metrics, are as follows:

1. No large-scale upstream regional detention alternatives on the American River (Auburn Dam) will be considered in this investigation. Previous studies had recommended construction of Auburn Dam but it was unacceptable and therefore not authorized. Such a solution would exceed the scope of this study and the Common Features authorization, but it could be addressed as a part of the State of California's Central Valley Flood Control Plan.
2. Plans must avoid adverse effects to endangered and threatened species in the Greater Sacramento area. Primarily, these are the valley elderberry longhorn beetle, giant garter snake, delta smelt, Swainson's hawk, Central Valley steelhead, Sacramento River winter run Chinook salmon, and Central Valley spring run Chinook salmon.

3. Plans should minimize adverse effects on cultural resources to the degree practicable. Effects will be measured in terms of a qualitative description of effects associated with each plan. In the event that the proposed project has an effect on any cultural resources identified within the project area or cultural resources identified in previously unsurveyed areas, those affected sites would be formally evaluated for their eligibility for listing in the NRHP. If the affects of the proposed project on an eligible or listed property are found to be significant, mitigation measures would be required.

4. Adverse impacts to riparian vegetation should be avoided to the extent practicable. In some areas, the trees and shrubs on or near levees provide the only waterside habitat that remains for many sensitive wildlife species. According to some estimates, riparian forests in the Central Valley have declined by as much as 98 percent during the last 150 years. The remaining trees provide important environmental, recreational, and cultural benefits. This is not absolute constraint except in those cases where the habitat for special status species would be jeopardized. Compliance will be measured in terms of acres of riparian vegetation lost. Within the boundaries of the American River Parkway (or "Parkway") the vegetation is thus afforded added protection under the Federal and California Wild and Scenic Rivers Acts. Both acts designate the Lower American River as wild and scenic within the boundaries of the Parkway. This designation prohibits Federal and State assistance to, or construction of, water resource related projects that adversely affect the extraordinary values qualifying the river for wild and scenic status. These values include support for the anadromous fish that seasonally occupy the Lower American River, Bannon Slough, and the lower portion of the NEMDC.

5. Plans should avoid adverse hydraulic effects that increase flood risks to other parts of the system to the extent practicable. This will be measured in terms of increased flood damages to other areas.

6. Plans should avoid effects to existing infrastructure (bridges, highways, railroads, utilities, airports) to the extent practicable. This will be evaluated in terms of costs for any modifications to existing infrastructure needed to implement the plan.

7. Plans must not provide additional bird habitat that would conflict with the Sacramento Airport restrictions. Wildlife strikes to aircraft pose a serious hazard to safety and cause damages over $300 million dollars annually in the United States alone. The majority of wildlife strikes occur in the immediate vicinity of airports. The Federal Aviation Administration (FAA), the U.S. Air Force, the Corps, the U.S. Environmental Protection Agency, USFWS, and the U.S. Department of Agriculture - Wildlife Services signed a Memorandum of Agreement (MOA) in July 2003 to acknowledge their respective missions in protecting aviation from wildlife hazards. The basis of the MOA is FAA Advisory Circular (AC) 150/5200-33, titled "Hazardous Wildlife Attractants on or Near Airports." This constraint will be evaluated in terms of a qualitative description of the potential for plans to attract bird populations to the airport vicinity.

8. Plans should minimize the relocation and/or removal of structures to the extent practicable. Relocation and removal of structures will add significant costs to plans, as well as being viewed as undesirable by the residents of the Sacramento area. This constraint will be evaluated in terms of the number of structures that must be removed.

2-6. WITHOUT-PROJECT CONDITION

The without-project condition is the most likely condition expected to exist in the future in the absence of a proposed water resources project. Proper definition and forecast of the future without-project condition are critical to the success of the planning process. The future without-project condition constitutes the benchmark against which plans are evaluated. Other plans that have been adopted for the planning area and other current planning efforts with high potential for implementation or adoption shall be considered as part of the forecasted without-project condition.

The following general assumptions have been made in regard to the without-project condition for this study:

- In 2014-2015, the Joint Federal Project auxiliary spillway with six submerged tainter gates at Folsom Dam will be completed and a new water control manual will be adopted.
- In 2016-2017, the 3.5-foot mini-raise of the Folsom Dam will be completed.
- SAFCA will put their Life Cycle Management (LCM) plan for vegetation management on levees into place.
- The elements of the Common Features project that have been implemented are assumed to be in place.

- The elements of the Common Features project that have not been implemented are assumed not to be in place. Because they will be evaluated in the follow-on GRR, their presence is not assumed as part of the future without-project conditions.

2-7. WITHOUT-PROJECT LEVEE PERFORMANCE

a. Without-Project Levee Performance by Reach. In order to evaluate the without-project levee performance, geotechnical reliability analysis was conducted. This analysis is described in detail in Appendix F, Geotechnical. This analysis considered various modes of poor performance leading to levee failure. These modes were underseepage through the levee foundation leading to piping and instability of the landside levee slope under steady state conditions. Additional judgment-based conditional probability of poor performance was included in the R&U analysis, considering the existing and past erosion history of the levee and riverbank, maintenance, seepage/sand boils and sliding historical conditions, encroachments, vegetation on the levee slopes and within the levee critical area, animal burrows and other external damaging conditions. External erosion was also included in the judgment curve, together with the history of seepage and sand boils observed in the area during high water elevation, maintenance conditions, vegetation on the levee slopes, rodent activity, encroachments, and utility penetrations.

The levees in the Natomas Basin were divided into reaches based upon similar problems, similar geometry, the applicability of similar potential management measures, or reasons of convenience. Plate 7 and Figure 2-6 show how the study team divided the study area into reaches. A set of conditional-probability-of-poor performance versus floodwater-elevation graphs were developed as related to underseepage piping, stability and judgment. The probability of geotechnical poor performance of a levee is conditional on the uncertainties associated with hydrologic and hydraulic aspects of determining the water surface profile during a flood.

b. Reach A. Reach A is located along the Sacramento River, with its downstream limit at the confluence with the American River and its upstream limit at San Juan Road. This reach is in a highly urbanized area, with a county road, the Garden Highway, running along its crest. The levee in this reach has issues with seepage, stability, and vegetation. The geotechnical levee performance curve indicates that this reach has a probability of failure of 99.8% with water up to the top of the levee. A break in this part of the levee would inundate Gateway Oaks, the neighborhood immediately adjacent to the levee, with one foot of water in less than an hour.

c. Reach B. Reach B is located along the Sacramento River, with its downstream limit at San Juan Road and its upstream limit at Elverta Road. This reach is less urbanized than Reach A, but does still have residences near it. Garden Highway runs along its crest. The levee in this reach has issues with seepage, erosion, overtopping, and vegetation. The geotechnical levee performance curve indicates that this reach has a probability of failure of 59.7% with water up to the top of the levee. A break in this part of the levee would inundate the airport with one foot of water within two hours.

d. Reach C. Reach C is located along the Sacramento River, with its downstream limit at Elverta Road and its upstream limit at the confluence with the Natomas Cross Canal. This reach is in a rural area. Garden Highway runs along its crest. The levee in this reach has issues with seepage, erosion, overtopping, and vegetation. The geotechnical levee performance curve indicates that this reach has a probability of failure of 50.0% with water up to the top of the levee. A break in this part of the levee would allow water to begin to reach the densely populated area in the southern part of the basin within 14 hours.

e. Reach D. Reach D is located along the Natomas Cross Canal. The Natomas Cross Canal is affected by backwater from the Sacramento River. This reach is in a rural area. The levee in this reach has issues with seepage, erosion, overtopping, and vegetation. The geotechnical levee performance curve indicates that this reach has a probability of failure of 98.1% with water up to the top of the levee. A break in this part of the levee would allow water to begin to reach the densely populated area in the southern part of the basin within 14 hours.

f. Reach E. Reach E is located along the Pleasant Grove Creek Canal, with its downstream limit at the Natomas Cross Canal and its upstream limit at Sankey Road, a low spot in the levee known as the Sankey Gap. This reach is in a rural area. The levee in this reach has issues with seepage, stability, erosion, and overtopping. The geotechnical levee performance curve indicates that this reach has a probability of failure of 98.1% with water up to the top of the levee.

g. Reach F. Reach F is located along the Natomas East Main Drain Canal, with its upstream limit at Sankey Road, and its downstream limit at Elverta Road. This reach is in a rural area. The levee in this reach has issues with stability, erosion, and overtopping. The geotechnical levee performance curve indicates that this reach has a probability of failure of 99.8% with water up to the top of the levee.

h. Reach G. Reach G is located along the Natomas East Main Drain Canal, with its upstream limit at Elverta Road and its downstream limit at Del Paso Road. This reach is in a transition area from rural to urban. The levee in this reach has issues with seepage and stability. The geotechnical levee performance curve indicates that this reach has a probability of failure of 80.9% with water up to the top of the levee.

i. Reach H. Reach H is located along the Natomas East Main Drain Canal, with its upstream limit at Del Paso Road and its downstream limit at its confluence with the American River. This reach is in a highly urbanized area. The levee in this reach has issues with seepage and stability. The geotechnical levee performance curve indicates that this reach has a probability of failure of 80.9% with water up to the top of the levee. A break in this part of the levee would inundate Truxel, the neighborhood immediately adjacent to the levee, with one foot of water in less than an hour.

j. Reach I. Reach I is located along the American River, with its upstream limit at the Natomas East Main Drain Canal and its downstream limit at its confluence with the Sacramento River. This reach is in a highly urbanized area. The levee in this reach has issues with seepage and stability. The geotechnical levee performance curve indicates that this reach has a

probability of failure of 51.4% with water up to the top of the levee. A break in this part of the levee would inundate Truxel, the neighborhood immediately adjacent to the levee, with one foot of water in less than an hour. Reach I, while having the lowest probability of failure of all of the levee reaches, has the most severe effects on the population in the event of a failure.

If a failure were to occur at Reach I, the time available for evacuation is the least of any segment of the Natomas levees, and rescue from this area may not be possible. A levee failure on the American River in the Truxel area of southern Natomas would cause flood water to reach a depth of 1 foot in approximately 20 minutes in portions of the Truxel area; depths could reach four feet in these areas within three hours. Flood water depths could ultimately reach 15 feet in portions of Natomas. The rapid inundation would result in some of the evacuation routes in the Truxel area being impassable within 30 minutes of levee failure resulting in a significant threat to human life.The potential for loss of life is highest in this area. Preliminary estimates of loss of life using data from Hurricane Katrina result in the potential loss of 19 lives in the Truxel rescue area associated with an American River levee failure, the potential loss of 13 lives in the Truxel rescue area associated with a NEMDC failure results, and the potential loss of 9 lives in the Gateway Oaks rescue area associated with a Sacramento River levee failure.

A significant amount of the critical infrastructure is located in the lower part of the Natomas Basin. City of Sacramento Fire Station 15 is located near the intersection of Truxel Road and El Camino Avenue in the Truxel neighborhood of South Natomas. This critical facility is located in an area identified as a rescue area from a failure on the American River north levee (Reach I) on the City/County of Sacramento Comprehensive Flood Management Plan Rescue and Evacuation Mapping Evaluation maps. Inundation times (when floodwaters reach a depth of one-foot, making the route impassable) for the evacuation routes in the Truxel area of South Natomas (vicinity of Fire Station 15), range from 0-30 minutes for portions of San Juan and Truxel Roads near their intersection, 2-8 hours for Interstate 80 Road, and 4-8 hours for El Camino Avenue.

The flood depths are the maximum in this location. Figure 2-12 below shows the floodplains resulting from a levee failure at Reach I. As can be seen in this figure, even a 2-year frequency event causes serious flooding in the event of a levee failure on Reach I. Larger, less frequent events would have catastrophic consequences should the levee fail at Reach I.

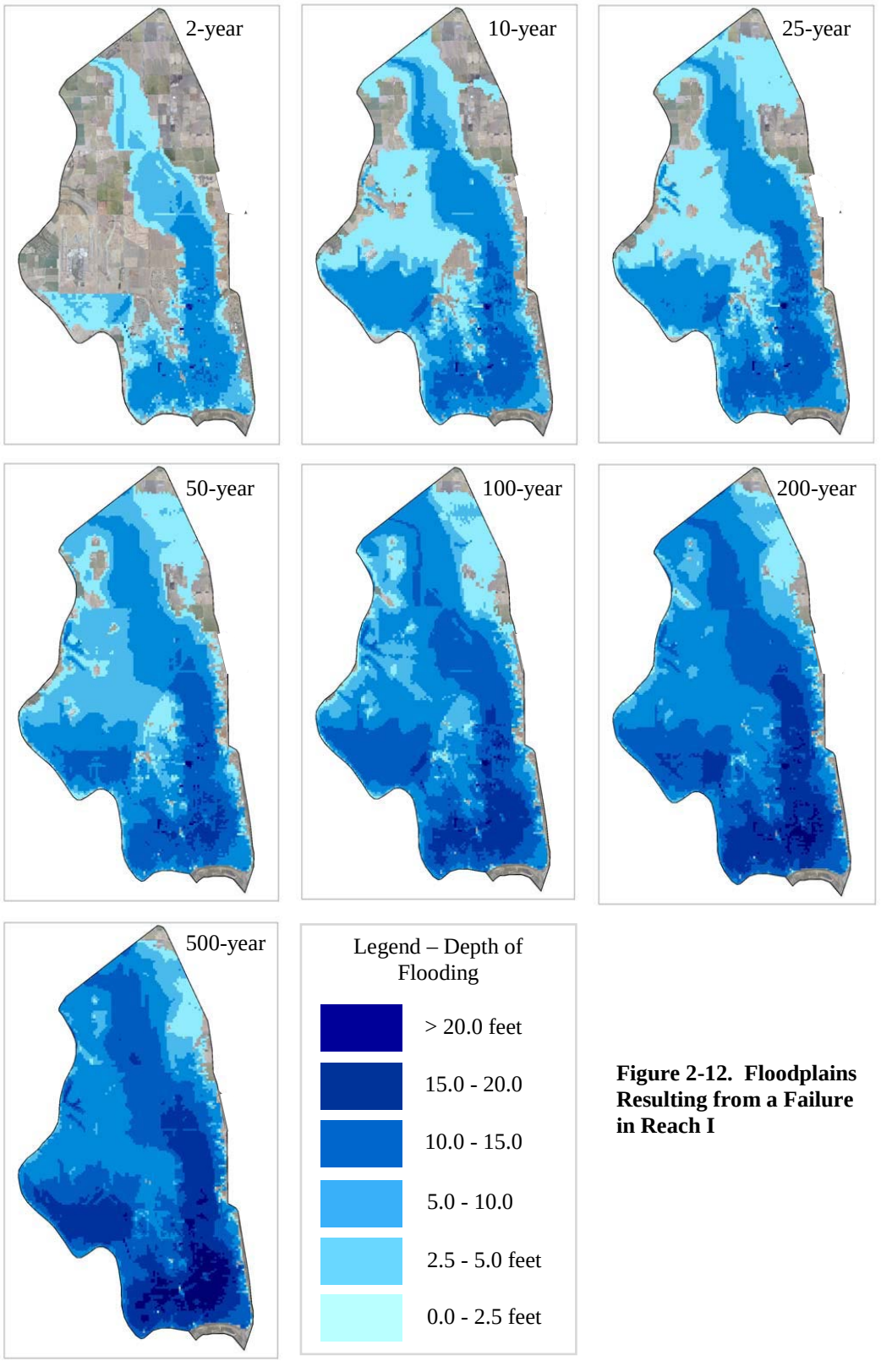


Figure 2-12. Floodplains Resulting from a Failure in Reach I

b. Summary of Levee Problems by Reach in the Natomas Basin. The risk of poor performance based on judgment for the Natomas Basin levees is fairly high because of the existing conditions of the levee. Maintenance and the inspection of the Natomas levees is difficult or in many reaches impossible, particularly on the waterside slope, due to the heavy vegetation and encroachments into the levee slope that reaches the crest of the levee on almost the entire length. An inventory of levee penetrations in the Natomas levee shows numerous penetrations that were not constructed in accordance with Corps requirements or with any approval from the Corps of Engineers or the maintenance agency. The past history of the Natomas levee shows more flood fighting during high river stages than other nearby areas. Consequently, if the water reaches an elevation close to the crest of the levee it was considered that the levee may require additional flood fighting, and the risk of failure is much higher than the rest of the analyzed levee units.

In June 2009, an expert elicitation was conducted for the purpose of developing the geotechnical judgment portion of the curves for the Common Features project. This expert elicitation was conducted in accordance with ETL 1110-2-561, "Appendix E, Expert Elicitation in Geological and Geotechnical Applications" 31 January 2006. The members of the expert elicitation team were highly recognized professional specialists, representing the Reclamation Districts managing and operating the levee system, and specialists in erosion and in geotechnical issues. The expert elicitation focused on the judgment part of the curves representing the probability of poor performance versus floodwater elevation. The expert elicitation was conducted over a three-day period in which the most representative reaches of each basin of the study were discussed. Details of the expert elicitation can be found in Appendix F, Geotechnical. The expert elicitation team discussed and reached consensus on the impact of different factors of the judgment curve, such as:

- Vegetation on the levees and within the levee right of way
- Penetrations through the levee and foundation
- Encroachments into the levee and levee right-of-way
- Erosion of the riverbank and waterside slopes of the levee
- Animal burrows

The levee performance curves are summarized in Table 2-8. For each reach, the probability of failure information displayed in the table was derived through interpolation of the without-project geotechnical risk and uncertainty (GRU) curves using stages associated with each frequency event taken from the hydraulic without-project frequency-stage curves. Both sets of curves are presented in Enclosure 2 of the Appendix H, Economics.

Table 2-8. Summary of Levee Performance Curves

Reach	Without-Project Probability of Failure (%)						
	2-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
A	7	64	86	88	90	95	99
B	13	27	38	41	45	51	57
C	3	13	23	30	36	44	50
D	12	60	80	84	90	95	98
E	3	52	77	83	90	99	99
F	43	60	78	84	90	95	99
G	26	44	53	58	63	68	79
H	7	14	26	33	42	51	81
I	1	6	8	9	12	19	51

The geotechnical curves for poor performance and risk of failure considering the conclusions of the expert elicitation were provided for further analysis in HEC-FDA.

Because the urban area of the Natomas Basin is also the lowest in elevation in the basin, levee failures have swift impacts on evacuation routes from the basin. Large scale flooding can happen very rapidly, depending upon the location of a levee failure. Table 2-9 shows the times expected until urban evacuation routes are impassible for various levee failure locations.

Table 2-9. Expected Time for Flooding of Urban Evacuation Routes

Reach	Minimum Time until Urban Evacuation Routes are Impassible
American River North Levee	20 minutes
Sacramento River just above Confluence with American River	1 hour
Lower Natomas East Main Drainage Canal	2 hours
Sacramento River	1.5 days
Natomas Cross Canal	1.5 days
Upper Natomas East Side Levees	1.5 – 2 days

A Summary of Levee Problems in the Natomas Basin is included in the following table. In assessing the locations of the problems, it was generally assumed that the water surface elevation would be at the top of the levee, except in the case of overtopping where the mean 200-year event plus an allowance of three feet was used. The Natomas Basin is the area bounded on the west by the Sacramento River, bounded on the south by the American River, bounded on the north by the NCC, and bounded on the east by the PGCC and the NEMDC. Plates 8 through 10 show the floodplains for the Natomas Basin. In addition to the problems of seepage, stability, erosion and overtopping, those areas that are constrained by urbanization are also indicated in Table 2-10.

Table 2-10. Levee Problems by Reach

Reach	PROBLEMS						p_f^*(%)
	Seepage	Stability	Erosion	Overtopping	Urbanized	Vegetation	
A	X	X	-	-	X	X	99.8
B	X	-	X	X	X	X	59.7
C	X	-	X	X	-	X	50.0
D	X	-	X	X	-	X	98.1
E	X	X	X	X	-	-	99.8
F	-	X	X	X	-	-	99.8
G	X	X	-	-	X	-	80.9
H	X	X	-	-	X	-	80.9
I	X	X	-	-	X	-	51.4

* Probability of failure reported is when water is at the top of the levee.

c. Without Project Damages. Without-project damages for the Natomas Basin are based on potential damages due to levee failure to residential structures and contents, non-residential structures and contents (commercial, industrial, public, and farm), and automobiles. Other damage/benefit categories, including agricultural/crops, traffic disruption, and emergency costs, will be addressed in the follow-on reevaluation studies.

The southern portion of the Natomas Basin is very urbanized with commercial, industrial, residential, and public buildings. The Sacramento International Airport occupies a portion of the western Natomas Basin. Land use in the northern portion of the Natomas Basin is predominantly agricultural.

There are approximately 23,000 structures in the Natomas Basin. Structure counts are presented in Table 2-10. Total value of damageable property (structures and contents) is displayed in Table 2-11 and is approximately $8.5 billion.

Table 2-10. Total Structure Count, Natomas Basin

Structure Count By Damage Category	
Damage Category	**Structure Count**
Commercial	303
Farm	21
Industrial	156
Public	85
Residential	22,265
TOTAL	**22,830**

Table 2-11. Total Value of Damageable Property

CATEGORY	VALUE OF DAMAGEABLE PROPERTY		
	Structures	Contents	Total
Commercial	681	308	989
Farm	6	7	13
Industrial	458	249	707
Public	440	275	715
Residential	4,076	2,038	6,114
TOTAL	**5,661**	**2,877**	**8,538**

Values in $Millions, October 2010 Price Level

Single-event damages for the 2-, 10-, 25-, 50-, 100-, 200-, and 500-year flood events were computed in the economic model (HEC-FDA) and are presented in Table 2-12. The damages shown are based on flooding from a levee breach along the Natomas Cross Canal (NCC). The consequences from a breach are greatest from a breach on the NCC than from any of the other water sources (Sacramento River, Pleasant Grove Creek Canal, Natomas East Main Drainage Canal, and American River). Potential damages from a breach on the NCC range from $6.3 billion for the 2-yr event to $7.0 billion for the 500-year event.

Table 2-12. Without-Project Single-Event Damages

Damage Category	Single-Event Without-Project Flood Damages						
	2-yr	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
Residential	4,133	4,386	4,444	4,495	4,513	4,519	4,520
Commercial	760	814	832	849	857	868	875
Industrial	530	585	596	609	619	627	637
Public	537	597	604	639	647	650	651
Farm	9	10	11	11	11	11	12
Auto Losses	333	339	339	339	339	339	339
TOTAL	**6,302**	**6,731**	**6,826**	**6,942**	**6,986**	**7,014**	**7,034**

Damages Based on Levee Breach from Natomas Cross Canal (NCC)
Values in $Millions, October 2010 Price Level

Expected annual damages (EAD) were computed in HEC-FDA for the without-project condition. Total EAD as computed by HEC-FDA is estimated at nearly $1.4 billion. Without-project EAD by damage category is shown in Table 2-13.

Table 2-13. Without-Project Expected Annual Damages

DAMAGE CATEGORY	WITHOUT-PROJECT EAD
Automobiles	67
Commercial	190
Farm	2
Industrial	130
Public	108
Residential	866
Total	**1,363**

Values in $Millions, October 2010 Price Level

These EAD numbers were then adjusted to account for human behavior by making assumptions about post-flood event rebuild periods, rebuild scenarios, floodplain inventory stock, and a reasonable assumption of the number of floods allowed to occur over the 50-year period of analysis before the Basin would be abandoned. A model was developed using @Risk software specifically for this study to account for rational human behavior, which is the basic economic methodological premise in most economic studies. Rational human behavior, in the case of flooding in the Natomas Basin, was captured in the model in the form of a rebuild period, rebuild scenarios, loss of inventory stock, and a limit to the number of flood events that would occur before the Natomas Basin would be abandoned and people would decide not to live there. One drawback of HEC-FDA is that it is frequency-based, and its computational framework is not set up to account for these factors related to human behavior; the Natomas @Risk model was set up to be able to account for human behavior through the use of Monte Carlo simulation and life-cycle analysis. The major assumptions used in the model are:

- After a flood event, the floodplain inventory stock would only be replaced by not more than 80% of the damaged property; this assumption captures the idea that not all floodplain occupants would choose to rebuild and live in the Natomas Basin after a flood event – some occupants would choose to leave the area.

- A rebuild period of three (3) years. Rebuilding would take place over a 3-year period immediately following the flood event. The process of reducing the inventory stock to 80% of damaged property and rebuilding over a 3-year period would start all over with the next flood event

- Four (4) rebuild scenarios were delineated, and range from a “slow” rebuild to an “aggressive” rebuild. For example, in the “slow” rebuild scenario, it was assumed that 20% of those properties damaged would be rebuilt in each of the 3 years of rebuilding.

- There is a limit of three (3) flood events that would be allowed to occur in the Basin at which point people would decide not to rebuild and live in the Basin; once this limit was reached, the model assumes that the Natomas community would abandon the region.

Using the @Risk model, without-project EAD is reduced from $1.363 billion to approximately $462 million. Appendix H, Economics, contains this analysis.

d. Summary of Without Project Conditions. Nine different index points were analyzed, each associated with one of the nine reaches identified for the Natomas Basin. Because the levees around the Natomas Basin have different problems, or different combinations of problems, each has a different probability of poor performance in a flood. Furthermore, with each levee reach there are different consequences when the levee fails. The worst-case scenario is seen as Reach D, along the NCC. For all frequency events analyzed (2-yr to 500-yr flood events), a breach in Reach D would inundate almost the entire Basin, including the most heavy-populated area (south of Elkhorn Boulevard) as well as the Sacramento International Airport. The data here reflects a 1 in 5 chance of failure in any given year, with flood waters reaching greater than 20 feet in depth in some locations in the 10-year floodplain. For Reach F, in a 10-year floodplain, the flood waters are anticipated to reach less than 5 feet in depth and the geographic extent of flooding is much smaller than for Reach D. When considering a 100-yr floodplain, the extent of flooding for Reach D remains essentially the same as in its 10-year floodplain; however, the extent of flooding for Reach F increases when going from its 10-year to 100-year floodplains.

2-8. LOCAL CONCERNS

Local concerns represent desired positive changes and/or restrictions that are important to various stakeholders, but cannot be classified as either an objective or a constraint. While not incorporated directly into the plan formulation or analysis, these concerns and goals can help compare plans that have similar outputs. These concerns are:

1. Plan formulation should include one or more plans that are aimed to achieve the minimal 200-year urban level of protection standard as defined by the State of California.

2. Plans should be compatible with local land use plans to the extent practicable. This is will be evaluated in terms of a qualitative discussion of compatibility. Improvements should be compatible with the NBHCP that was developed as a requirement of the Endangered Species Act, designed to support applications for Federal permits under Section 10(a)(1)(B) of the Act. The purpose of the Conservation Plan is to promote biological conservation in conjunction with economic and urban development in the Natomas Basin.

3. Plans should be maintainable and to the extent practicable should minimize costs for operation, maintenance, repair, rehabilitation, and replacement. This constraint will be evaluated in terms of costs for operation, maintenance, repair, rehabilitation, and replacement.

4. To the extent practicable, plans should be able to be implemented quickly with the goal of being ready for authorization in the next WRDA, along with a schedule that reduces near-term damages. Sacramento has an unacceptably high risk of flooding that poses a

serious threat to life, health and safety. This constraint will be measured in terms of its completion date relative to other plans

CHAPTER 3 - ALTERNATIVES

This chapter focuses on the Natomas Basin portion of the authorized project and describes the formulation of alternative plans to address the planning objectives, the evaluation and comparison of these plans and the identification of a tentative selected plan.

3-1. PLAN FORMULATION RATIONALE

The purpose of the plan formulation in this interim reevaluation study is to develop an array of alternatives to address the planning objectives and constraints, establish the plan that can be supported Federally, and compare that plan to the locally developed early implementation plan to determine if there is Federal interest in that plan. To accomplish this, the interim general reevaluation study supporting the post authorization change evaluates an array of alternatives, called Federal Implementation Plans, to establish the limit on Federal cost sharing. The post authorization change is not a full reformulation of the authorized project, but it does include a new economic analysis.

A wide variety of management measures were developed to address the planning objectives for the Natomas portion of the authorized Common Features Project. These measures were evaluated and then screened. Formulation strategies were then developed to address various combinations of the planning objectives and planning constraints. Based upon these strategies, various combinations of the measures were assembled to form an array of preliminary plans. The preliminary plans were then evaluated, screened, and reformulated, resulting in a final array of alternatives. From the final array of alternatives, a selected plan is identified.

A guiding principle in the plan formulation strategy was that all of the reaches were dependent upon each other, forming a closed system around the Natomas Basin. The Natomas basin is protected by 42 miles of perimeter levees that are part of the Sacramento River Flood Control System. The levees are configured such that they prevent the various rivers and channels that completely surround the basin from overflowing into the basin. Therefore, the 42 miles of levee protecting the basin form a ring levee protecting the basin. In addition to the basin being protected by a ring levee, it is also a single hydrologic unit. Depending on the magnitude of a flood event, a levee failure anywhere on the perimeter of the basin would cause damages to the densely populated southern end of the basin. For certain reaches, it takes a larger flood event to cause serious flooding as compared to other reaches. However, for all reaches, it is possible to have serious flooding with a certain level flood event, making it a single hydrologic unit as well as a system.

Therefore, any plan that did not improve levee performance around the entire perimeter of the basin would be considered incomplete. The criteria by which the performance of the alternatives was compared were the reduction in flood risk and associated damages. Reduction of flood risk translates into a reduction in risk to public health, safety, and property associated with seepage, erosion, instability, vegetation, and encroachments.

3-2. MANAGEMENT MEASURES

a. No Action. The Corps is always required to consider "No Action" as one of the alternatives for selection. With the No Action Plan, it is assumed that no additional features would be implemented by the Federal Government or by local interests to achieve the planning objectives, over and above those elements of the Common Features project that will have been implemented prior to reauthorization of the project. Since the No Action Plan is required to be included among the candidate plans in the final array of alternatives, it is described in more detail in the paragraph, Plan 1: No Action, later in this chapter.

b. Measures to Address Planning Objectives. A management measure is a feature or activity at a site, which addresses one or more of the planning objectives. A wide variety of measures were considered, some of which were determined to be infeasible due to technical, economic, or environmental constraints. Each measure was assessed and a determination made regarding whether it should be included in the formulation of alternative plans. The measures are identified in Tables 3-1 and 3-2 with the objectives that they address.

Table 3-1. Measures and Objectives (Seepage, Overtopping, Erosion, Stability, Releases and Vegetation and Encroachment)

Measures	Seepage	Over-topping	Erosion	Levee Stability	Vegetation & Encroachments	Screened Out
Slurry Wall	X					
Seepage Berms	X					
Relief Wells	X					
Sheet Pile Wall	X			X	X	Yes
Embankment Zoning	X			X		Yes
Stability Berm	X			X		
Construct New Levee	X	X	X	X	X	
Widen Levee	X		X	X	X	
Setback/Adjacent Levee	X	X	X	X	X	
Widen Sacramento Bypass and Weir		X				
Increased use of all Bypasses and Weirs	X	X	X			
Better Emergency Evacuation Plans	X	X	X			
Levee Across Natomas	X					
Remove Ditches (Drainage)	X					Yes
Armor Levees w/Rip Rap			X			
Armor Levees w/ Vegetation			X			
Channel Grade Control			X			Yes
Reduce Peak Flows from Folsom			X			
Reduce Levee Slopes (Flatten)	X		X			
Vegetation Management	X		X		X	
Flood Warning System	X	X	X			
Manage Land Use	X	X	X			
Increase Upstream Storage (Perm or Temp)	X	X	X			
Internal Levee Repairs	X		X		X	
Re-op reservoirs upstream from Folsom	X	X	X			Yes
Forecast Based Operations of Upstream Reservoirs	X	X	X			Yes
Cosumnes Bypass - Folsom Dam - Deer Creek	X	X	X			Yes
Flood Walls		X				Yes
Increase Levee Elevations		X				
Managing overtopping failure		X				
Upstream Storage by lowering levees in Reclamation Districts 1500 and 1001	X	X	X			Yes
Incorporate Elkhorn as conveyance/storage	X	X	X			
Controlled releases at predetermined locations	X	X	X			Yes
New Upstream Storage (Not Auburn)	X	X	X			Yes
Manage overtopping of levees on east side of Natomas		X				

Table 3-2. Measures and Objectives (Community Connection and Risk Education)

Measures	Community Connection	Risk Education	Screened Out
Incorporate Features (such as adjacent levees or super levees) that allow vegetation/encroachments to remain or to allow urbanization features	X		
Establish Fishing access Points	X		Yes
Clarify Public Access Rights to levees	X		Yes
Obtain Public Access at Levees	X		Yes
Bicycle Trails	X		
Adopt a Levee Program	X		Yes
Hands across the River with Sac and West Sac	X		Yes
Levee Festival	X		Yes
Media Plan During Construction	X		
Establishment of Standards for Development projects near Levee	X		
Evacuation Plan		X	
Training for Hospitals, Schools, Public Facilities		X	
Publicity on Website such as DWR Websites/Info		X	
Community Workshops (town hall meetings) in conjunction with regular communication with Residents via Informational Materials		X	
Percent of Population carrying flood insurance		X	
Provide flood risk information on Property Tax Notice		X	Yes
Blue Lines on Telephone Poles to indicate water level		X	Yes
Development of School Curriculum on Flooding		X	Yes

An initial evaluation of the measures was performed to assess their response to the planning constraints, with emphasis on cost effectiveness and environmental concerns. In the formulation of plans, measures were first screened and then combined into plans based upon specific plan formulation strategies.

3-3. MEASURES FORWARDED FOR CONSIDERATION

a. Seepage. Levee underseepage and, to a lesser extent, levee through-seepage problems have been identified at many locations around the Natomas Basin perimeter levee system. Underseepage problems can be corrected through the use of cutoff walls, seepage berms, and relief wells. Through-seepage can be corrected by constructing cutoff walls or stability berms. Using cutoff walls in locations where through-seepage is a concern addresses both through-seepage and underseepage. Therefore, the following discussion focuses exclusively on underseepage remediation.

(1) Seepage Berms. Seepage berms are wide embankments placed outward from the levee landside toe to lengthen the underseepage path and thereby lower the exit gradient of seepage through permeable layers under the levees to acceptable levels (Plate 11). Berms typically extend from 80 feet (a minimum berm width) to 300 feet from the landside toe of the

levee. The thickness of the berm depends on the severity of the seepage flow but generally begins at 5 feet near the landside levee toe for a 100-foot berm or 7.5 feet for a 300-foot berm and tapers to a thickness of 3 feet at the end of the berm.

(2) Relief Wells. Relief wells provide protection against excessive levee underseepage by providing a lower resistance pathway for underseepage to exit to the ground surface at the landside toe of the levee without creating sand boils or piping levee foundation materials. Relief wells are an option for addressing underseepage only in reaches where continuous sand and gravel layers have been identified by the geotechnical explorations and analyses. Relief wells are also the measure of last resort where other measures cannot be implemented or are determined to be incomplete.

Relief wells require periodic maintenance and frequently suffer loss in efficiency with time for a variety of reasons. These can include clogging of well screens by carbonate incrustation and iron deposition, intrusions of muddy surface waters, or bacterial growth. Relief wells may malfunction for a variety of reasons including vandalism, breakage, or excessive deformation of the well screens due to ground movements, corrosion or erosion of the well screen, and a gradual loss in efficiency with time. Most relief wells undergo some loss in capacity probably due to the slow movement of foundation fines into the filter pack with a corresponding reduction in permeability.

Relief wells are constructed near the landside toe of the levee to provide pressure relief beneath surface fine-grained soils (clay or silt “blanket”). The wells are constructed using drilling equipment to bore a hole vertically through the fine-grained blanket layer and into the coarse-grained aquifer layer beneath. Pipe casings and filters are installed to allow the pressurized water to flow to the ground surface, thereby relieving the pressures beneath the clay blanket. A collection pipe or ditch is used to carry seepage water to a surface drain.

Relief wells generally are spaced at 50- to 100-foot intervals. They can be used to avoid obstructions on the land side of the levee toe (such as buildings or trees) that otherwise would have to be removed for the construction of seepage berms. Although during elevated river stages relief wells conduct water to the surface without pumping (artesian flow), pumping costs are incurred to convey the collected water back into the river. Additional maintenance costs associated with the wells include annual inspections, periodic video surveying, well performance testing, cleaning, and miscellaneous repairs. Monitoring wells (piezometers) are installed between relief wells to allow monitoring of the relief wells to ensure that hydraulic pressure is being relieved.

(3) Cutoff Walls. Cutoff walls reduce underseepage by providing a barrier of low-permeability material through the levee and levee foundation where sandy or gravelly soils of higher permeability can transmit seepage during high water stages. The cutoff wall depths necessary to limit underseepage at the design water surface elevation are determined by geotechnical analysis. Cutoff walls are generally installed to depths that will tie in with existing impervious or lower permeability soil layers beneath the levee foundation.

Cutoff walls can be constructed by a number of methods to suit site conditions and schedule requirements. The most common methods include the installation of cutoff walls consisting of a soil-cement-bentonite (SCB) mix, cement-bentonite mix, or a soil-bentonite mix

using conventional trench methods, deep soil mixing or trench remixing deep. The SCB mix is used where the cutoff wall is constructed through the centerline of a levee that has been constructed with potentially unstable soil materials. In that case, if the encapsulating material begins to slough, the SCB wall can provide structural stability. Soil bentonite walls can be installed through the centerline of an adjacent levee where the mass of the joint structure significantly reduces the potential for instability.

Plate 11 illustrates a typical cutoff wall through a levee centerline. Cutoff walls are typically constructed using an excavator with a long-stick boom capable of digging a trench to a maximum depth of approximately 80 feet. However, use of clam shell excavators can extend this distance by as much as 30 feet to reach depths as great as 110 feet. Bentonite slurry is pumped into the trench during trench excavation to prevent caving. The soil and bentonite or soil, cement, and bentonite are mixed to achieve the required cutoff wall strength and permeability, and the mixture is backfilled into the trench. Construction of a conventional slurry cutoff wall through the center of the levee typically requires that the existing levee be degraded as much as one-third of the levee height to prevent hydraulic fracturing. Select fill is used to rebuild the levee.

Deep soil mixing cutoff walls can reach depths of 200 feet. They are constructed by parallel augers drilling vertically through the levee and substrate. Cement and bentonite are pumped into the interconnected holes as the augers are inserted and withdrawn. The levee is normally degraded as necessary to create a 30-foot flat top width on which the equipment operates.

Trench remixing deep cutoff walls can be constructed to depths similar to those of deep soil mixing walls. The trench remixing method uses a cutter chain on a wide shaft (similar to a large chain saw) set vertically into the foundation soil. Cement and bentonite are pumped into the shaft at various depths as the cutters move along the wall alignment. Again, the levee is normally degraded as necessary to create a 30-foot flat top width on which the equipment operates.

(4) Comparison. The efficiency of each measure is related to its cost-effectiveness. Comparative cost is thus a key indicator of efficiency, and the measures that can minimize long-term costs are entitled to the highest rating. To screen the various seepage remediation measures, a generic levee reach representing the common seepage problems likely to be encountered along the Sacramento River east levee was created. Each seepage remediation measure was then applied to the 1,000-foot levee reach and the annualized cost per foot, including operation and maintenance, was calculated. Table 3-3 displays the results of this comparison.

Table 3-3. Annualized Cost Summary for Seepage Mitigation Measures (per linear foot)

Option	Lands	Levees	PD&E	CM	Contingency	O&M	Total
65-Foot SB Cutoff Wall	$0	$21	$3	$2	$5	$0	$30
80-Foot SB Cutoff Wall	$0	$26	$3	$2	$6	$0	$37
110-Foot SB Cutoff Wall	$0	$97	$11	$7	$18	$0	$126
65-Foot SCB Cutoff Wall	$0	$44	$6	$4	$9	$0	$62
80-Foot SCB Cutoff Wall	$0	$55	$6	$5	$11	$0	$77
110-Foot SCB Cutoff Wall	$0	$148	$18	$12	$30	$0	$207
100-Foot-Wide Seepage Berm	$5	$15	$2	$1	$4	$0	$27
300-Foot-Wide Seepage Berm	$15	$67	$8	$6	$17	$0	$112
60-Foot Well Spacing	$2	$58	$7	$5	$12	$59	$143
100-Foot Well Spacing	$2	$35	$5	$3	$7	$35	$87

Note: Annualized costs assume a 50-year life term and a 4.375% interest rate.

Selection of a seepage remediation measure is influenced by the depth and continuity of pervious soil layers, adjacent land use, environmental constraints, construction cost, construction schedule, and long-term maintenance capability. Of the three remediation methods (seepage berms, seepage wells, and seepage cutoff walls), fully penetrating cutoff walls are generally preferred because (1) they are the least costly (particularly if an cement-bentonite [SB] mix is feasible); (2) they are the most reliable under uncertain hydraulic and geotechnical conditions (e.g., water surface elevations above design and variations in foundation soil conditions); and, (3) when combined with an adjacent levee, cause little construction disturbance outside the levee footprint. Seismically induced ground shaking along the Sacramento River east levee could compromise the integrity of a soil-cement-bentonite (SCB) wall constructed through the centerline of the levee (near the channel) and it would be costly to repair the resulting deformation. However, a soil-cement-bentonite wall constructed through an adjacent levee in this reach would be much less susceptible to deformation in a ground-shaking event because of its malleability and location farther away from the river channel.

Relief wells cause the least amount of construction disturbance but require routine maintenance of the wells themselves and the drainage and pumping facilities necessary to support them. For this reason, they are the most expensive and least reliable as a large-scale seepage remediation method. Seepage berms are feasible where there is sufficient room for construction; however, they cause significant construction disturbance because of the size of their footprint and the soil excavation and hauling activity necessary to create them. Seepage berms also can be expensive depending on their width and the availability of soil material, and they may be less reliable than cutoff walls or relief wells under uncertain hydraulic and geotechnical conditions (e.g., water surface elevations above design and variations in foundation soil conditions).

b. Erosion. The measure of waterside armoring in a manner similar to that used for the Sacramento River Bank Protection Project was selected as the measure was generally least environmentally damaging and most cost effective. Other measures include armoring that removes vegetation, a launchable trench filled with rock, and providing additional access to provide for inspection and repair. The primary objective of erosion control efforts along the Sacramento River east levee is to stabilize the submerged toe of eroding banks (where it meets the channel bottom) to arrest retreat of the upper bank, preserve berm width, and reduce the

potential for destabilization of the adjacent levee foundation and loss of extensive mature riparian vegetation.

As shown on Plate 11, the measures that could be implemented to accomplish this objective are as follows:

(1) Placement of rock riprap on the existing or restored levee-foundation slope from the channel bed to about the average summer water level on the bank, with toe protection, as required, to resist and accommodate scour of the channel bed.

(2) Construction of cobble-covered soil slopes extending from the riprap up the slope to about the average winter water surface elevation. Among the affected bank protection sites, the maximum slope of the surface of the soil fill would be 3H:1V and the minimum would be 10H:1V. A layer of cobbles and filter material would be placed on the top of the soil to provide protection of the levee foundation from catastrophic scour and soil surface erosion. Riparian vegetation would be planted through the cobbles, with species varying according to the elevation above the average summer water surface elevation.

(3) Construction of a limited cobble slope on the bank (i.e., above the average winter water level) with retention of existing riparian vegetation above it. By providing construction access by barge, rather than clearing vegetation on the berm to provide construction access from the Garden Highway, the removal of riparian vegetation would be further limited. This would be employed wherever this construction method is practical. Where larger-diameter trees are present near where the cobble slope joins the natural upper-bank slope, they will be marked and avoided during construction to the extent feasible. Where trees exist within the area of the proposed cobble slope and the thickness of the soil-cobble layers is less than two feet, the existing trees may be retained.

(4) Inclusion of instream woody material structures in the design of the bank protection improvements to enhance habitat mitigation. These structures would consist of whole-tree and/or rootwad clusters anchored into the revetment on the lower portion of the cobble-covered soil slope, such that portions of the woody material typically would be submerged even during the low-flow season.

In the past, these measures have proven to be effective and acceptable in addressing bank erosion problems in the Lower Sacramento and American River channels. Selection of the erosion control measures identified would be consistent with current design and construction practices but may be severely limited as a result of the Corps ETL 1110-2-571, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures.

c. Stability. The levees extending along the east side of the Natomas Basin between the NCC and the Natomas East Main Drain Canal pumping facility south of Elkhorn Boulevard have landside and waterside slopes that are considered too steep (2H:1V or greater) to remain stable when subjected to prolonged high water conditions. This condition can be addressed by flattening the affected levee slopes to achieve at least a 3H:1V geometry. Where land side space permits, the requisite dimensions can be achieved by adding width to the existing levee section and thereby creating an oversized levee section similar to an adjacent levee.

d. Overtopping. All of the NCC south levee reaches, many of the Sacramento River east levee reaches, and a portion of the PGCC west levee lack the height required to meet the State's 200-year flood protection requirements. In all reaches, the final levee configuration would be designed to meet the Corps criteria of a 20-foot-wide minimum crown, a 3H:1V waterside slope, and a 3H:1V (preferred) or 2H:1V (maximum) landside slope. Because the levees in most of the project reaches currently have landside slopes of 2H:1V, flattening most of these slopes to a 3H:1V profile would be implemented. For all reaches of the Natomas levee system, raising the levee in place would be a feasible measure to address levee height deficiencies. For most reaches it is the only feasible measure. However, along the Sacramento River east levee, because of the availability of land, levee height deficiencies may also be corrected by constructing a new adjacent levee. The new adjacent levee is the preferred measure because of the potential to strengthen the existing levee, minimize construction-related impacts on residences along the Garden Highway, and avoid removal of extensive waterside vegetative and structural encroachments along this levee segment. Moreover, through its attachment to the existing levee, the adjacent levee could provide a sufficiently stable soil mass to support construction of a soil-bentonite cutoff wall. By contrast, raising the levee in place would substantially interfere with existing Garden Highway residences during the construction process and would likely require removal of extensive vegetative and structural encroachments along this levee segment.

The measures that could be implemented to accomplish the necessary levee raises include:

(1) Raising the Existing Levees in Place. This measure involves increasing the crown elevation of all levee height-deficient levee segments in the Natomas Basin, including the NCC south levee and portions of the Sacramento River east levee. Where the required raise is minor (six inches or less), the raise would be limited to the levee crown area, provided that there is enough existing crown width to accommodate the raise without narrowing the crown to a width that is less than the minimum requirement. For most of the affected levee segments, however, a greater crown raise would be required and/or the levee slopes would need to be flattened. The required crown elevation would be met through a full levee raise. Full levee raises consist of an embankment raise from the landside or waterside toe (or both) upward to the increased crown elevation. This would require partially excavating the levee slope to provide a working platform for equipment, typically 10 feet wide, and rebuilding the levee to the appropriate elevation by benching the new embankment material into the existing embankment material. Plate 11 illustrates a levee raise and flattening of a landside levee slope from 2H:1V to 3H:1V.

(2) Constructing a New Adjacent Levee. This measure involves construction of a new levee adjacent to and adjoining the existing levee as shown in Plate 11. This measure is considered feasible for all reaches of the Sacramento River east levee except Reach A, where urban subdivisions preclude expansion of the existing levee footprint. The new adjacent levee would be constructed with a crown elevation three feet above the 200-year design water surface elevation. In the upper reaches, where the existing levee has height deficiencies of as much as three feet, the crown of the adjacent levee would be higher than the existing levee and Garden Highway roadway. In the lower reaches, where the existing levee has sufficient freeboard, the new adjacent levee would be the same height as the existing levee.

e. Vegetation and Encroachments. Addressing the Corps policy on vegetation and encroachments is another major variable to be considered in the formulation. The Corps' levee guidance requires an assessment of encroachments on levee slopes, including utilities, fences, structures, retaining walls, driveways, and excessive vegetation. Where such encroachments constitute a threat to the stability of a levee or its maintenance, they must be removed or rendered into an acceptable condition. Measures to address vegetation issues include: substantial removal of waterside vegetation and widening the existing levee, obtaining a variance for the existing vegetation condition from the standard vegetation guidelines set forth in the ETL, construction of a new adjacent levee that would require the approval of a variance to the ETL, or construction of a new setback levee.

Along the Sacramento River east levee, however, the removal of extensive amounts of vegetation and numerous structural encroachments associated with residences along the Garden Highway would be strongly resisted by the residents themselves and by others in the Natomas Basin and would conflict with efforts to preserve habitat for special-status species. This would add significant cost and uncertainty to the project delivery process and delay early implementation of the project improvements. Additionally, given the pervasive extent of the vegetation on the levee, it was deemed unlikely that a variance for the existing condition would be granted. For these reasons, construction of a new adjacent levee in this segment of the system would be preferred.

Additionally, the woodlands remaining on the waterside of the levees along the Sacramento River are predominately native tree species. These trees are a remnant of the historic riparian ecosystem in the valley. Because of the wide-scale reduction in riparian woodlands over the past century, this ecosystem is now confined to a series of narrow corridors extending along the waterside margins of the Sacramento River and its tributaries. These corridors provide the primary, and in some regions the only, habitat link between the woodland patches that survive on the valley floor and the undeveloped woodlands of the foothills of the Coast Range and Sierra Mountains. Several special status fish species use the Sacramento River and are likely to rear in the floodplain habitat along the margins of the waterside slope and berm of the project area levees.

Along the waterside of the American River North levee and the lower reach of the Natomas East Main Drain Canal west levee, the woody vegetation is within the boundaries of the American River Parkway and is thus protected under the provisions of the Federal and California Wild and Scenic Rivers Acts. Removal of this vegetation would therefore require a careful balancing of the resulting public safety benefits and environmental burdens.

f. Non-Structural Measures. Risk reduction, risk education, and connecting the river to the community are objectives that can be addressed through the implementation of non-structural measures. These measures are included in the five basic approaches to non-structural flood risk management:

(1) Zoning. Avoid using the floodplain for activities other than those compatible with periodic flooding. Institute floodplain development requirements, such as land-use controls, which minimize new unsafe development in high-risk areas. In addition to these measures, the non-Federal interest is required to publicize floodplain information and provide this information to zoning and other regulatory agencies.

(2) Building Codes. Building codes can promote construction techniques that reduce damages to future construction due to flooding. These techniques include the raising of structures and flood proofing.

(3) Outreach. Table 3-2 contains a wide array of measures that address the objectives of risk education and community cohesion. In addition to these measures, the non-Federal interest is required to inform affected interests of the protection afforded by the project.

(4) Evacuation Plan. Having robust and effective evacuation plans and warning systems to get the people out of harm's way, should the need arise. Authorized features include three telemeter stream flow gauges upstream from the Folsom Reservoir and modifications to the flood warning system along the Lower American River.

(5) Insurance. Mitigate losses to those who are subject to flooding by providing indemnification through forms of public and private insurance.

The first line of defense against flood risk should be to avoid or minimize damages through land-use controls and regulations for safe floodplain development. Figure 3-1 below shows the order in which solutions for flood risk management would ideally implemented.

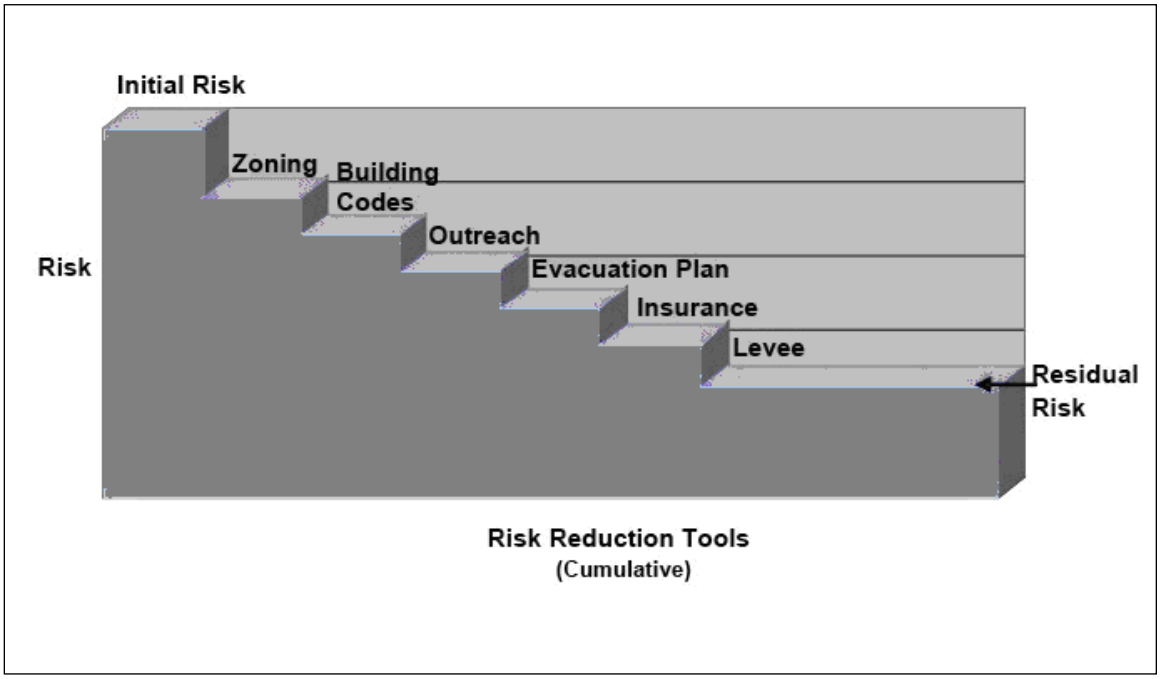


Figure 3-1. Implementation of Flood Risk Management Solutions.

Permanent relocation, raising in place, and flood proofing of existing structures are non-structural measures that were eliminated from consideration in prior studies due to the concentrated urbanization of the Greater Sacramento area. Non-Structural Measures from Tables 3-1 and 3-2 are summarized in the following matrix, Table 3-4. The measures identified in the column: Authorized Project, are those from previous American River Common Features authorizations. The measures identified under: State Programs, are those included in the State of California's Public Law 84-99 Eligibility Retention and Flood System Improvement Framework

or the FloodSAFE California program. The determination is then made to include the measures as a part of the No Action plan, a part of the non-structural plan for reauthorization, or screened from further consideration.

Table 3-4. Non-Structural Measures

Measure	Authorized Project	State Programs	No Action	Non-Structural Alternative
Zoning				
Floodplain Management	*	X	X	X
Provide floodplain information to regulatory agencies	*	X	X	X
Building Codes				
Local Building Codes		X	X	
Outreach				
Selected Outreach Measures from Table 3-2			X	
Annual Publication of Residual Risks	*	X	X	X
Evacuation Plan				
Telemeter Stream Flow Gages	X			X
Modifications to Flood Warning System	X			X
Insurance				
Federal Flood Insurance Program	*		X	X

* Required items of local cooperation

Measures listed in the column, Non-Structural Alternative, will be included in all of the action alternatives in the final array of plans.

3-4. MEASURES DROPPED FROM CONSIDERATION

Some measures originally identified that could contribute to addressing the Natomas Basin's flood problems and needs were reviewed and dropped from further consideration for the reasons outlined below:

a. Complete Permanent Evacuation of the Natomas Basin. A screening-level estimate of the costs of evacuating the Basin permanently and relocating everything in the Basin elsewhere was made. This cost was based on the average depreciated replacement value of the structures in the Basin, including average relocation costs per structure of $137,500. Table 3-5 shows how the total cost was determined.

Table 3-5. Cost of Total Evacuation of Natomas Basin

Type of Structure	Number of Structures	Average Depreciated Replacement Value ($Million)	Total Depreciated Replacement Value ($Million)	Estimated Relocation Costs ($Million)	Total ($Million)
Commercial	303	2.2	681	42	723
Industrial	156	1.8	458	21	479
Public	85	5.2	440	12	440
Farm	21	0.285	6	3	9
Residential	22,265	0.183	4,100	3,100	7,200
TOTAL	**22,830**	**--**	**5,685**	**3,178**	**8,851**

The estimated cost for total permanent evacuation of the Natomas Basin is $8.8 Billion. Early estimates of providing improvements to the existing levees were 10% to 12% of this total. Therefore, this alternative was eliminated.

b. Upstream Storage. As indicated in the constraints, no large-scale upstream regional detention alternatives on the American River (Auburn Dam) will be considered in this investigation. Previous studies had recommended construction of Auburn Dam but it was unacceptable and therefore not authorized. Such a solution would exceed the scope of this study and the Common Features authorization, but it could be addressed as a part of the State of California's Central Valley Flood Control Plan.

c. Yolo Bypass Improvements. This measure is described in the report, "Lower Sacramento River Regional Project Conceptual Design and Cost." It would consist of lengthening the Fremont Weir and widening the Yolo Bypass and Sacramento Bypass to increase the amount of flood water conveyed through these facilities and reduce the amount of flood water conveyed through the Sacramento River channel downstream of the Bypass. This would reduce the extent of the levee raising work that is needed along the NCC south levee, the Sacramento River east levee, and the PGCC west levee to meet the State 200-year flood protection requirements. The Yolo Bypass improvements that could be incorporated in this measure include the following:

- Redesign and reconstruction of the Fremont Weir,
- Construction of a new setback levee along the eastern edge of the Yolo Bypass extending from the Fremont Weir to the north levee of the Sacramento Bypass,
- Construction of a weir and closure structure in the Sacramento Deep Water Ship Channel south of I-80,
- Removal of existing Sacramento River Flood Control Project levees in the lower reach of the Yolo Bypass,
- Redesign and reconstruction of the Sacramento Weir,
- Widening the Sacramento Bypass.

The estimated cost of the measures for the comprehensive bypass is $4,500,000,000 and it is beyond the scope of the Common Features project. Because of the extent and cost of these improvements, all of which would lie outside SAFCA's jurisdiction, this group of measures

would require an unprecedented degree of State, Federal, and local cooperation and funding, and therefore would not address the planning constraint of being able to be implemented quickly with the goal of being ready for authorization in the next Water Resources Development Act, along with a schedule that reduces near-term damages. In addition, the measures would not reduce the water surface elevations in Natomas enough to reduce seepage under and through the levee nor address the stability issues. Therefore, it does not alleviate the need to implement other measures to address the seepage, stability, erosion, and vegetation and encroachment issues with the existing Natomas Basin perimeter levees through implementation of either a fix-in-place or adjacent levee alternative. For these reasons, these measures are not pursued further as a component of the Common Features project, but are considered worthy of further evaluation as part of the State's pending update of the CVFPP in order to address regional flooding issues.

d. Widening the Sacramento Bypass. Implementation of Folsom improvements would provide reduced risk to both areas adjacent to the Sacramento River and areas adjacent to the Yolo Bypass. With the addition of an additional by-pass adjacent to the Sacramento Bypass or expansion of the Sacramento Bypass, the risk reduction that would otherwise benefit areas along the Yolo Bypass would be refocused to the areas adjacent to the Sacramento River below the confluence with the American River. Risk along the Yolo Bypass would be no greater than that which would exist prior to improvements to Folsom. The separable cost of the Bypass is estimated to be $271 million but it would not provide significant benefits to the reaches of the project area north of the confluence with the American River and adjacent to the Natomas Basin. In addition, the bypass would not reduce the water surface elevations in Natomas enough to reduce seepage under and through the levee nor address the stability issues. Therefore, it does would not alleviate the need to implement other measures to address the seepage, stability, erosion and vegetation and encroachment issues with the existing Natomas Basin perimeter levees through implementation of either a fix-in-place or adjacent levee alternative. Because the bypass is neither effective nor efficient in providing flood risk management to the Natomas Basin, it was eliminated from further consideration.

e. Transitory Storage. Three alternative locations were investigated as potential sites for transitional storage (or off-stream storage). These locations are shown on Plate 12.

(1) Robbins Basin (RD1500). Floodwaters would be diverted into the basin via an un-gated or gated weir at RM 69.50 on the Sutter Bypass that would be 5,280 feet long. To successfully perform, the basin would be empty at the start of weir flow. To assure this, all levees surrounding the basin would be improved. The target stage for diverting water into the basin would be the minimum elevation of the surrounding existing condition levees, 40.4 feet (NGVD'29) for a storage space of approximately 988,000 acre-feet. Exit gates and/or a weir would also be needed to drain the water from the basin after the flood peak. They would be located at the lowest spot in basin, in the left levee of the Sacramento River at about RM 85.00, about one mile upstream of the Fremont Weir.

The total cost for implementing transitory storage in the Robbins Basin would be $1,066,000,000. These costs include: construction of intake and outtake structures for water to enter and leave the detention basin, costs to improve the perimeter levees around the detention basin to current standards, and costs to acquire real estate easements for water storage and to purchase and/or relocate existing properties in the basins. The stage in the Sacramento River at RM 70 (about halfway between the Cross Canal and American River confluences) would be

reduced by up to 2.3 feet for the 200-year event. This reduction in water surface elevation would not, however, preclude the need for the Natomas levee modifications.

(2) Nicolaus Basin (RD1001). Floodwaters would be diverted into the basin via a gated weir approximately 500 feet long at RM8.501 on the Feather River. To assure that the basin is empty at the start of weir flow, all levees surrounding the basin would be improved. The target stage for diverting water into the basin would be equal to the minimum elevation of the surrounding existing condition levees, 42.0 feet (NGVD 29), for a storage space of 25,000 acre-feet. Exit gates and/or weir would also be needed to drain the water from the basin after the flood peak. They would be located at the lowest spot in the basin, along the left levee of the Sacramento River. The total cost for implementing transitory storage in the Nicolaus Basin would be $545,000,000. The stage in the Sacramento River at RM 70 would be reduced by up to 1.8 feet for the 200-year event.

(3) Elkhorn Basin (RD 537, 827, 785, 1600). Floodwaters would be diverted into the basin via an ungated 10,560-foot long weir at RM 69.00 on the Sacramento River.
For this alternative to successfully perform, it is necessary, to assure that the basin would be empty at the start of weir flow all levees surrounding the basin would be improved. The target stage for diverting water would be the minimum elevation of the surrounding existing condition levees, 30.27 ft (NGVD 29), for a storage space of 225,000 acre-feet. Exit gates and/or a weir would also be needed to drain the water from Elkhorn Basin after the flood peak. The total cost for implementing transitory storage in the Elkhorn Basin would be $401,000,000. The stage in the Sacramento River at RM 70 would be reduced by up to 0.9 foot for the 200-year event.

As with the measures above, transitory storage would not reduce the water surface elevations in Natomas enough to reduce seepage under and through the levee nor address the stability issues. Therefore, it does not alleviate the need to implement other measures to address the seepage, stability, and vegetation and encroachment issues with the existing Natomas Basin perimeter levees. Because of the extent and likely cost of these improvements these measures would require an unprecedented degree of State, Federal, and local cooperation and funding. Because transitory storage would be neither effective nor efficient in providing flood risk management to the Natomas Basin, it was eliminated from further consideration.

f. Cross Natomas Levee. This measure involves construction of a cross levee running east to west across the Natomas Basin. It is described in the report entitled Natomas Cross Levee Conceptual Design and Cost Estimates (January 2009). The report considers two cross levee alignments. Alignment 1 crosses the Basin about 500 feet north of Elkhorn Boulevard to protect existing developed areas in the City of Sacramento (Plate 13). To protect the Airport, this alignment turns north before reaching Powerline Road and then west to connect to the Sacramento River east levee just downstream of RD 1000's Prichard Lake pumping facility. Alignment 2 crosses the Basin just north of Everta Road (Plate 13). In each case, the new levee would be designed to meet the State's 200-year flood protection requirements. Alignment 1 would cover a distance of about eight miles, while Alignment 2 would extend for approximately 6.5 miles. Construction of Alignment 1 would require 5.9 million cubic yards of material and its footprint would cover approximately 385 acres. Alignment 2 would require 5.0 million cubic yards and it would cover 330 acres of land.

These levee alignments would make it unnecessary to proceed with levee raising and seepage remediation improvements along the NCC south levee, the PGCC west levee, and portions of the Sacramento River east levee and the NEMDC west levee. Alignment 1 would leave about half the Natomas Basin outside the urban levee perimeter and Alignment 2 would leave out over a third of the Basin, including in both cases all of the lands that are in Sutter County.

Although the new cross levee alignments would reduce the length of the urban levee perimeter in Natomas, the land acquisition, road relocation, and material requirements of the new levee would cause a significant increase in cost. Alignment 1 would add $282,000,000 to the overall cost of the project, and Alignment 2 would add $233,000,000, incurring substantially greater costs than other alternatives without achieving any additional flood damage reduction benefit. Table 3-6 shows a comparison of the costs of the two cross levee alignments with the perimeter levee plan.

Table 3-6. Comparison of Costs - Cross Levee Alignments and NLIP Perimeter Levee Plan ($ millions)

Alternative	Construction Cost*	Total Cost*	Cost Increase
NLIP Perimeter Levee Plan	438	618	N/A
Cross Levee Alignment 1	675	900	282
Cross Levee Alignment 2	640	851	233

**Source of these costs is the SAFCA NLIP Early Implementation Project Plan Formulation Report, February 2009*

In addition, both alignments would strand recent investments in improving the south levee of the NCC, would result in the need to raise State Route (SR) 99 or otherwise protect SR 99 from flooding, divide Reclamation District (RD) 1000 and disrupt several portions of the Natomas Basin irrigation and drainage system and require reconfiguration of these systems, would present significant barriers to achieving the goals of the Natomas Basin Habitat Conservation Plan (NBHCP), and would leave a portion of the Basin currently planned for development by Sutter County outside the urban levee perimeter and likely cause Sutter County to exercise its rights under SAFCA's joint exercise of powers agreement to prevent the expenditure of Consolidated Capital Assessment District funds on this measure. For these reasons, it is likely that RD 1000 and Sutter County would exercise their rights under SAFCA's joint exercise of powers agreement to prevent the expenditure of Consolidated Capital Assessment District funds on this measure.

In addition to the issue of cost, the Sacramento International Airport was opposed to the cross levee, citing its concerns that additional flood waters in the vicinity of the airport would cause a significant increase in the number of aircraft bird strikes.

For the reasons identified above, this measure was dropped from further consideration.

g. New Setback Levee. This measure involves construction of a new levee along an alignment parallel to the existing levee alignment of the Sacramento east levee, but set back from the existing alignment by 500 to 1,000 feet.

The Sacramento River Flood Control Project is designed to convey the vast majority of the floodwaters entering the system upstream of the Natomas Basin over the Fremont Weir and through the Yolo Bypass, thereby limiting the flows entering the Sacramento River channel downstream of the weir. Accordingly, setting back the levee on the east side of the river would create an inherent risk of encouraging larger flows into the channel that could overwhelm the levee system downstream of Natomas. For this reason, the Setback Levee alternative would have to be integrated into a larger regional plan of flood protection and could not be implemented apart from the updated Central Valley Flood Protection Plan. This alternative would therefore not be eligible for early implementation.

A levee setback occupying more than the upper 14 miles of this area would also likely be infeasible because of (1) the presence of waterside residences along the existing levee and the need to maintain access to these residences from the Garden Highway; and (2) the proximity of the Sacramento River east levee to the Airport, and the need to prevent project features from increasing potential hazards to aviation safety. Airport managers have previously expressed objections to consideration of a levee setback within the 10,000-foot Airport Critical Zone because of the potential that the setback area, which would likely hold shallow water during winter and spring, could attract wildlife that would increase hazards to aircraft. For this reason, the existing Garden Highway levee would have to be maintained and the new setback levee would have to be designed around the Airport.

The setback levee would have a significantly larger footprint than either the Fix-in-Place or Adjacent Levee alternatives, requiring substantially more real estate and borrow material to construct, making it much more costly than these alternatives. It would also increase the amount of agricultural land converted to non-agricultural use over other measures. For all of the above reasons, a basin-wide setback levee was eliminated from further consideration.

h. Backside Armoring. The report "Development Fee Support: Levee Overtopping Resiliency Measures for Lower American River," 31 August 2007, prepared for SAFCA, evaluated alternatives and determined that the preferred measure to provide levee resiliency would be to utilize an articulated concrete block (ACB) revetment system. Further study of this system would be required, including additional hydraulic modeling and laboratory tests to determine if the measure can withstand anticipated durations of overtopping (15-28 hours) which are longer than the 8-hour test results that are currently available. Because of the costs associated with this measure, it has been deferred for consideration after implementation of the NLIP.

i. Closing of Sankey Road Gap. The affected portion of the PGCC west levee includes the location where Sankey Road crosses into the Natomas Basin. Historically, when the levees protecting the Natomas Basin were constructed in the period between 1911 and 1914, a gap was left in the levee between the Pleasant Grove Creek Canal and the Natomas East Main Drainage Canal (Reaches E and F). Referred to as the "Sankey Road Gap" this low spot in the levee has been hardened to accept overflows from the Cross Canal watershed into the interior of the Natomas Basin during large flood events. This was by agreement between the landowners to the east and the advocates for construction of the Natomas levees.

Closing the gap in this levee was eliminated from consideration early in the screening process. The main reason for its elimination is because it would violate the agreement put into place when the levees were originally constructed. This is not considered to be significant

source of flooding, because a very limited amount of flow can spill through this gap into the Natomas Basin. For low-frequency, high-stage flood events, flow through the Sankey Road gap floods only a small piece of agricultural area with very few damages. Additionally, in the follow-on GRR, closing of the Sankey Road gap will be further evaluated.

j. Summary. From the analyses described above, it was concluded that the best way to address flood risk management in the Natomas Basin is to improve the Natomas levees. Therefore, measures other than Natomas levee modification are not pursued further. However, the measures not carried forward in this report may be considered worthy of further evaluation as part of the State's pending update of the CVFPP. In the future, SAFCA could contribute to improving segments of the SRFCP, such as its bypass systems, through its development fee program. This would further reduce the risk of flooding in the project area and provide flood risk reduction benefits to SRFCP-protected lands outside the project area. The early implementation of the Common Features project would not create any substantial hydraulic or other obstacles to pursuing such a strategy.

Table 3-7 below summarizes the measures eliminated in initial screening.

Table 3-7. Measures Eliminated from Consideration

Measure	Reason(s) for Elimination
Complete Evacuation of the Natomas Basin	The estimated cost for total permanent evacuation of the Natomas Basin is $8.8 Billion. Early estimates of providing improvements to the existing levees were 10% to 12% of this total.
Upstream Storage	This measure was beyond the scope of this report.
Yolo Bypass Improvements	This measure was beyond the scope of this report. Additionally, it does not reduce water surface elevations enough to adequately address the seepage and stability issues with the existing Natomas Basin perimeter levees.
Widening the Sacramento Bypass	This measure does not provide significant benefits to the reaches of the project area north of the confluence with the American River and adjacent to the Natomas Basin. Additionally, it does not reduce water surface elevations enough to adequately address the seepage and stability issues with the existing Natomas Basin perimeter levees.
Transitory Storage	This measure does not reduce water surface elevations enough to adequately address the seepage and stability issues with the existing Natomas Basin perimeter levees
Cross-Natomas Levee	The land acquisition, road relocation, and material requirements of this measure would cause a significant increase in cost. Additionally, it would strand recent investments in improving the south levee of the NCC, divide RD 1000 and disrupt the existing agricultural irrigation and drainage system in Natomas, and leave the portion of the Basin currently planned for development by Sutter County outside the urban levee perimeter.

Measure	Reason(s) for Elimination
New Setback Levee	Implementing this measure on the east side of the river would create an inherent risk of encouraging larger flows into the channel that could overwhelm the levee system downstream of Natomas. It is also likely to be infeasible because of the presence of waterside residences along the existing levee and the need to maintain access to these residences from the Garden Highway, and the proximity of the Sacramento River east levee to the Airport, and the need to prevent project features from increasing potential hazards to aviation safety.
Backside Armoring	Because of the costs associated with this measure, it has been deferred for consideration after implementation of the NLIP.
Closing of Sankey Road Gap	While modeling indicates that overflows into the gap increase the depth and extent of the interior floodplain in the northern portion of the Basin during the 100-year flood, it does so without causing damage to buildings or infrastructure.

3-5. ARRAY OF NATOMAS ALTERNATIVES

a. Basis for Alternatives. Based on the evaluations of measures described above, an initial array of alternatives was formulated based on tradeoffs between different planning constraints. This array of plans primarily demonstrates the trade-offs between the constraint of minimizing the relocation and/or removal of structures to the extent practicable with the constraints of avoiding effects to existing infrastructure to the extent practicable and avoiding impacts to riparian vegetation to the extent practicable.

In order to evaluate various combinations of measures, screening level estimates were developed for the measures carried forward for consideration. The reaches identified in Chapter 2 were again used to develop combinations of measures into alternatives plans. For six different water surface elevations, the various measures needed to fix the levee problems were analyzed. As the screening costs were developed, the most appropriate seepage, stability, vegetation, height deficiency, and erosion mitigation measures for each reach and for each water surface elevation were selected for evaluation. Two different methods for fixing levees were evaluated. These two methods were to fix the levees in-place or to fix them through the use of an adjacent levee.

b. Plan 1: No Action. The without project condition assumes that no additional features would be implemented by the Federal Government or by local interests to achieve the planning objectives, over and above those authorized elements of the Common Features project that will have been implemented prior to reauthorization of the project. Critical assumptions in defining the no action alternative include:

- The elements of the Common Features project that have been implemented are assumed to be in place.

- The elements of the Common Features project that have not been implemented are assumed not to be in place. Because they will be evaluated in the follow-on GRR, their presence is not assumed as part of the future without-project conditions.

- In 2014, the Joint Federal Project, auxiliary spillway with six submerged tainter gates at Folsom Dam will be completed.

- In 2016, the 3.5-foot mini-raise of the Folsom Dam will be completed.

- SAFCA will put their Life Cycle Management (LCM) plan for vegetation management on levees into place.

- The County of Sacramento and the City of Sacramento have a flood warning and evacuation plan in place and will implement it in the event of a flood.

The No-Action Alternative serves as the baseline against which the impacts and benefits of the action alternatives for the Natomas Basin are evaluated.

c. Plan 2: Authorized Project. The authorized project includes the Common Features components that are a part of the WRDA 1996 and 1999 authorizations. It has a current cost estimate of $279,500,000. At the time, it was thought that the relatively modest scope of the authorized improvements would be sufficient to protect the Natomas Basin from very rare floods in the Sacramento-Feather River watershed. However, subsequent engineering analyses have made it clear that substantial modifications to the scope of the Common Features Project are needed to achieve the flood risk management benefits of the authorized project in the Natomas Basin. As authorized, the project would not reduce risk associated with failure mechanisms other than overtopping and would not attain the anticipated benefits.

d. Plan 3: Fix In-Place Alternative.

Strategy: Meet the planning objectives by improving the perimeter levees around the Natomas Basin by fix in-place methods. By mitigating levee problems in place, the relocation and/or removal of homes and businesses is minimized to the extent practicable.

Measures: Measures for this plan are shown below in Table 3-8.

Table 3-8. Fix In-Place Alternative Measures

Reach	Measures				
	Seepage	**Stability**	**Erosion**	**Vegetation**	**Over-Topping**
NAT A	Cut-off Wall	Drained Stability Berm	-	Long-term	Raise
NAT B	Cut-off Wall/Seepage Berm	-	*	Long-term	Raise
NAT C	Cut-off Wall/Seepage Berm	-	*	Long-term	Raise
NAT D	Cut-off Wall	-	-	Long-term	Raise
NAT E	Cut-off Wall	-	Waterside Armor	Long-term	Raise
NAT F	Flattened Landside Slope	Stability Berm	Waterside Armor	Long-term	Raise
NAT G	Cut-off Wall	-	-	Long-term	Raise
NAT H	Cut-off Wall	-	-	Long-term	-
NAT I	Cut-off Wall	-	-	Long-term	-

**Waterside Armor for Reaches B and C will be done under the Sac Bank Program; not included as a cost feature*

Discussion: While fixing or raising the levee in-place minimizes the relocation of houses and businesses by confining the footprint of the levee to nearly its existing footprint, the construction will require the reconstruction of the Garden Highway to current roadway standards, significantly increasing its width, and therefore, the costs of this plan. Additionally, compliance with the vegetation ETL will require that vegetation is removed from the levee. The costs of removal of this vegetation and the costs for mitigation for the loss of habitat provided by the vegetation are not included, as they are being treated as deferred maintenance that must be performed by the local sponsor prior to the implementation of a Federal project.

e. Plan 4: Adjacent Levee Alternative.

Two strategies were developed which resulted in the same combination of measures.

Strategy: Meet the planning objectives by improving the perimeter levees around the Natomas Basin by adjacent levee methods, where practical. By mitigating levee problems with an adjacent levee, effects to existing infrastructure are avoided to the extent practicable and impacts to riparian vegetation are avoided to the extent practicable.

Strategy: Meet the planning objectives by improving the perimeter levees around the Natomas Basin by choosing the least cost levee improvement method for each reach.

Measures: This strategy is best met by the construction of an adjacent levee where practical that would include a cut-off wall where seepage is an issue. The measures for this plan are shown by reach in Table 3-9.

Table 3-9. Adjacent Levee Alternative Measures

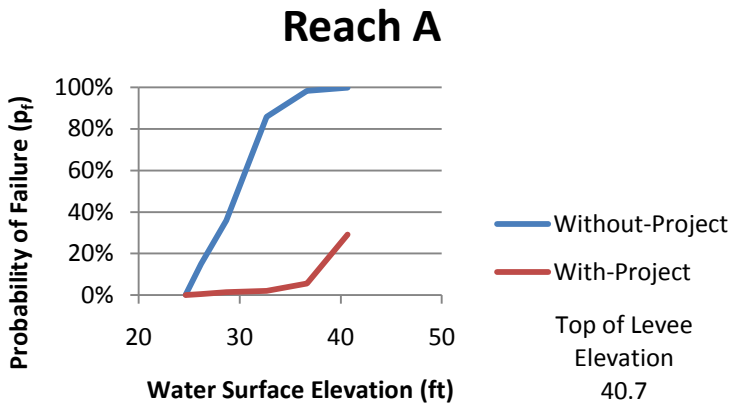
Reach	Measures				
	Seepage	**Stability**	**Erosion**	**Vegetation**	**Over-Topping**
NAT A	Cut-off Wall	Stability Berm	-	Widen Existing Levee	Raise
NAT B	Cut-off Wall/Seepage Berm	-	Adjacent	Adjacent	Raise
NAT C	Cut-off Wall	-	Adjacent	Adjacent	Raise
NAT D	Cut-off Wall	-	Waterside Armor	-	Raise
NAT E	Cut-off Wall	-	Waterside Armor	-	Raise
NAT F	Flattened Landside Slope	-	Waterside Armor	-	Raise
NAT G	Cut-off Wall	-	-	-	Raise
NAT H	Cut-off Wall	-	-	-	-
NAT I	Cut-off Wall	Widen Existing Levee	-	Widen Existing Levee	-

Discussion: Improvement of levee problems through an adjacent levee avoids the mitigation of habitat loss due to the removal of vegetation. Additionally, this alternative offers substantial savings in the avoidance of major alteration to the Garden Highway. This alternative can be considered because the non-Federal sponsor was successful in obtaining a variance for this post authorization change report. The variance can be found in Appendix I.

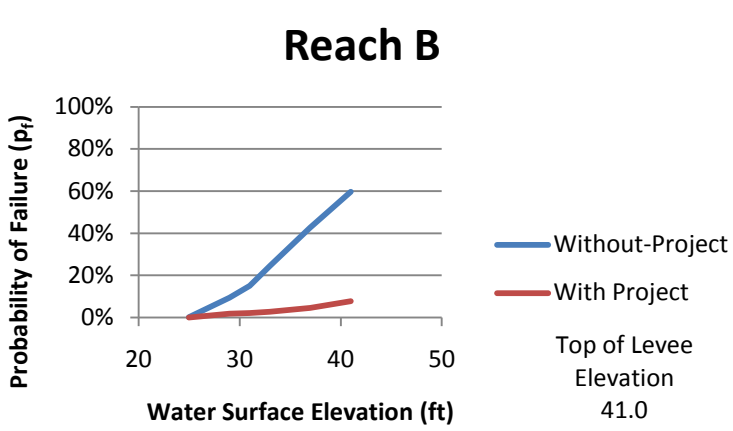
f. Geotechnical Performance. From a geotechnical performance point of view, whether a measure is labeled “fix-in-place” or “adjacent levee” does not change its geotechnical performance (i.e., a measure has the same geotechnical performance no matter how it’s categorized), and therefore, benefits for each measure (method of fix) and benefits between the two categories of alternative evaluated, are the same. This can be seen in Table 3-10.

Table 3-10
Geotechnical Levee Performance Curves (Without- and With- project)

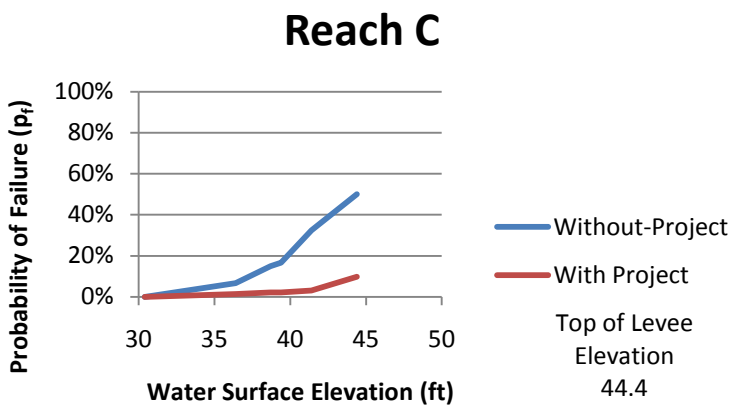
Reach A		
Water Surface Elevation (ft)	Without-Project p_f*	With-Project p_f*
24.7	0%	0%
26.2	15%	1%
28.7	36%	1%
32.7	86%	2%
36.7	98%	6%
40.7	100%	29%



Reach B		
Water Surface Elevation (ft)	Without-Project p_f*	With-Project p_f*
25.0	0%	0%
29.0	9%	2%
31.0	15%	2%
33.0	24%	3%
37.0	43%	5%
41.0	60%	8%



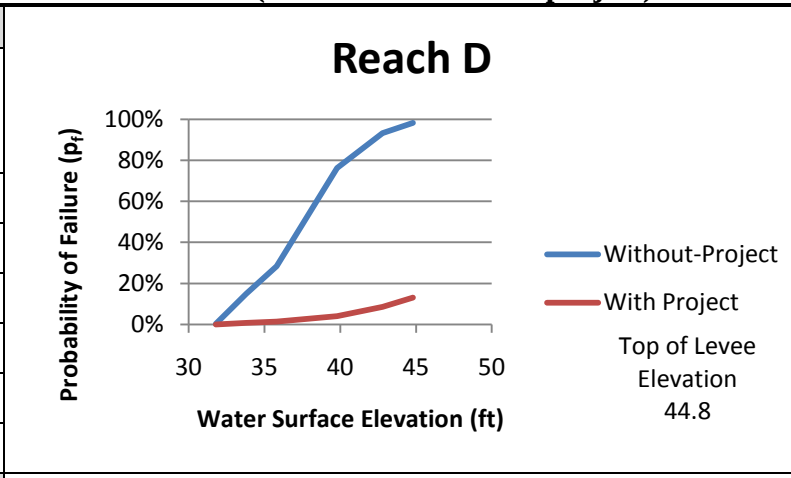
Reach C		
Water Surface Elevation (ft)	Without-Project p_f*	With-Project p_f*
30.4	0%	0%
36.4	7%	1%
38.7	15%	2%
39.4	17%	2%
41.4	32%	3%
44.4	50%	10%



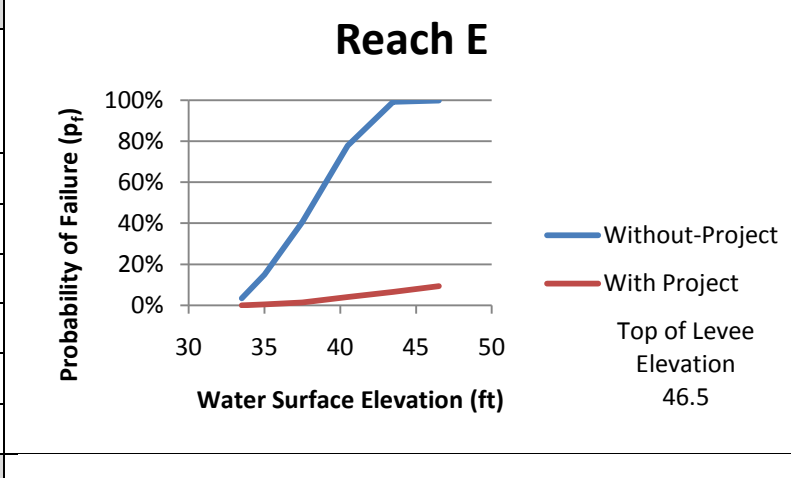
*The table shows that for each reach there is still a slight chance of failure (per fragility curve) with a project in place. What is not apparent from the values in the table is the possibility of overtopping/failure occurrences when engineering uncertainties are considered and when risk analysis is applied.

Table 3-10 (continued)
Geotechnical Levee Performance Curves (Without- and With- project)

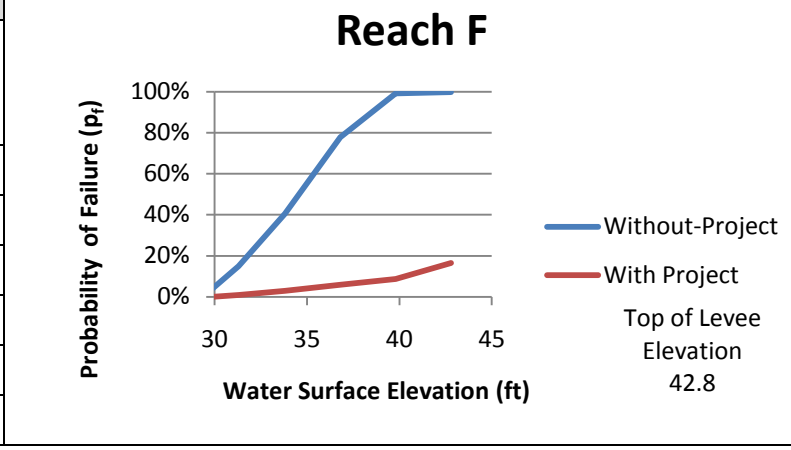
Reach D		
Water Surface Elevation (ft)	Without-Project p_f*	With-Project p_f*
31.8	0%	0%
33.8	15%	1%
35.8	28%	1%
39.8	76%	4%
42.8	93%	9%
44.8	98%	13%



Reach E		
Water Surface Elevation (ft)	Without-Project p_f*	With-Project p_f*
33.5	3%	0%
35.0	15%	0%
37.5	41%	1%
40.5	78%	4%
43.5	99%	7%
46.5	100%	9%



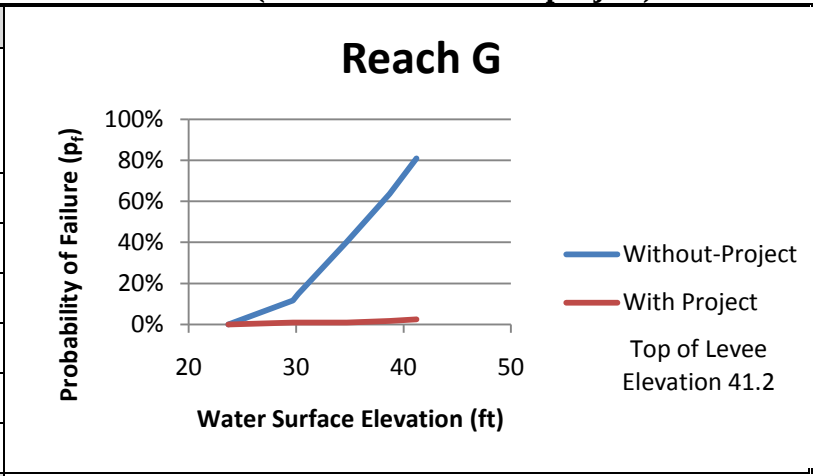
Reach F		
Water Surface Elevation (ft)	Without-Project p_f*	With-Project p_f*
29.8	3%	0%
31.3	15%	1%
33.8	41%	3%
36.8	78%	6%
39.8	99%	9%
42.8	100%	17%



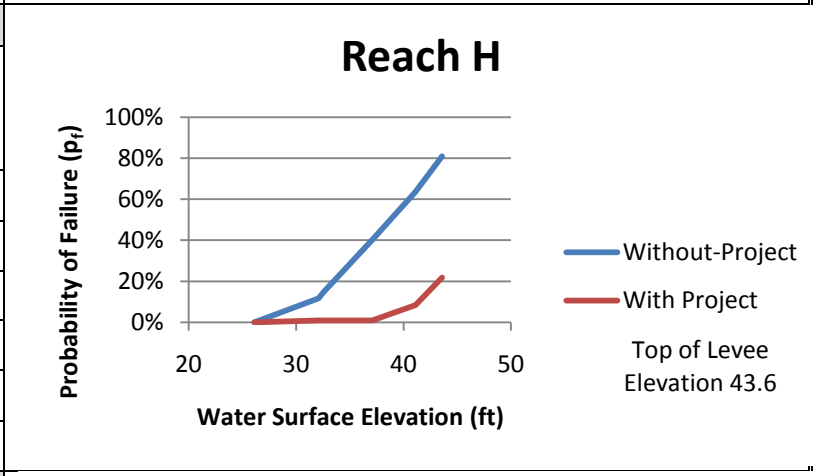
* The table shows that for each reach there is still a slight chance of failure (per fragility curve) with a project in place. What is not apparent from the values in the table is the possibility of overtopping/failure occurrences when engineering uncertainties are considered and when risk analysis is applied.

Table 3-10 (continued)
Geotechnical Levee Performance Curves (Without- and With- project)

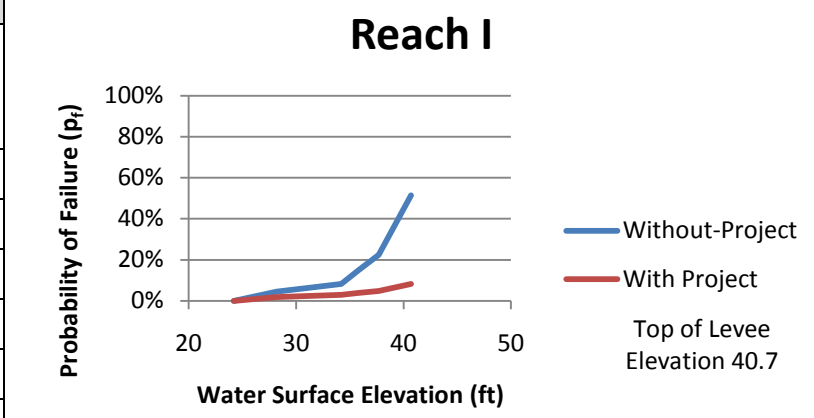
Reach G		
Water Surface Elevation (ft)	Without-Project p_f*	With-Project p_f*
23.7	0%	0%
29.7	12%	1%
30.2	15%	1%
34.7	40%	1%
38.7	64%	2%
41.2	81%	2%



Reach H		
Water Surface Elevation (ft)	Without-Project p_f*	With-Project p_f*
26.1	0%	0%
32.1	12%	1%
32.6	15%	1%
37.1	40%	1%
41.1	64%	8%
43.6	81%	22%



Reach I		
Water Surface Elevation (ft)	Without-Project p_f*	With-Project p_f*
24.2	0%	0%
28.2	4%	2%
34.2	8%	3%
35.8	15%	4%
37.7	22%	5%
40.7	51%	8%



* The table shows that for each reach there is still a slight chance of failure (per fragility curve) with a project in place. What is not apparent from the values in the table is the possibility of overtopping/failure occurrences when engineering uncertainties are considered and when risk analysis is applied.

f. Economic Analysis. As discussed in the section on levee problems, the Natomas levees were divided into nine reaches, based on similar problems. For each reach, the appropriate levee improvements were determined for both fix in-place and adjacent levee

alternatives (see Tables 3-8 and 3-9). The reaches then became "building blocks" of a complete plan for the basin. The costs for the improvements for each levee section were determined and added together for a complete plan cost. The analysis of separate levee segments was not intended as a traditional incremental analysis for the purpose of determining which reaches are to be included in the selected plan and which are separable items. A fundamental premise of this investigation was that, because the levees constitute a system, the reaches are dependent. To reduce the risk of flooding effectively, the entire system must be improved. Therefore, the most efficient measures for each reach were combined into system-wide alternatives. In doing so, we were able to differentiate outputs by reach. An analysis of separate levee sections was used to determine the efficiency of the method of levee repair and its construction sequencing.

The development of the plans starts with the reach in which the chance of flooding and the consequences of flooding were the greatest (reach D). Generally, with improvement to each segment, either the chance of flooding in the Basin, the consequences of flooding in the Basin, or both are reduced, resulting in the overall risk of flooding in the Basin to be reduced and benefits to be achieved. While each may have resulted in benefits, the population and property at risk remain constant, as flood risk is merely transferred to next weakest point (levee reach) around the Basin. Because the levees around the Natomas Basin have different problems, or different combinations of problems, each has a different probability of failure performance in a flood. Of the nine reaches analyzed, Reach D, at the NCC, had the highest probability of failure. Following this logic, the segments were considered in the following order:

- Improvement Step 0 – Without-Project
- Improvement Step 1 – Improve Reach D
- Improvement Step 2 – Add Reach A
- Improvement Step 3 – Add Reach E
- Improvement Step 4 – Add Reach B
- Improvement Step 5 – Add Reach C
- Improvement Step 6 – Add Reach H
- Improvement Step 7 – Add Reach G
- Improvement Step 8 – Add Reach F
- Improvement Step 9 – Add Reach I

Making improvements to all of the reaches around the Basin results in an AEP of about 0.015. Table 3-11 displays the costs of the individual segments and the summation of those costs. Each segment of levee has specific measures to address the specific problems of that reach. Additionally, two categories of alternatives were identified for plan formulation purposes; a "fix-in-place" and "adjacent levee" alternative. Generally speaking, each measure can be part of both a "fix-in-place" and "adjacent levee" alternative, as the salient factor that determines how a measure is categorized is dictated mostly by where the measure is physically located. From a geotechnical performance point of view, whether a measure is labeled "fix-in-place" or "adjacent levee" does not change its geotechnical performance (i.e., a measure has the same geotechnical performance no matter how it's categorized), and therefore, benefits for each method of improvement and benefits between the two categories of alternative evaluated, are the same. This can be seen in Table 3-11.

Table 3-11. Economic Analysis

Groups	Alternative Type	Expected Annual Damages	Annual Benefits	Annual Cost	Cost of Reach Improvement	Net Benefits	B/C Ratio
Without Project		462	-	-	-	-	-
Fix D	Adjacent Levee			2.0	2.0		
	Fix In-Place			2.0	2.0		
Fix D+A	Adjacent Levee			8.3	6.4		
	Fix In-Place			8.6	6.6		
Fix D+A+E	Adjacent Levee			11.5	3.2		
	Fix In-Place			12.0	3.4		
Fix D+A+E+B	Adjacent Levee			26.7	15.3		
	Fix In-Place			29.2	17.2		
Fix D+A+E+B+C	Adjacent Levee			31.7	4.9		
	Fix In-Place			36.0	6.8		
Fix D+A+E+B+C+H	Adjacent Levee			35.6	3.9		
	Fix In-Place			39.9	3.9		
Fix D+A+E+B+C+H+G	Adjacent Levee			37.8	2.2		
	Fix In-Place			42.4	2.5		
Fix D+A+E+B+C+H+G+F	Adjacent Levee			41.3	3.4		
	Fix In-Place			46.1	3.7		
Fix D+A+E+B+C+H+G+F+I	Adjacent Levee	19	443	42.7	1.5	400	10.4
	Fix In-Place			47.6	1.5	395	9.3

Table 3-12. With-Project Residual Damages and Benefits
Damages/Benefits in $Millions

Reach	Population at Risk from 1% Chance Event	Structure Count by Damage Category					Without Project Expected Annual Damages	Residual Damages	Average Annual Benefits	Benefit to Cost Ratio
		Commercial	Farm	Industrial	Public	Residential				
Without Project	70,000	303	21	156	86	22,265	462	--	--	--
Fix D	70,000	303	21	156	86	22,265	462			
Fix D A	70,000	303	21	156	86	22,265	462			
Fix D A E	70,000	303	21	156	86	22,265	462			
Fix D A E B	70,000	303	21	156	86	22,265	462			
Fix D A E B C	70,000	303	21	156	86	22,265	462			
Fix D A E B C H	70,000	303	21	156	86	22,265	462			
Fix D A E B C H G	70,000	303	21	156	86	22,265	462			
Fix D A E B C H G F	70,000	303	21	156	86	22,265	462			
Fix D A E B C H G F I	70,000	303	21	156	86	22,265	462	19	443	10.4

Interest rate: 4.375%, Period of Analysis is 50 years

For purposes of preliminarily screening of alternatives, total project first costs and interest during construction (IDC) were estimated for the various measures (methods of fixes) in each reach and by alternative type ("fix-in-place" or "adjacent levee"). First costs and IDC were added together to derive total investment costs. Investment costs were then amortized assuming a 50-year period of analysis and an interest rate of 4.375%.

Table 3-13 displays the average annual benefits and average annual costs, cumulative costs, and the benefit-to-cost ratio.

Table 3-13. Comparative Economic Analysis ($ Million)

	Fix In-Place Alternative	Adjacent Levee Alternative
First Cost	815.2	720.5
IDC	104.7	102.2
Total Investment	919.9	822.8
Amortized Cost	45.6	40.8
OMRR&R	2.0	1.9
Total Annual Cost	47.6	42.7
Average Annual Benefits	443	443
Net Benefits	395	400
BC Ratio	9.3	10.4
% Damages Reduced	96%	96%

Interest rate: 4.375%, Period of Analysis is 50 years

Based upon these analyses, the plan that reasonably maximizes net benefits is the Adjacent Levee plan. Therefore, the Adjacent Levee plan is considered to be the interim NED plan. The plan is considered interim because it is acknowledged that without considering raises, the plan has substantial residual risks. The issue of raises will be addressed in the follow-on Common Features GRR.

3-6. COMPARISON OF ALTERNATIVES

a. **Comparison of Federal Implementation Plans.** The Federally Supportable Plan is identified through an evaluation of the Federal Implementation Plans – those plans that assume full Federal implementation and do not include consideration of the early implementation features constructed by SAFCA. The Federally Supportable Plan is the Federal Implementation Plan that maximizes net national economic benefits while meeting other Federal criteria.

Comparison is the fifth step in the planning process, which is based on the evaluation of the effects of the alternatives, the fourth step in the planning process. Comparisons are made between the Fix In-Place Alternative (Plan 3) and the Adjacent Levee Alternative, (Plan 4). Plan 1, No Action is not included in the comparison since it is the basis from which impacts are measured and, therefore, it has no costs, benefits or impacts. Plan 2, the Authorized Project is also not included since the plan is not effective in producing the desired benefits for which the project was originally authorized. The more detailed evaluations of the environmental effects of the alternatives are presented in the accompanying Environmental Impact Statement and previous Environmental Impact Statements by reference. In the Environmental Impact Statements, all plans are compared on the basis of providing a level of performance equal to the

mean 200-year event plus three feet of freeboard – the level of performance desired by the non-Federal interests. The comparison made here is between plans that do not include raises.

b. Planning Objectives. Table 3-14 summarizes how each of the plans meets the planning objectives detailed in Chapter 2.

Table 3-14. Evaluation Against Objectives

Objective	Plan 3 – Fix In Place	Plan 4 – Adjacent Levee
Reduce flood risk to public health, safety, and property in the Natomas Basin associated with under- and through-seepage.	Similar reduction of risk due to underseepage and through-seepage.	
Reduce flood risk to public health, safety, and property in the Natomas Basin due to levee erosion.	Stabilizes slopes through water-side armoring. Some costs of this are associated with the Sac Bank program.	Addresses erosion through a combination of water-side armoring and construction of adjacent levees.
Reduce flood risk to public health, safety, and property in the Natomas Basin due to levee instability.	Addresses stability problems with stability berms.	Addresses stability problems with stability berms and widening the existing levee.
Reduce flood risk to public health, safety, and property in the Natomas Basin associated with vegetation and encroachments on the levees.	Vegetation management will be addressed by removal in compliance with the ETL.	Vegetation management will be addressed by a combination of removal in compliance with the ETL, building adjacent levees, and widening the existing levee.
Reduce flood risk to public health, safety, and property in the Natomas Basin associated with levee overtopping.	Overtopping is not addressed with this plan.	Overtopping is not addressed with this plan.
Educate the public about ongoing residual risk.	None of the plans address this directly, except through the existing flood warning and evacuation plans.	
Provide opportunities to connect the community to the river.	All plans have the opportunity to add recreational elements.	

c. System of Accounts. A method of displaying the positive and negative effects of various plans is to use the System of Accounts as suggested by the U.S. Water Resources Council. The accounts are categories of long-term effects, defined in such a manner that each proposed plan can be easily compared to others. The four accounts used to compare proposed water resource development plans are the NED, environmental quality (EQ), regional economic development (RED) and other social effects (OSE) accounts. The system of accounts includes the display of items required by Section 904 of WRDA 1986.

(1) National Economic Development. The intent of comparing alternative flood control plans in terms of NED is to identify the beneficial and adverse effects that the plans may have on the national economy. Beneficial effects are considered to be increases in the economic value of the national output of goods and services attributable to a plan. Increases in NED are expressed as the plan's economic benefits and the adverse NED effects are the investment opportunities lost by committing funds to the implementation of a plan. Comparison of the plans under consideration using the NED account is shown above in Table 3-13. The values for net benefits shown on the table are the differences between the average annual economic benefits associated with each plan and the average annual cost of the plans. The table indicates that Plan 4 has higher average annual net benefits than Plan 3.

(2) Environmental Quality. The EQ account is another means of evaluating the alternatives to assist in making a plan recommendation. The EQ account is intended to display the long-term effects that the alternative plans may have on significant environmental resources. Significant environmental resources are defined by the Water Resources Council as those components of the ecological, cultural, and aesthetic environments which, if affected by the alternative plans, could have a material bearing on the decision-making process. A comparison of the effects that the proposed plans may have on the EQ resources is shown on Table 3-15. If a plan has a clear advantage over other plans, that box has been shaded.

Table 3-15. Environmental Quality Account

	Plan 3 – Fix In Place	Plan 4 – Adjacent Levee
Flooding	Positive effect by reducing the risk of flooding	
Sedimentation and Erosion	For all plans, positive effect by reducing the risk by preventing erosion on levee slopes. Potential for short-term sedimentation discharge during construction.	
Water Quality	Potential for short term impacts during waterside construction activities.	Plan minimizes the amount of waterside construction since there are adjacent levees in the plans.
Air Quality	For all plans, short term effects during construction.	
Noise	For all plans, short term effects during construction.	
Aquatic Habitat	Negative effect where waterside vegetation removal is required. Plan has the maximum amount of waterside vegetation removal. Coordination with USFWS indicated this removal could result in a jeopardy opinion.	Negative effect where waterside vegetation removal is required. Plan minimizes the amount of waterside vegetation removal.
Riparian Habitat	Negative effect where waterside vegetation removal is required. Plan has the maximum amount of waterside vegetation removal. Coordination with USFWS indicated this removal could result in a jeopardy opinion.	Short term negative effects until compensation trees have time to re-establish.
Wetland Habitat	Significant loss of riparian habitat.	Minimum loss of riparian habitat
Upland Habitat	For all plans, no net loss of habitat.	
Endangered Species	Compensation will replace all endangered species habitat. Habitat will be replaced in a manner that will increase connectivity for species.	
Cultural Resources	Some cultural resources may be adversely affected by the project. Mitigation measures would be required for those resources determined to be adversely affected by the proposed project.	
Aesthetics	No long term effects will result from the project.	
Historical Values	No long term effects will result from the project.	

(3) Regional Economic Development. The RED account is intended to illustrate the effects that the proposed plans would have on regional economic activity, specifically, regional income and regional employment. The comparison of possible effects that the plans may have on these resources is shown in Table 3-16.

Table 3-16. Regional Development Account

	Plan 3 – Fix in Place	Plan 4 – Adjacent Levee
Employment and Labor Force	Positive effect on regional labor during construction.	
Business and Industrial Activity	Positive effect as risk of flooding is reduced.	
Local Government Finance	Positive effects as reduced risk of flooding will likely lead to increases in property values.	

(4) Other Social Effects. The OSE account typically includes long-term community effects in the areas of public facilities and services, recreational opportunities, transportation and traffic and man-made and natural resources. A comparison of the effects that the proposed

alternatives would have on OSE resources is shown on Table 3-17. If a plan has a clear advantage over other plans, that box has been shaded.

Table 3-17. Other Social Effects Account

	Plan 3 – Fix in Place	Plan 4 – Adjacent Levee
Loss of Life	Positive effect as flood risk decreases.	
Public Health and Safety	Positive effects on both long-term and short-term public health and. safety as flood risk decreases.	
Public Facilities and Services	Positive effect as flood risk decreases.	
Recreation and Public Access	No change.	
Traffic and Transportation	Will disrupt traffic on Garden Highway during construction. After completion, Garden Highway will be improved. Airport will be subject to fewer disruptions in service.	Minimal disruption of Garden Highway traffic. Airport will be subject to fewer disruptions in service.
Man-made Resources	Disruption of agricultural activities in basin during construction. Will remove land from agricultural production. Positive effects on agriculture in basin as flood risk decrease after implementation.	
Natural Resources	Some temporary and permanent loss of habitat and waterside riparian woodland.	Some temporary and permanent loss of habitat and waterside riparian woodland; however, effects are limited to minimal disturbance of riverward levee slope.

d. Response to Planning Constraints. The following table describes how the alternative plans relate to each of the planning constraints. If a plan has a clear advantage over other plans, that box has been shaded.

Table 3-18. Response to Planning Constraints

Constraint	Plan 3 –Fix in Place	Plan 4 – Adjacent Levee
No large-scale upstream regional detention alternatives on the American River (Auburn Dam) will be considered in this investigation.	No large-scale upstream regional detention alternatives on the American River (Auburn Dam) were considered in this investigation.	
Plans must avoid adverse effects to endangered and threatened species in the Greater Sacramento area.	All plans include relocation of ditches to facilitate migration of GGS. All plans include habitat creation and management in connection with project borrow activities.	
	Significant impacts to endangered and threatened species resulting from vegetation removal.	No impacts to endangered and threatened species.
Plans should minimize adverse effects on cultural resources to the degree practicable.	For all plans, impacts will be minimized by avoidance where possible, and by recovery and preservation where disturbance is unavoidable.	

Constraint	Plan 3 –Fix in Place	Plan 4 – Adjacent Levee
Adverse impacts to riparian vegetation should be avoided to the extent practicable.	The fix in place alternative would require significant removal of vegetation.	Construction of the adjacent levee along the Sacramento River east levee would have minimum affect on riparian vegetation.
Plans should avoid adverse hydraulic effects that increase flood risks to other parts of the system to the extent practicable.	No transfer of risk due to overtopping from levee improvements	
Plans should avoid effects to existing infrastructure (bridges, highways, railroads, utilities, airports) to the extent practicable.	The fix in place levee requires removal and rebuilding of the Garden Highway.	Along the east levee of the Sacramento River, the adjacent levee has the least effect on existing infrastructure.
Plans must not violate the Sacramento Airport restrictions regarding providing additional bird habitat.	All plans have aviation safety components, including relocation of irrigation and drainage infrastructure in the Airport Operation Area and grading of the Airport's northern bufferlands to improve surface drainage and reduce the risk of bird strikes.	
Plans should minimize the relocation and/or removal of structures to the extent practicable.	Plan minimizes the removal of structures.	Plan removes structures greater number of structures

e. Response to Local Concerns. The following table describes how the alternative plans relate to each of the local concerns.

Table 3-19. Response to Local Concerns

Concern	Plan 3 –Fix in Place	Plan 4 – Adjacent Levee
Plan formulation should include one or more plans that are aimed to achieve the minimal 200-year urban level of protection standard as defined by the State of California.	Minimal 200-year level of protection was evaluated. However, due to uncertainties in the hydraulic modeling, raises cannot be recommended at this time.	
Plans should be compatible with local land use plans to the extent practicable.	Plan is compatible with local land use plans.	
Plans should be maintainable and to the extent practicable should minimize costs for operation, maintenance, repair, rehabilitation, and replacement.	Plans are equally maintainable.	
To the extent practicable, plans should be able to be implemented quickly with the goal of being ready for authorization in the next WRDA, along with a schedule that reduces near-term damages.	This plan will require more time to implement due to more real estate acquisition, relocation of the Garden Highway, and removal of and mitigation for existing waterside vegetation on the levee.	This plan will be implemented more quickly than Fix in-Place because of less real estate acquisition, no relocation of the Garden Highway, and minimal disturbance of existing waterside vegetation on the levee.

e. Formulation Criteria. The final array of alternative plans was formulated to address the four formulation criteria suggested by the U.S. Water Resources Council. These criteria are completeness, effectiveness, efficiency and acceptability. The plans are now compared against these criteria based upon the evaluations of the plans.

(1) Completeness. Completeness is a determination of whether or not the plan includes all elements necessary to achieve the objectives of the plan. It is an indication of the degree that the outputs of the plan are dependent upon the actions of others. By making improvements to the entire perimeter of the levee, either plan provides as complete a system of flood risk management to the basin as can be done without including levee height increases. While the plans still have a residual risk due to overtopping, they support the goal of reducing risk to critical infrastructure, including that necessary for an emergency evacuation.

With the variance obtained by CVFPB and SAFCA for this post authorization change report regarding the removal of waterside vegetation, the Adjacent Levee Alternative (Plan 4) is more complete than the Fix In-place Alternative (Plan 3) because of the impacts to special status species. While mitigation costs were determined for the Fix In-Place Alternative, these costs are a proxy since consultation under the Endangered Species Act would probably result in a jeopardy opinion. In the opinion, the Adjacent Levee Alternative could well be identified as a reasonable and prudent alternative.

(2) Effectiveness. Each of the plans provides contributions to the planning objectives. Effectiveness is defined as a measure of the extent to which a plan achieves its objectives. Each of the plans is similarly effective in meeting the planning objectives, as measured by the average annual benefits and annual exceedance probabilities.

(3) Efficiency. Efficiency is a measure of the cost effectiveness of the plan expressed in net benefits. Based on the comparison of net NED benefits and benefit to cost ratios, the Adjacent Levee Alternative is more efficient than the Fix In-Place Alternative.

(4) Acceptability. The plans in the final array are both formulated to meet Federal law and policy. However, the Fix In-Place Alternative is less acceptable because of its conflicts with special status species. The comparison of acceptability is also defined as acceptance of the plan to the local sponsor and the concerned public. Because of the environmental impacts associated with the removal of waterside vegetation with their accompanying public and resource agency concerns, as well as issues related to the relocation of the Garden Highway, the Fix In-Place Alternative is much less acceptable than the Adjacent Levee Alternative.

f. Trade-off Analysis. Based on the comparison of the alternatives, Plan 4 has greater NED benefits than Plan 3, and has significantly fewer adverse environmental impacts. The Adjacent Levee Alternative (Plan 4) meets all of the formulation criteria better than the Fix In-Place Alternative (Plan 3).

3-7. PLAN SELECTION

a. Federally Supportable Plan. Because the non-Federal interests have initiated implementation of the NLIP, it is necessary for this Interim General Reevaluation Report to

determine a Federally Supportable Plan. This is the plan that would be implemented by the Corps if the non-Federal interests had not initiated implementation of the project. The Federally supportable Plan establishes a limit on Federal participation in the recommended reauthorization. As determined in Section 3-5.f. above, the Federally Supportable Plan has a scope that encompasses the entire perimeter of the Natomas Basin and reasonably maximizes net benefits without levee raises. This plan is deemed the NED plan for this interim document.

As Plan 4, the Adjacent Levee Alternative, is the most cost effective plan and meets other planning criteria, it forms the basis for the Federally Supportable Plan. The Adjacent Levee Alternative was carried forward for additional design activities that are required for the development of detailed cost estimates. In the cost estimates for the initial array of alternatives, the differences in the screening level costs for Reach E in the Adjacent Levee Alternative and the Fix In-Place Alternatives are well within the range of contingencies. The differences in the costs were a trade-off between road reconstruction costs and the costs of fill material and real estate. The assumption for the Adjacent Levee alternative was that road reconstruction would not be required. In further development of the designs, however, it was determined that construction activities would require reconstruction of the road. In addition, the smaller construction footprint minimizes the real estate that would have to be acquired through the condemnation process, a process that would be expected to be lengthy. Since the alternatives in these reaches are neutral with respect to vegetation impacts, impacts to special status species and impacts to the Garden Highway, it became the engineers' choice to include fix in-place repairs for Reach E as a part of the Adjacent Levee Alternative. These decisions may be revisited in Value Engineering studies during the design phase of the project.

The formulation of the array of alternatives is hypothetical since it does not include the early implementation by the non-Federal interests. Therefore, to determine the plan that could actually be implemented, the plan is modified to reflect that early implementation by non-Federal interests has been taking place.

Follow-on studies will reexamine the inclusion of levee raises once the uncertainties in the hydraulic modeling.

b. Recommended Plan. The recommended plan is the Federally Supportable Plan, defined as the NED plan. This is the Adjacent Levee Alternative that does not include levee raising. The plan includes features for improving the perimeter levee system around the Natomas Basin.

c. Basis for Crediting. Credit for features constructed by non-Federal interests are limited to either the costs saved by the Corps in implementing the Federally Supportable Plan or the actual expenditures by the non-Federal interests in support of a plan that provides the same level of outputs. The Recommended Plan serves as the basis for crediting. The basis of credit will be based on the non-Federal costs that are included in the detailed cost estimates prepared using the Corps' Micro-Computer Aided Cost Estimating System (MCACES) described below in Section 4-9.

d. Basis for Federal Cost Sharing. Federal cost sharing is limited by the Federal cost of the Federally Supportable Plan. This cost apportionment will be based on detailed MCACES cost estimates described below in Section 4-9.

3-8. MITIGATION

Project mitigation needs have been coordinated with U.S. Fish and Wildlife Service (FWS), National Marine Fisheries Service (NMFS), and the California Department of Fish and Game (DFG) over the past four years as the Natomas Levee Improvement Program Landside Improvement Project (NLIP) has gone through the 408/404 permit process. During the previous three phases of the project, project-induced impacts have been sufficiently compensated for through Section 7 Consultation at the Federal level and the 2081 Permit at the State level. No additional compensation was recommended under the Fish and Wildlife Coordination Act. Although Federal agencies are not required to mitigate for State listed species, mitigation for these species is required for species that are also Federally listed (e.g., fish, giant garter snake) or as recommended under the Fish and Wildlife Coordination Act. The non-Federal sponsor is required to comply with California Endangered Species Act and these compliance measures are included as part of the project. While in the process of coordinating the project, steps were taken to avoid, minimize, reduce, and compensate for impacts to endangered species. Compensatory mitigation was first evaluated within the project area, and if these steps were not sufficient, mitigation banks were then considered.

In 1997 the Natomas Basin Habitat Conservation Plan (NBHCP) was approved under Section 10 of the Endangered Species Act by FWS and Section 2081 of the California Fish and Game Code by DFG. The NBHCP established a multiple-species conservation program for the Natomas Basin that is managed by the Natomas Basin Conservancy (Conservancy), a private, non-profit organization that serves as "plan operator" of theNBHCP. To avoid conflict with NBHCP lands, the resource agencies requested that the project be coordinated with the Conservancy. In the Programmatic Biological Opinion for the project, FWS analyzed the cumulative effects of the project on the NBHCP, specifically stating that "while SAFCA is not a signatory to the NBHCP, the plan sets forth a regional conservation strategy that covers the entire basin. The NBHCP's efficacy in maintaining a viable population of giant garter snakes in the Basin depends, in a significant part, on the retention of a sufficient amount of undeveloped acreage throughout the Basin, to … provide habitat for all 22 of the NBHCP covered species, including the giant garter snake [and Swainson's hawk]." Another purpose of this coordination was to enhance the existing lands under jurisdiction of the NBHCP and increase connectivity between core habitat reserves that are distributed throughout the Basin.

Overall, the project is an opportunity to employ a landscape-scale vision, helping to advance the goals and objectives of the NBHCP. Rather than a piecemeal approach to habitat protection, the project secures and expands the amount of habitat protection in the Basin, establishes the components that tie the NBHCP preserves and disparate mitigation sites together in perpetuity under public ownership, and increases the quality and viability of this area. The following goals were considered when developing the mitigation plan:

- Increase the amount of protected habitat;
- Expand and consolidate the protected habitat in the Natomas Basin;
- Strengthen connectivity between the NBHCP reserves;
- Avoid significant habitat impacts, particularly to Swainson's hawks and special-status fish, through careful project design and construction phasing;
- Develop a mitigation and monitoring plan and a long-term management plan; and,

- Utilize disturbed area to mitigate impacts.

The Natomas Basin is a unique ecological system separated from other systems by a circular levee system. Regional watershed boundaries, such as found in the Natomas Basin, may act as partial gene flow barriers (Paquin *et al*. 2006), resulting in defined population sets with unique adaptive characteristics. Biologists are conducting population dynamics studies of the giant garter snake in the Middle-American Basin, which lies north of the Natomas Cross Canal (NCC) (Hansen 2003, 2004). However, no snakes have been found to move within or across the NCC itself, suggesting that snakes are not moving between the middle-American Basin and the Natomas Basin. If the NCC represents a barrier to movement within the greater American Basin, then giant garter snakes may be present in two separate and genetically isolated sub-populations, requiring separate conservation and management

a. Habitat Creation and Management.

(1) New GGS Canal. All of the habitat being created for GGS is required as part of the Section 7 Consultation under the U.S. Fish and Wildlife Endangered Species Act. The new GGS Canal would provide connectivity of aquatic habitat in the northern basin and the southern basin and to managed marsh lands and rice fields. The GGS canal will also function as a movement corridor for the snake to areas that have been isolated from larger habitat areas. This connectivity increases habitat values for the snake and makes the entire system more functional as water will flow through areas instead of standing areas.

The material excavated to create the new GGS canal will be used to construct the adjacent levee and will be completed prior to filling of the existing canal habitat. This construction sequencing prevents any temporal loss of habitat for the snake and is therefore, considered an in-kind replacement of the old habitat. The new canal will also be maintained for the sole purpose of habitat for the GGS which will increase the value from the current canal, which is operated as an irrigation canal.

(2) Managed Marsh Creation and Rice Preservation. Several soil borrow sites would be finished graded and planted with native riparian and marsh vegetation after the completion of borrow activities to create managed seasonal and perennial marsh habitat that would benefit the GGS. Design of the marshes would follow the templates established by NBHCP. These design templates feature a combination of uplands and shallow water bodies sinuosity of swales, and good water control structures to manage precise water levels at different times of the year. Marsh design and management would optimize the value of GGS habitat but minimize the attraction to wildlife species considered to be potentially hazardous to aircraft at low elevations approaching or departing from runways. An essential component of the managed marshes would be procurement of a firm, reliable water supply and good water quality throughout the GGS active season of April-October. Many marsh areas would be created adjacent to existing NBHCP marsh preserves, thereby providing for greater contiguous management areas and enhancing the overall habitat value of the adjacent preserves.

Large areas of property obtained for the project will also be retained in rice cultivation through an arrangement with a grower or TNBC. Rice fields have become important habitat for GGS, particularly associated canals and their banks for both spring and summer active behavior

and winter hibernation. While within the rice fields, snakes forage in the shallow water for prey, utilizing rice plants and vegetated berms dividing rice checks for shelter and basking sites.

(3) Managed Grasslands. Managed Grasslands provided foraging habitat for Swainson's hawk (State listed species). The proposed levee improvements would result in landside slopes that are less steep than the existing slopes, and several reaches of the Sacramento River east levee would have adjoining 100- to 300-foot-wide earthen seepage berms with nearly flat slope. Grasslands not on levee slopes include those borrow sites on the airport bufferlands, which will be designed to prevent water from ponding which could attract waterfowl, and other borrow sites off airport bufferlands restored to alfalfa. The alfalfa grassland sites would be managed under agreement with TNBC. The primary management objective on managed grasslands on airport lands would be to reduce hazardous wildlife populations to the extent necessary to comply with Title 14, part 139 of the Code of Federal Regulations and FAA advisory circulars that address hazardous wildlife. While the grasslands provide habitat for the Swainson's hawk many are also an incidental benefit of the slopes, berms, and compliance with the CFR and FAA advisory.

(4) Woodlands. As part of the Fish and Wildlife Coordination Act Report (CAR) woodlands consisting of native species would be established at several sites as a component of the proposed project. These woodlands will provide habitat for Swainson's hawk as well as several birds protected under the Migratory Bird Treaty Act.

Groves would be established throughout the project areas. Groves would generally be at least 50 feet wide and several 100 feet long, depending on location constraints. Portions of the created woodlands would be at least 100 feet wide or wider to promote successful nesting birds deeper within the grove canopy, where next parasitism by crows, cowbirds, and starlings is less of a factor in breeding success.

(5) Valley Elderberry Longhorn Beetle. The valley elderberry longhorn beetle is a Federally listed endangered species, protected under the Endangered Species Act. The species is nearly always found on or close to its host plant, elderberry shrub. Many of the shrubs are found throughout the project area. The preferred conservation measure for these shrubs is to transplant them and plant additional seedlings along with associated native plants. All elderberry shrubs located within the project area will be transplanted to the woodland groves or corridor. Additional seedlings will be planted along with the transplants and the woodlands will provide the associated native requirement. This method of planting will meet two requirements; compliance with Biological Opinion and compensation recommended in the CAR for woodlands.

(6) Shaded Riverine Aquatic Habitat (SRA). SRA habitat is defined as nearshore aquatic habitat occurring at the interface between a river and adjacent wood riparian habitat. The principal attributes of this cover are: (1) an adjacent bank composed of natural, eroding substrate supporting riparian vegetation that either overhang or protrude into the water; and (2) water that contains variable amounts of woody debris, such as leaves, logs, branches, and roots and has variable depths, velocities, and currents. Riparian habitat provides structure (through SRA habitat) and food for fish species. Shade decreases water temperatures, while low overhanging branches can provide sources of food by attracting terrestrial insects. As riparian areas mature, the vegetation sloughs off into the rivers, creating structurally complex habitat consisting of large woody debris that furnishes refugia from predators, creates higher water velocities, and provides

habitat for aquatic invertebrates. For these reasons, many fish species are attracted to SRA habitat.

b. Environmental Considerations of Alternatives. The Adjacent Levee alternative was designed to avoid impacts to shaded riverine aquatic (SRA) habitat along the Sacramento River. The SRA is habitat for many State- and Federally-listed fish species and State-listed Swainson's Hawk. Removal of waterside vegetation under the Fix-in-Place alternative would require mitigation under Section 7 Consultation with NMFS. Construction of the adjacent levee allows waterside vegetation to remains due to the shift landward of the levee prism.

Mitigation for the Fix-in-Place and Adjacent Levee alternatives are very similar, with the exception of loss of riparian habitat due to the removal of waterside trees required under the Fix-in-Place alternative. This is because the Fix-in-Place alternative would require the replacement of the Garden Highway on top of the levee being brought up to current road standards. The new standards require widening the existing Highway to about the same width as the adjacent levee.

During evaluation of borrow sites, consideration was given to using the sites for mitigation once the material was extracted. This allowed the project to be limited to one land purchase, eliminating the need to haul material from a commercial source into the basin. The sites were evaluated for quality of borrow material, proximity to TNBC lands, connectivity to other habitat, and proximity to placement location. The end result is that material is only handled once, borrow sites are used to mitigate for fish and wildlife impacts, air quality impacts are minimized, and the cost is reduced for the overall project.

c. Section 7 Consultation and Fish and Wildlife Coordination Act. A Biological Assessment has been prepared and coordinated with the resource agencies. Section 7 Consultation under the Endangered Species Act has been on-going as part of the Natomas Levee Improvement Program. A biological opinion will be obtained from both National Marine Fisheries Service and the U.S. Fish and Wildlife Service for this project and is scheduled for December 2010.

This project will be coordinated with the FWS under the Fish and Wildlife Coordination Act. It is anticipated that all mitigation covered under Federal and State endangered species consultation will also mitigate any impacts to fish and wildlife resources and no additional compliance with the biological opinion and 2081 permit would be required.

Early discussion with the U.S. Fish and Wildlife service indicated that compensation for effects to federally listed species would require replacement of any habitat lost due to project activities. Because the Natomas basin is an isolated basin which must function alone to provide habitat for the species, compensation would be based on an acre for acre replacement. Habitat for species includes aquatic and rice habitat, canals, and managed marsh.

Mitigation for woodlands was based on canopy cover lost and diameter of trees removed. The required amount of replacement acres is based on ratios of trees per acre that will result in a similar habitat that will be lost due to project construction. Shaded riverine aquatic habitat mitigation was based on linear footage of trees removed and temporal loss of habitat for endangered species.

Table 3-20 displays the impacts and mitigation proposed for the Fix-in-Place and Adjacent Levee Alternatives. This mitigation is what is currently in the Biological Assessment and has been coordinated with FWS, NMFS, and DFG.

Table 3-20. Natomas Basin Environmental Impacts and Proposed Mitigation

Alternative	Project Element (Habitat Type Impacted)	Impacted Acreage	Acres of Mitigation Needed
Adjacent Levee			
	Permanently Impacted Aquatic & Rice Habitats/ Managed Marsh	202	202
	Woodland (SWH)	104	234.7
	Upland Agriculture (SWH)	224.7	224.7
	Shaded Riverine Aquatic Habitat (ESA Fish Species)	8.3	25
	Lower GGS Canal	32.8	32.8
Fix-in-Place			
	Permanently Impacted Aquatic & Rice Habitats/ Managed Marsh	202	202
	Woodland (SWH)	103	267.8
	Upland Agriculture (SWH)	277	277
	Shaded Riverine Aquatic Habitat (ESA Fish Species)	42.84	128.52
	Lower GGS Canal	32.8	32.8

d. Cost Effectiveness/Incremental Cost (CE/ICA) Analysis Methods. A CE/ICA analysis was performed for mitigation of the project using IWR-Plan. Two analyses were completed; those that are required under the Biological Opinion and Incidental Take Permit under the Federal Endangered Species Act and those required under California Endangered Species Act and 2081 Permit. Costs are based on projected cost developed under the planning process using the Corps MCACES.

e. Endangered Species CE/ICA. Two plans were analyzed for the Federal Endangered Species; Plan A uses borrow sites as compensation lands for the GGS habitat, Plan B uses non-borrow lands for the compensation lands for GGS habitat. As can been seen on Table 3-20 the best buy plan is Plan A because it does not have the added cost of additional lands. Also construction of mitigation sites is lower because some of the design configuration is done during the borrow extraction process.

Consultation with FWS required the compensation of 202 acres of managed marsh habitat for the GGS. All of the habitat being created for the GGS is required as part of the

Section 7 Consultation under the U.S. Fish and Wildlife Endangered Species Act. Therefore, all of 202 acres of managed marsh are justified to comply with the Biological Opinion.

Additionally 33 acres of GGS canal are required to replace the existing canal and to mitigate for impacts to Waters of the U.S. under Section 404 of the Clean Water Act. While a ratio is not a mitigation process used for Section 7 Consultation, the impact to the GGS canal is an in-kind replacement and is being constructed prior to removal of the existing habitat. The canal will also result in the no net loss of waters of the U.S. If the project was not able to mitigate on-site or in-kind a mitigation bank would be required. After contacting several mitigation banks it was determined that the average cost per acre for GGS is $35,000 for a total cost of $8,225,000, for the 235 required acres. This cost far exceeds both Plan A or B.

Coordination with NMFS for the NLIP Phase 1-4a has resulted in a concurrence of not-likely to adversely affect listed fish species. Coordination was done for the outfall structures along the mainstem of the Sacramento River. This coordination determined that the outfall structures area were a required element of the project and that conservation measures for impacts to SRA in-kind was feasible. The outfall structures will remove approximately 8.3 acres of SRA habitat and the recommendations in the concurrence letter was to replace at a ratio of 3:1 if this cannot be done on-site. Since it has not been determined if the compensation can be accomplished on-site, a mitigation bank was used in the CE/ICA analysis. A total of 25 acres of SRA would be required at a mitigation bank, at $150,000 per acre for a total cost of $375,000. This cost is included in both Plans A and B.

To comply with the Biological Opinion, Concurrence letter from NMFS, and the Section 404 permit the incremental output must be 260 acres of combined managed marsh and GGS canal. If these acreages are not compensated for the project will be in violation of the Endangered Species Act.

Table 3-21. Best Buy Alternative for Federal Endangered Species

Alternative	Incremental Output (acres)	Incremental Cost Per Output ($1,000)	Total Output (acres)	Total Cost ($1000)
No Action	0.00	$0.00	0.00	$0.00
Plan A	260	$2,538.20	260	$659,930
Plan B	260	$3,304.87	260	$859,266

f. California Endangered Species Act and FWCA CE/ICA. The cost analysis for the State Listed species and FWCAR recommendations was completed for each reach of the project incrementally. The increments are as follows:

- Plan A – This would include 90 acres of grasslands created in Reach C
- Plan B – Plan A plus 60 acres of grasslands created in Reach B
- Plan C – Plan A and B, plus 50 acres of grasslands created in Reach A
- Plan D – Plan A - C, plus 24.7 additional acres of grassland created in Reach A
- Plan E – Plan A - D, plus 47.9 acres of woodlands created for impacts in Reach B
- Plan F – Plans A - E, plus 1 additional acre of woodlands impacts in Reach I

- Plan G – Plans A - F, plus 4 additional acres of woodlands impacts in Reach I
- Plan H – Plans A - G, plus 81.9 additional acres of woodlands created for impacts in Reach B
- Plan I – Plans A – H plus 51.2 acres of woodlands created for impacts in Reach A
- Plan J – Plans A - I plus 13.8 acres of woodlands for impacts in Reach I
- Plan K – Plans A – J plus 34.6 acres of woodlands created for impacts in Reach C
- Plan L – Plans A – K plus 1.7 acres of woodland created for impacts in Reach D

The cost of each increment is shown in Table 3-22. Costs are based on projected cost developed under the planning process using the Corps MCACES.

Table 3-22. Incremental Cost Analysis.

Alternative	Total Output (acres)	Total Cost ($1000)	Incremental Output (acres)	Incremental Cost ($1,000)	Incremental Cost Per Output ($1,000)	Total Output (acres)
No Action	0.00	$0.00	0.00	0.00	$0.00	0.00
Plan A	90	$181,058	90	$181,058	$2,011	90
Plan B	150	$302,718	60	$121,660	$2,018	150
Plan C	200	$404,943	50	$102,225	$2,024	200
Plan D	224.7	$455,445	24.7	$ 50,502	$2,026	224.7
Plan E	272.6	$608,596	47.9	$153,151	$2,232	272.6
Plan F	273.6	$611,959	1.0	$ 3,363	$2,236	273.6
Plan G	277.6	$625,546	4.0	$ 13,587	$2,253	277.6
Plan H	359.5	$904,134	81.9	$278,588	$2,514	359.5
Plan I	410.7	$1,078,311	51.2	$174,177	$2,625	410.7
Plan J	424.5	$1,125,262	13.8	$ 46,951	$2,650	424.5
Plan K	459.1	$1,264.691	34.6	$139,429	$2,754	459.1
Plan L	460.8	$1,271,560	1.7	$ 6,869	$2,759	460.8

Grasslands are created in either borrow areas or along the levee slopes and berms. Woodlands are proposed to be created in a linear stretch outside the levee vegetation free zone but within the acquired easement or in borrow areas. Woodlands are also proposed for areas within the Dry Creek floodplain where they would not impede capacity. The Dry Creek basin is currently owned by the non-Federal sponsor.

The acreage and cost of each plan were entered in the IWR-Plan software to generate mitigation alternatives and complete the CE/ICA analysis on the plans. The software identifies the cost effectiveness and incrementally justified, known as the Best Buy Plans.

Figure 3-4 displays the results of the CE/ICA analysis in graphic form. Of significance are three raises in the cost per increment. The first raise is between plans D and E. This is where the woodland compensation is added to the analysis. The second raise, which is not as significant, is between plans E and F, when the 1 acre of woodland for the Sacramento River east levee is added. The third significant raise is between Plans J and K. This is because Plans K and

L are small acreages for the same cost. When designing compensation – the smaller the acreage the higher the per acre cost becomes.

Although the cost of the last two increments may not have as much benefit, all of the increments are justified to comply with the FWCAR recommendations and the State Endangered Species Act.

g. CE/ICA Summary. Although some increments of the CE/ICA may not appear to be incrementally justified, all of the increments are required to comply with Endangered Species Act or recommended under the Coordination Act Report. The CAR does not recommend any additional mitigation beyond that required for in the Biological Opinion or for the 2081 Permit for take of State listed species.

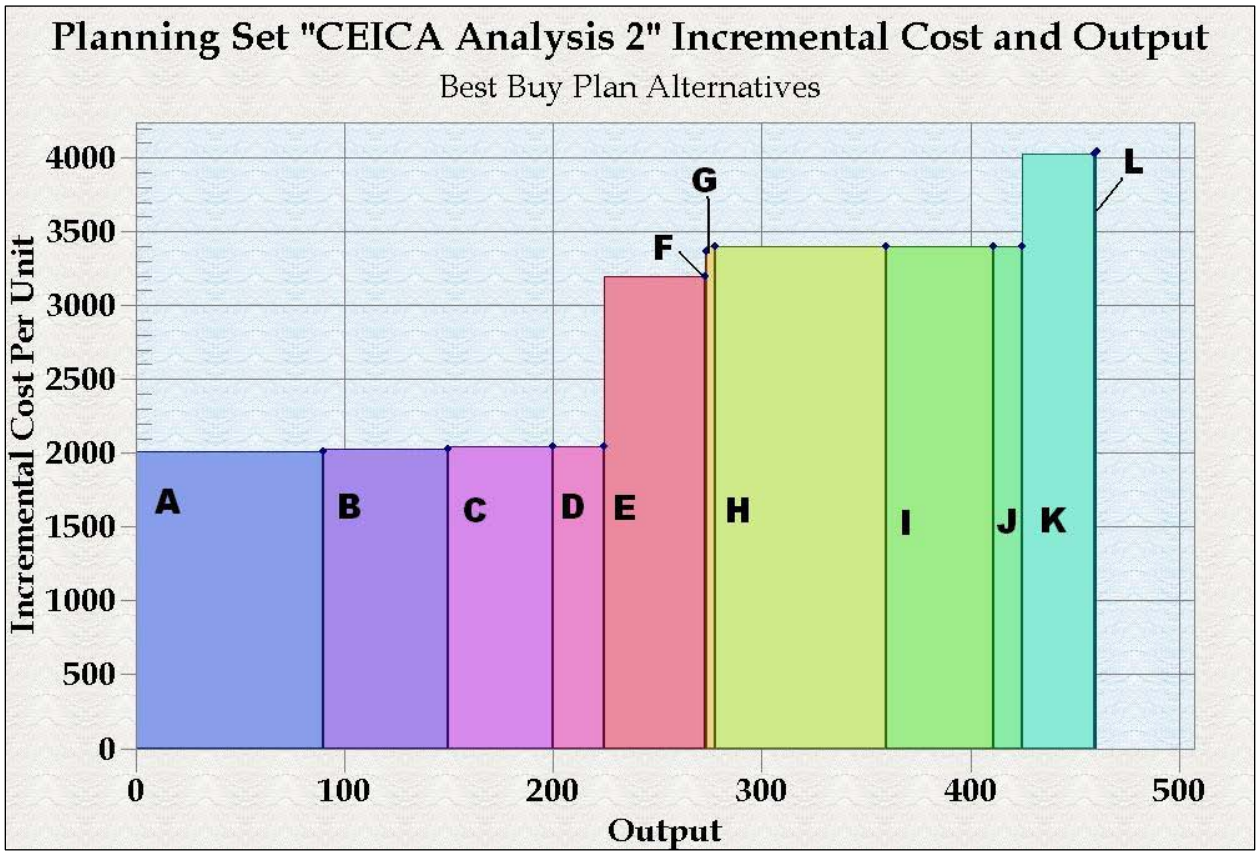


Figure 3-4. CE/ICA for State listed species and FWCA recommendations

h. Cultural Resources Mitigation. The USACE, SAFCA, and California State Historic Preservation Officer (SHPO) have entered into a Programmatic Agreement (PA) to define how consultation with the SHPO will be managed during the life of the project. The PA incorporates relevant standards and definitions from the Section 106 regulations. The PA requires that SAFCA and USACE define an area of potential effects (APE) and identify and evaluate cultural resources for eligibility for listing in the National Register of Historic Places (NRHP) before construction of each phase of the Project, rather than in a single inventory and evaluation effort. If historic properties would be adversely affected by the Project, SAFCA shall prepare a historic

properties treatment plan (HPTP) for review and approval by USACE and the SHPO. The project wide HPTP stipulates the actions to be taken by SAFCA to resolve adverse effects of the Project on Historic Properties. While not a signatory to the PA, John Tayaba of the Shingle Springs Rancheria and designated Most Likely Descendent (MLD) for the project, was consulted during preparation of the project wide HPTP. Identification of archaeological sites and mitigation of adverse effects to historic properties is ongoing and occurs with consultation between SAFCA, the SHPO, USACE, and the Shingle Springs Rancheria.

3-9. RISK AND UNCERTAINTY

Areas of risk and uncertainty are analyzed and described so that decisions can be made with knowledge of the degree of reliability of the estimated benefits and costs and of the effectiveness of the alternative plans.

Areas of risk and uncertainty are described in Table 3-23.

Table 3-23. Areas of Risk and Uncertainty

Areas of Concern	Risk	Potential Impact	Mitigation Measures
Model Uncertainty	Low	Possible misidentification of final array of alternatives	The measures recommended are needed no matter the levee height. Optimization of levee height can be done after hydraulic models are complete.
Implementation Delays	High	Reduction of flood risk is delayed; 80,000 residents and $7 billion in property remain at risk	Local sponsor has elected to begin implementation
Hazardous, Toxic, and Radioactive Waste	Moderate	Discovery of possible HTRW contamination on east side of basin could cause delays and added expense resulting from clean-up	In order to minimize the footprint of the levee on the east side, the fix in-place method was the engineers' choice.
Real Estate Acquisition	High	On the east side of the Basin, SAFCA has identified several unwilling sellers. Delays could result from litigation necessary to acquire these properties.	In order to minimize the footprint of the levee on the east side, the fix in-place method was the engineers' choice

a. Model Uncertainty. Hydraulic modeling for the Common Features Project continues to be under refinement. The model was has been developed using the NGVD '29 rather than the

NAVD ’88 datum. This results in additional uncertainty in the stage/frequency relationship. The topography from the Comprehensive Study is being used as the basis for the current hydraulic model. Review of recent ground control elevations has determined that the ground control for the Comprehensive Study topography is not exactly based upon the NGVD’29, as was originally thought. This is mainly due to the use of obsolete ground control elevations in areas of ground subsidence. Because of this, one cannot simply convert the Comprehensive topography from NGVD’29 to NAVD’88 using Vertcon (a National Geodetic Survey software tool for datum conversion) because the data was not relative to the NGVD’29 datum to begin with. Analysis shows that Vertcon typically over-predicts the conversion from the Comprehensive Study topography to NAVD’88. Without a hydraulic model that is fully corrected for the NAVD’88 datum, refinements of the model could, therefore, potentially affect the optimization of benefits associated with levee raising. Therefore, this levee raising cannot be confirmed to be in the Federal interest without additional hydraulic modeling efforts.

b. Implementation Delays. The Natomas Basin is subject to average annual damages in the amount of $462 million. Each year the project is delayed results in a loss of benefits. Any differences in evaluation resulting from risks and uncertainties in the analysis are insignificant when compared with the benefits lost associated with delay.

c. Hazardous, Toxic, and Radioactive Waste. Phase I Environmental Site Assessments (ESAs) were conducted on several parcels within the project area. In Reaches E and F, pesticides and herbicides may persist in the soil, and asbestos-containing pipelines may exist on the sites, because the much of the area was historically used for agricultural purposes. In order to lessen the risk of encountering HTRW in these reaches, the engineers’ choice was to minimize the levee footprint by utilizing the fix in-place alternative.

d. Real Estate Acquisition. On the east side of the Basin, SAFCA has identified several unwilling sellers of the real estate necessary to implement an adjacent levee plan. If this were to be the selected plan in this area, delays could result from litigation necessary to acquire these properties. In order to mitigate the risk associated with the potential delays due to condemnation procedures, the fix in-place alternative was the engineers’ choice.

This page left intentionally blank.

CHAPTER 4 - THE SELECTED PLAN FOR THE NATOMAS BASIN

This chapter provides details on the selected plan and its implementation requirements. The chapter integrates the revaluated Natomas Basin portion of the Common Features Project with the previously authorized and constructed portions of the project.

4-1. DESCRIPTION OF THE SELECTED PLAN

a. Plan Components. In addition to the features included in the 1996 and 1999 authorizations, the selected plan includes the additional features to complete the plan for flood risk management to the Natomas Basin. The principal features of this plan are: (1) seepage remediation and embankment stabilization along the NCC south levee, the Sacramento River east levee, the PGCC and the southern portion of the NEMDC west levees. including construction of an adjacent levee adjoining the Sacramento River east levee; (2) agricultural irrigation and drainage improvements, including construction of a new GGS/Drainage Canal; (3) habitat creation and management in connection with project borrow activities; (4) aviation safety components, including relocation of irrigation and drainage infrastructure in the Airport Operation Area and grading of the Airport's northern bufferlands to improve surface drainage and reduce the risk of bird strikes; and (5) right-of-way acquisition to facilitate long-term operation and maintenance activities.

The modifications to existing interior drainage facilities have been limited to bringing the facilities in compliance with Corps criteria for penetrations through levees (upgrading discharge lines, pumps, etc. to raise the drainage over the top of levee). No assessment of the capacity of existing facilities to address the residual flooding from interior runoff was accomplished. The interior drainage plan of the Natomas Basin was developed by the City of Sacramento and is documented in the "Natomas Comprehensive Drainage Plan Conditional Letter of Map Revision", May 1997. Therein, it lays out the plan to keep the urban areas of the Natomas Basin out of the 100-yr floodplain. Beyond the 100-yr event, residual flooding from the exterior sources would cause much more significant flooding than interior residual flooding. Residual flooding from both interior and exterior sources will be will be considered further under the GRR as additional increments.

In April 2010, CVFPB applied for a variance to the vegetation requirements contained in Engineering Technical Letter 1110-2-571 in order to implement the selected plan. On June 17, 2010, the Corps' Levee Safety Officer at the Directorate of Civil Works at HQUSACE approved a vegetation variance request for the Common Features (Natomas Basin) Project Post Authorization Change Report. The variance is in Appendix I.

b. Project Reaches and Basic Levee Improvements. As indicated in Paragraph 2-4 (h), Summary of Levee Problems by Reach in the Natomas Basin, the Corps divided the levee system around the Basin into nine reaches. These reaches were then used to develop the alternatives in Chapter 3. These reaches are again used to help in describing the selected plan.

These reaches are specifically defined in the paragraphs that follow, along with the basic levee improvements that are proposed for each reach.

- Reach A: Sacramento River east levee from Interstate Highway 5 up to San Juan Road. The length of this reach is approximately 3.8 miles. The general improvements include widening the existing levee a minimum of 15 feet through construction of an adjacent levee and installation of approximately 3.4 miles of soil bentonite cutoff wall with a depth of 103.5 feet.
- Reach B: Sacramento River east levee from San Juan Road up to Elverta Road. The length of this reach is approximately 9.5 miles. The general improvements include widening the existing levee by construction of an adjacent levee, installation of approximately 4.3 miles of a soil bentonite cutoff wall that ranges in depth between 40 and 115 feet, and installation of approximately 5.6 miles of seepage berms that range in width from 80 to 300 ft.
- Reach C: Sacramento River east levee from Elverta Road up to Sankey Road at the west end of the south levee of the Natomas Cross Canal (NCC). The length of this reach is approximately 5 miles. The general improvements include widening the existing levee by construction of an adjacent levee, installation of approximately 4.6 miles of soil bentonite cutoff wall that ranges in depth between 19 and 65 feet, and installation of approximately 2.7 miles of seepage berms that range in width from 100 to 500 ft.
- Reach D:Natomas Cross Canal south levee from Sankey Road up to Howsley Road. The length of this reach is approximately 5.5 miles. The general improvements include widening the existing levee by fix in place construction and installation of a soil bentonite cutoff wall that ranges in depth between 60 and 75 feet.
- Reach E: Pleasant Grove Creek Canal west levee from Howsley Road up to Sankey Road. The length of this reach is approximately 3.3 miles. The general improvements include widening the existing levee by fix in place construction and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet.
- Reach F: The Natomas East Main Drainage Canal (NEMDC) west levee from Sankey road down to Elverta Road. The length of this reach is approximately 4.7 miles. The general improvements include widening the existing levee by fix in place construction, installation of approximately 2.6 miles of soil bentonite cutoff wall with a depth of 53-feet, and flattening the landside levee slope.
- Reach G: The NEMDC west levee from Elverta Road down to the pumping station just upstream of Dry Creek. The length of the reach is approximately 3.6 miles. The general improvements include improving the levee by fix in place construction and installation of a soil bentonite cutoff wall.
- Reach H: The NEMDC west levee from the pumping station just upstream of Dry Creek down to Northgate Boulevard. The length of this reach is approximately 4.5 miles. The general improvements include improving the existing levee by fix in place construction and installation of a soil bentonite cutoff wall with a depth of 41 feet.
- Reach I: The American River north levee from Northgate Boulevard down to interstate Highway 5. The length of this reach is approximately 1.8 miles. The general improvements include improving the levee by fix in place construction and installation of a soil bentonite cutoff wall with a depth of 37 feet.

c. SAFCA Implementation of NLIP. SAFCA's NLIP plan includes raising levees in Natomas to meet the new state standard of 200-yr mean water surface plus three feet of freeboard. This is beyond the scope of the selected plan. The selected plan includes levee modifications to top of the existing levee. The SAFCA design is considered a conservative design for a number of reasons. First, the design assumes no upstream levee failures. This results in more flow downstream in the project area than may actually occur during a flood event and consequently results in a higher levee design. Second, at the upstream end of the Natomas Basin sits the Fremont Weir, an uncontrolled weir. The weir acts as a regulator to the flow coming from the upper part of the system. What this means is that larger flood events do not necessarily translate into larger floods in the Natomas Basin because flow is diverted before it gets to the basin. This creates a practical limit to raising the Natomas levees. Third, previous risk and uncertainty analyses have shown that in order to achieve a 90% conditional non-exceedence probability (assurance) for the 0.5% (200-yr event), less than three feet of freeboard is required, a result of the action of the Fremont Weir discussed above.

While SAFCA's NLIP plan includes raising the levee, the raise increment is not included in the Recommended Plan. Therefore, the costs of the additional work undertaken by SAFCA are not included in the amount to be cost shared. As part of the upcoming Common Features GRR, the levee raise increment will be evaluated to determine the federal interest. Regardless of the outcome of that study (whether the Corps plan calls for a shorter or higher levee than the SAFCA plan), the plan actually being put in place is the SAFCA plan. The Corps study will serve to recommend what share of the SAFCA project the federal government will participate in. Figure 4-1 below shows the levee cross-section, and what part of it is constitutes the Recommended Plan, and what part is not included in it.

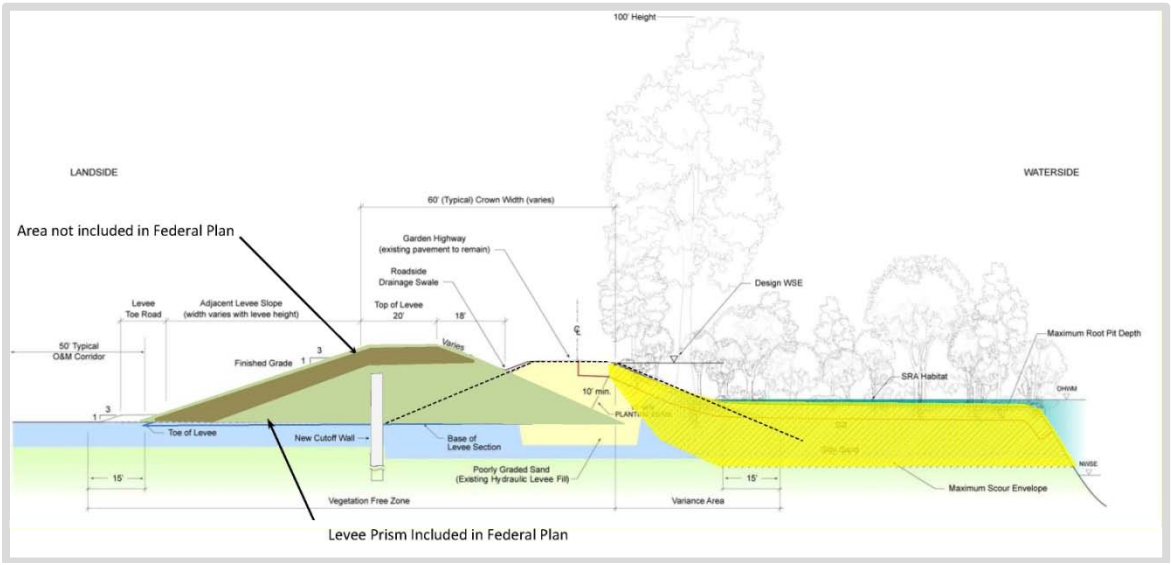


Figure 4-1. Levee Cross-Section Showing Federal Plan

NLIP plan components are being developed in phases. The first phases, 1through 4a, are being implemented by SAFCA as portions of the NLIP with approval by the Corps in accordance with Section 408. The description below does not include the raises being implemented by

SAFCA. However, a full description of SAFCA's planned work can be found in the FEIS/EIR.

Table 4-1 depicts how Reaches A through I, as described in Section 4-1.b., correspond and compare with the different phases of the NLIP.

Table 4-1. Comparison between Corps Reaches and NLIP Phases

Reach	NLIP Phase(s)	NLIP Phase Descriptions
Reach A	4b	3.4 miles of Phase 4b along the Sacramento River East Levee (SREL) and 0.4 miles of Phase 4b along the American River
Reach B	3, 4a	4.2 miles of Phase 3 along the SREL and 5.3 miles of Phase 4a along the SREL
Reach C	2, 3	0.6 miles of Phase 2 along the SREL (1), 3.7 miles of Phase 2 along the SREL (1B), and 0.7 miles of Phase 3 along the SREL
Reach D	1, 2, 3	1.8 miles of Phase 1 along the Natomas Cross Canal (NCC), 5.0 miles of Phase 2 along the NCC, and 0.5 miles of Phase 3 along the NCC
Reach E	4b	3.2 miles of Phase 4b along the Pleasant Grove Creek Canal (PGCC)
Reach F	4b	4.7 miles of Phase 4b along the Natomas East Main Drain Canal (NEMDC)
Reach G	4b	3.6 miles of Phase 4b along the Natomas East Main Drain Canal (NEMDC)
Reach H	4b	4.5 miles of Phase 4b along the Natomas East Main Drainage Canal (NEMDC) South
Reach I	4b	2.0 miles of Phase 4b along the American River

All mile lengths are approximated.

(1) Phase 1 Project Features, Construction complete.

Phase 1 consists of levee improvements on approximately 1.8 miles along Reach D.

- Natomas Cross Canal south levee improvements (westernmost 12,500 feet). Construct a seepage cutoff wall along the centerline of the Natomas Cross Canal south levee in Reach D: (to overlap the Sacramento River east levee by approximately 500 feet) and reconstruct the levee.

(2) Phase 2 Project Features.

Phase 2 consists of levee improvements on approximately 4.3 miles along Reach C and approximately 5.0 miles along Reach D.

- Natomas Cross Canal south levee improvements: Realign the Natomas Cross Canal south levee to provide additional height and more stable waterside and landside slopes, and to reduce the need to remove waterside vegetation. Construct seepage cutoff walls through the levee crown

in Reach D.

- Sacramento River east levee: Construct an adjacent levee from the Natomas Cross Canal to the end of Reach C. Use a combination of cutoff walls, seepage berms, and relief wells for seepage remediation.

- Construction of a new Giant Garter Snake (GGS)/Drainage Canal between the North Drainage Canal and Elkhorn Reservoir (referred to as the "GGS/Drainage Canal") from the North Drainage Canal to the slough east of Elkhorn Reservoir.

- Relocation of the Elkhorn Canal (highline irrigation canal) between the North Drainage Canal and Elkhorn Reservoir for a length of 10,500 feet and several hundred feet east of the landside toe of the Sacramento River east levee.

- Modify and relocate the RD 1000 Pumping Plant No. 2 within the project footprint.

- Establish habitat features for giant garter snake in the new GGS/ Drainage Canal. Recontour and create managed marsh and grassland on lands used as borrow sources to offset project effects on giant garter snake and Swainson's hawk habitats. Establish grassland on the slopes of the adjacent levee and seepage berms. Install woodland plantings to offset the loss of portions of tree groves within the landside levee footprint.

- Realign and relocate irrigation and drainage canals and other infrastructure, such as utility poles, as needed to accommodate the flood damage reduction measures.

- Remove encroachments as required.

- Excavate earthen material at the borrow sites, then return the sites to preconstruction uses or suitable replacement habitat.

(3) Phase 3 Project Features.

Phase 3 consists of levee improvements on approximately 3.9 miles along Reach B, approximately 0.7 miles along Reach C, and approximately 0.5 miles along Reach D.

- Along the Sacramento River east levee in Reach B, construct an adjacent levee from just north of Elverta Road to just south of I-5. And, provide seepage remediation through the use of a hanging cutoff wall in some sub-reaches and a seepage berm in others.

- Along the Pleasant Grove Creek Canal west levee (Reach E), flatten and widen the levee slopes and construct hanging cutoff walls, to reduce seepage potential.

- Along the Natomas East Main Drainage Canal west levee from Elkhorn Boulevard to NEMDC Stormwater Pumping Station, widen and flatten the slopes of the existing levee and construct a cutoff wall to reduce seepage potential.

- Along the NEMDC west levee from NEMDC Stormwater Pumping Station to Northgate Boulevard, construct a cutoff wall in the existing levee and/or reconstruct portions of the levee where required to reduce seepage potential and slope instability.

- Relocate portions of the Elkhorn Canal downstream of Elkhorn Reservoir. Pipe approximately 9,400 feet of the canal between the new adjacent levee and Teal Bend Golf Club and in an area adjacent to the landside residential properties; and reconstruct the canal parallel to the adjacent levee at a distance of approximately 200 feet from the levee.

- Construct a new GGS/Drainage Canal downstream of Elkhorn Reservoir, designed to provide drainage and associated giant garter snake habitat between Elkhorn Reservoir and the West Drainage Canal at I-5.

- Establish habitat features for giant garter snake in the new GGS/Drainage Canal. Recontour and create managed marsh and grassland on lands used as borrow sources to offset project effects on giant garter snake and Swainson's hawk habitats. Establish grassland on the slopes of the adjacent levee and seepage berms. Install woodland plantings to offset the loss of portions of tree groves within the landside levee footprint.

- Realign and relocate irrigation and drainage canals and other infrastructure, such as utility poles, as needed to accommodate the flood damage reduction measures.

- Remove landside vegetation in along the Sacramento River east levee in improved areas.

- Remove encroachments as required.

- Excavate earthen material at the borrow sites and then return the sites to preconstruction uses or suitable replacement habitat.

- Modify irrigation distribution and agricultural drainage systems and infrastructure to allow for dewatering of the Airport West Ditch.

- Acquire right-of-way through fee title or easement interest within the footprint of the project features and at the borrow sites, and prevent encroachments into the flood damage reduction system.

(4) Phase 4a Project Features.

Phase 4a consists of levee improvements on approximately 5.9 miles along Reach B.

- Along the Sacramento River east levee construct an adjacent levee, with cutoff walls, seepage berms, and relief wells, where required, to reduce seepage potential.

- Install cutoff wall in the adjacent levee in a portion of the Sacramento River east levee to provide additional seepage remediation.

- At the Natomas Central Mutual Water Company (NCMWC) Bennett Pump Station and Northern Main Pump Station, flatten levee side slopes, install cutoff wall, and modify or replace the existing pumps and motors.

- Replace the South Lauppe Pump - remove the pump, intake, and support structure prior to initiation of a separate Corps project to construct bank protection at the site. Following completion of Corps' bank protection project, SAFCA would reconstruct the pump, intake, and support structure.

- Modify Private River Pumps – relocate discharge pipes and upgrade motors and pumps at nine private river pumps at NCC south levee and Sacramento River east levee to be compatible with levee improvements.

- Relocate and extend the Riverside Canal (highline irrigation canal) upstream of Powerline Road along the Sacramento River east levee; relocate the canal east of the adjacent levee, residences, and tree groves; and construct a piped section at the toe of the new adjacent levee.

- Modify the NCMWC Riverside Pumping Plant – relocate the pumping plant's discharge pipes to accommodate the levee design and modify or replace the plant's existing pumps and motors accordingly.

- Modify RD 1000 Pumping Plants Nos. 3 and 5 – Relocate the pumping plants' discharge pipes above the 200-year design water surface, extend the pipes to tie into existing discharge pipes within the waterside bench, replace or modify pumps and motors, and perform other seepage remediation, including relocating the landside stations away from the levee to accommodate the relocated discharge pipes.

- Replace agricultural wells outside the levee improvements and construct new wells to provide a water supply for habitat mitigation features.

- Excavate earthen material at the borrow sites and then return the sites to preconstruction uses or suitable replacement habitat. For the Phase 4a Project levee and canal improvements along the Sacramento River east levee, the Fisherman's Lake Borrow Area is anticipated to be the primary source of soil borrow material. However, additional borrow sites may be needed for Phase 4a Project work along the Sacramento River including the I-5 Borrow Area; the Elkhorn Borrow Area; South Sutter, LLC; Krumenacher; the Airport north bufferlands; and the Twin Rivers Unified School District stockpile site. For the Phase 4a Project construction on the NCC south levee, the Brookfield borrow site is anticipated to be the primary source of soil borrow material.

- Establish a habitat complex in the Fisherman's Lake Borrow Area (Fisherman's Lake Habitat Complex) through the creation of approximately 140 acres of agricultural upland habitat; establishment of perennial native grasses on levee slopes, seepage berms, and access and maintenance areas; creation of up to 120 acres of managed seasonal and perennial marsh; and establishment of woodlands consisting of native riparian and woodland species at locations along

the landside of the Sacramento River east levee.

- Realign and relocate private irrigation and drainage infrastructure (wells, pumps, canals, and pipes); and relocate utility infrastructure (power poles) as needed to accommodate the levee improvements and canal relocations.

- Acquire lands along the Sacramento River east levee, NCC south levee, and at associated borrow sites.

- Remove encroachments as required.

- Exchange properties between SAFCA and Sacramento County Airport System (SCAS) in Reaches C:4A and B:5B–6 of the Sacramento River east levee. SAFCA and SCAS would carry out a land exchange that would support expansion of Airport buffer lands along the eastern edge of the new Elkhorn Irrigation Canal and provide SAFCA additional habitat mitigation land along the upper portion of the Sacramento River east levee outside of the 10,000-foot Airport Critical Zone.

d. Corps Implementation of Phase 4b. The remaining project features to provide flood risk management to the Natomas Basin, Phase 4b, would be implemented by the Corps. This phase will include levee improvements on approximately 3.8 miles along Reach A, approximately 3.2 miles along Reach E, and approximately 4.5 miles along Reach H. Additionally, SCAFA will not be able to construct 2.1 miles out of the 5.9 miles of Sacramento River improvements included in Phase 4a. This portion will also be constructed by the Corps. This portion is included in Reach B.

- Sacramento River East Levee (Reach A): Construct an adjacent levee with a flattened landside slope and cutoff wall, where required, to reduce potential underseepage and seepage through the levee.

- Sacramento River East Levee (Reach B): Construct an adjacent levee with a flattened landside slope and cutoff wall, where required, to reduce potential underseepage and seepage through the levee.

- PGCC (Reach E) and NEMDC South (Reach H): Install a cutoff wall from Howsley Road to Sankey Road on the PGCC west levee. On the NEMDC South, install a cutoff wall, and flatten the slope for approximately 500 feet south of Elkhorn Boulevard.

- PGCC (Reach E) and NEMDC South (Reach H): Erosion repair and rock slope protection at locations where erosion around the outfall structures penetrating the levee has been observed. Construct additional remediation to protect against damage caused by beavers and burrowing animals.

- PGCC (Reach E): Upgrade or remove five culverts that currently drain the area east of the PGCC by passing water under the canal to drainage ditches along the landside of the PGCC west levee. Under the culvert removal option, construct detention basins east of the PGCC levee

to provide replacement storage for drainage. Depending on the design of the detention basins, pumping stations may be needed to discharge water out of the basins and into the PGCC. Installation of culverts under Pierce-Roberts drain, Pleasant Grove Creek, and Curry Creek may also be needed to interconnect drainage subbasins.

- SR 99 NCC Bridge Remediation (Reach D)—Construct a moveable barrier system or a stop log gap at the south end of the SR 99 bridges to be used at high river stages to prevent overflow from reaching the landside of the NCC south levee. Modify the bridge deck connections to the supporting piers and abutments as needed to resist uplift pressure during high water stages. Install additional seepage remediation consisting of seepage cutoff walls where the bridges cross the NCC south levee.

- Realign the West Drainage Canal to shift an approximately 1-mile portion, starting at I-5, to an alignment farther south of the Airport Operations Area. Modify the existing canal east of the alignment to reduce bank erosion and sloughing, decrease aquatic weed infiltration, improve RD 1000 maintenance access, and enhance giant garter snake habitat connectivity.

- Relocate and/or replace the discharge pipes for RD 1000 Pumping Plant Nos. 1A and 1B along the Sacramento River east levee and Pumping Plant Nos. 6 and 8 along the NEMDC west levee to cross the levee above the design flood elevation. Construct new outfall structures for Pumping Plant Nos. 6 and 8.

- Relocate and/or replace the discharge pipes for City Sump 160 (Sacramento River east levee), and City Sump 102 (NEMDC west levee at Gardenland Park).

- Excavate earthen material at the borrow sites and then return the sites to preconstruction uses or suitable replacement habitat. For levee improvements along the Sacramento River east levee and the American River north, the proposed South Fisherman's Lake Borrow Area and the West Lakeside School Site are anticipated to be the primary source of soil borrow material. The proposed Triangle Properties Borrow Area would be the primary source of borrow material for levee improvements along the PGCC. The Krumenacher borrow site and Twin Rivers Unified School District stockpile site would be the source of borrow material for improvements to NEMDC South.

- Enhance connectivity between northern and southern populations of giant garter snake in the Natomas Basin by improving habitat conditions along the West Drainage Canal; and establish woodlands consisting of native riparian and woodland species in the vicinity of the American River Parkway as compensation for woodland impacts along the Sacramento River east levee, PGCC and NEMDC; and create up to 200 acres of managed marsh from Brookfield Borrow Site to compensate for impact to giant garter snake habitat as a result of loss of rice from levee and canal improvements, and widen and extend the canal south of the borrow site to enhance delivery of surface water.

- Relocate and realign private irrigation and drainage infrastructure (wells, pumps, canals, and pipes) and water and sanitary sewer lines, and relocate utility infrastructure (power poles) as needed to accommodate the levee improvements and canal relocations.

- In Sacramento River east levee, and NEMDC South, clear landside vegetation to prepare for Phase 4b Project levee and canal improvement work. To comply with Corps vegetation guidance, all vegetation would be cleared at least 15 feet from the landside toes of the improved levees.

- Waterside vegetation would be removed due to erosion control measures and modifications to pumping plants along the Sacramento River east levee. At the I-5 crossing, some waterside vegetation may need to be cleared to accommodate levee improvements to the extent they would encroach on the American River Parkway. Along the west levee of NEMDC South north of the Arden-Garden Connector west levee south of the NEMDC Stormwater Pumping Station, at a minimum vegetation removal would be required for all non-native trees from within the vegetation-free zone, all native trees that have a diameter of four inches or less, and all larger native trees that are located in the upper third of the waterside slope, the crown, or within 15 feet of the landside toe (or within the right-of-way, if less than 15 feet).

- Bank protection would be constructed along the NEMDC South and PGCC to address the waterside erosion sites.

- Acquire lands within the Phase 4b Project footprint along the Sacramento River east levee, NEMDC west, PGG west levee, and at associated borrow sites.

- Remove encroachments as required.

4-2. DESIGN AND CONSTRUCTION CONSIDERATIONS

The adjacent levee design will retain adequate accessibility for maintenance, inspection, monitoring and flood fighting. The vegetation-free zone along the over-widened levee crown, landside levee slope and landside easement areas will provide unimpaired access to and visibility of these areas under all conditions and at all times for these purposes. The levee crown will contain the existing Garden Highway and a separate levee maintenance road that will facilitate rapid daytime or nighttime deployment of vehicles and personnel. The maintenance road in the easement area along the landside toe will provide additional capacity. The waterside slope and berm of the existing levee will be accessible from the Garden Highway for inspection during non-flood conditions.

The adjacent levee design will improve the safety, structural integrity and functionality of the existing levee by enlarging the levee in a landward direction to create a new adjacent levee section setback from the waterside slope of the levee. This adjacent levee section exclusive of the waterside shell will meet all Corps requirements related to stability, seepage and seismic considerations. It will thus provide the functionality and reliability of a traditionally designed vegetation-free levee, while preserving the historic benefits of the protective shell along the waterside slope and berm of the existing levee. These benefits include resistance to erosion from flows and wind driven waves in the river channel and stabilization of the waterside slope in the event of ground shaking or slippage.

For improvements to the Natomas Basin, specific design criteria have been developed by SAFCA in cooperation with the State, the Corps and an independent board of senior consultants for meeting developing conceptual designs, as well as future detailed designs. Specific design criteria are listed below.

a. Levee Crown Profile. For the recommended plan, levee raising is not recommended, and therefore, details of the profile are not critical. For the locally preferred plan, levee raising is proposed and therefore, a discussion of the levee crown profile is necessary.

In establishing the design levee crown profile, a freeboard of three feet above the 200-year design water surface elevation or the existing levee crown elevation profile (whichever is higher), was used by SAFCA. In all cases, this satisfied the additional one foot of freeboard above the 100-year water surface required by FEMA in certain areas. Wind and wave run-up and setup were evaluated and determined to be contained within freeboard. The 200-year design water surface elevations in the Natomas Basin were identified using hydrology and hydraulics developed in connection with the Comprehensive Study. UNET modeling runs were calibrated to high-water marks from the 1997 flood. These runs assumed that levees outside the Natomas Basin would be raised at least to the design height called for under the SRFCP ("1957 Profile") and that these levees would not fail when overtopped.

b. Seepage Gradients. For through-seepage and underseepage analyses, steady-state seepage conditions at the 200-year design water surface elevations were used. Corps criteria were used to determine maximum allowable hydraulic exit gradients. For an existing flood-tested levee or adjacent levee, a maximum upward hydraulic exit gradient of 0.5 at the landside levee toe was used. For new levees on untested foundations (e.g., for a setback levee) a maximum hydraulic exit gradient of 0.3 was used. For new and existing agricultural drainage ditches and canals, a maximum upward hydraulic exit gradient of 0.5 was used. Seepage berms were sized such that the hydraulic exit gradient at the landside toe of the berm was 0.8 or less, with a maximum width of 300 feet. The hydraulic gradient at the toe of the levee embankment was 0.5 or less.

c. Levee Geometry. The geometry of the existing levee was evaluated to verify that it meets the minimum Corps requirements of a 20-foot wide crown, a 3H:1V waterside slope, and a 3H:1V landside slope (preferred) or a 2H:1V (minimum allowable) landside slope.

d. Seismicity. Levees were assessed for their performance during an independent seismic event with a 200-year recurrence interval. Based on this assessment, each levee segment was assigned a risk of deformation rating of "low," "moderate," or "high." For reaches with "moderate" or "high" ratings, cutoff walls inserted through the centerline of the existing Sacramento River east levee were eliminated as a feasible levee improvement measure.

e. Vegetation. For modifications to the existing levee crown, it was assumed that vegetation larger than two inches in diameter would be removed from the top one-third of the waterside slope, the crown, and the landside slope (including a landside 15-foot maintenance access corridor). For an adjacent levee, vegetation larger than two inches in diameter would be

removed from the crown and the landside slope, including at least a 15-foot maintenance access corridor.

4-3. EVALUATION OF BORROW SITES

a. Potential Sources of Borrow. The demand for borrow material will create several opportunities for incorporating measures into the project that address identified agricultural irrigation and drainage, habitat conservation, and aviation safety opportunities in the Natomas Basin. Potential sources of borrow were identified in light of these opportunities.

(1) Borrow Site Selection Criteria. The principal considerations in the selection of borrow area sites were; 1) suitability of the soil as levee construction material; 2) proximity to construction areas; and, 3) potential to contribute to multiple project objectives. The use of borrow sites near the construction areas would contribute to the efficiency and acceptability of the selected plan by shortening hauling distances and avoiding use of major roadways, thereby reducing the costs and environmental effects (transportation and air quality) of project construction activities. For borrow sites within approximately one mile of the point of use, scrapers rather than trucks may be used in some instances to move soil material from a borrow site to a construction area, thereby reducing the amount of material handling required and further reducing associated construction costs and air pollutant emissions. The use of borrow sites that could be graded and preserved as habitat areas or graded for improved surface drainage would increase the acceptability of the early implementation project by providing incidental environmental benefits and contributions to aviation safety.

(2) Qualifying Lands. Based on these site selection criteria, the following lands in the Natomas Basin were identified as likely sources of soil borrow:

(a) Airport Bufferland Parcels. Sacramento County Airport System owns approximately 3,000 acres of bufferlands in the western portion of the Natomas Basin. Agricultural leases on these lands have not been renewed in recent years in order to reduce their attraction to birds and lower the risk of collisions between birds and aircraft. A portion of these lands (approximately 600 to 700 acres) located north of the Airport Operations Area in the vicinity of Elverta Road have been identified as a potential borrow source. These lands were selected because of their proximity to the construction areas along the Sacramento River east levee and because their use as borrow sites could include a reclamation strategy that would improve surface drainage of the area, limit the extent and duration of standing water on the land following rain storms, and further reduce the attraction of the area to water fowl and other birds.

(b) Private Rice Lands. There are several privately owned parcels in the northern portion of the Natomas Basin around Fisherman's Lake in the southern portion of the Basin, and in the triangle area northeast of the Basin that have been used for rice cultivation. These lands were identified as a potential borrow source because of their proximity to the construction areas along the Sacramento River east levee, the NCC south levee, and the PGCC west levee and because their use as a borrow source with appropriate reclamation would facilitate preservation and/or creation of high-quality aquatic habitat for giant garter snake use.

(c) Private Field Crop Land. There are several privately owned parcels in the western portion of the Natomas Basin south of the Teal Bend Golf Club and around Fisherman's Lake that have historically been used for field crop production. These lands were identified as a potential borrow source because of their proximity to the construction areas along the Sacramento River east levee and because their use as a borrow source with appropriate reclamation would facilitate preservation and/or creation of high-quality upland foraging habitat for Swainson's hawk.

(d) Lands Used to Relocate Irrigation and Drainage Infrastructure. To accommodate levee slope flattening or adjacent levee construction along the Sacramento River east levee, the Elkhorn and Riverside Canals must be relocated. Because these irrigation canals provide potential giant garter snake habitat, their relocation could result in temporal losses of habitat value. Relocating these highline canals will require substantial amounts of borrow material for confinement of the new canals. This material could be provided through excavation and construction of a new drainage canal in the vicinity of the relocated irrigation canals. The new drainage canal would be designed and managed to serve as a dispersal corridor for giant garter snakes by connecting TNBC lands located along the existing West Drainage Canal near Fisherman's Lake with TNBC lands located along the existing North Drainage Canal north of the Airport. The new drainage canal would also facilitate dewatering and filling of the Airport West Ditch, a drainage and irrigation facility that currently runs through the Airport Operations Area. This facility has been identified as a potential wildlife attractant and a hazard to aircraft using the nearby runway. The lower portion of the new drainage canal (south of the Teal Bend Golf Club) could replace the West Ditch's irrigation and drainage functions, while the upper portion of the new canal (north of the Golf Club) could offset the loss of habitat value that would result from dewatering and filling the West Ditch.

b. Findings. Based on these preferences, the following borrow sources (as shown in Plate 14) have been identified for constructing the early implementation project:

(1) Brookfield Property. This private land located east of State Route 99 and north of Sankey Road was historically devoted to rice cultivation. Material removed from approximately 200 acres of this land has been used to improve the NCC south levee and a portion of the Sacramento River east levee in 2009. After removal and stockpiling of topsoil, the land was graded to obtain borrow material. Upon completion of this operation, the topsoil was re-deposited and the land is being reclaimed to a managed marsh and preserved in perpetuity as compensation for project impacts to giant garter snake habitat.

(2) Airport Northern Bufferlands. These lands, comprising approximately 600 to 700 acres, are located north of the Airport Operations Area, and are expected to provide soil for use along the upper and middle reaches of the Sacramento River east levee in 2010. After the removal of borrow material, the area will be graded to improve storm water drainage into the surrounding RD 1000 collection system so as to meet applicable FAA drainage standards, limit the standing water on the land following rain storms that might otherwise serve as an attractant to water fowl, and lower the risk of collisions between aircraft and these birds.

(3) South Sutter LLC. South Sutter LLC is a owned field crop land in the western portion of the Natomas Basin south of the Teal Bend Golf Club. Approximately 80 acres of the site have been identified as a suitable sources of borrow material for use in the reaches of the Sacramento River east levee south of the Airport. The borrow operation would involve removal and stockpiling of topsoil, shallow grading to obtain borrow material, re-deposition of the topsoil, reclamation of the borrow area to field crop production, and preservation of the land in perpetuity as compensation for project impacts to upland foraging habitat for Swainson's hawk.

(4) Lands Acquired for GGS/Drainage Canal Construction. Soil material excavated from the lands in the new drainage canal alignment would be suitable for constructing the berms that would confine the relocated Elkhorn and Riverside Canals. After the removal of borrow material, the new drainage canal would be reclaimed to create high quality aquatic habitat and managed as a giant garter snake dispersal corridor that would serve in part to offset the impacts associated with the irrigation canal relocations and the abandonment of the Airport West Ditch.

(5) Land in the Fisherman's Lake Area. The Fisherman's Lake Area adjacent to the Sacramento River east levee south of Powerline Road is the site of a major block of TNBC land comprising over 250 acres of managed marsh and upland habitat. Soil material could be excavated from an additional 280 acres of private land in this area for use in improving the Sacramento River east levee between Interstate 5 and Powerline Road. Upon completion of the borrow operation, the land would be reclaimed to a combination of managed marsh and uplands that would be consolidated with the existing TNBC land and managed in perpetuity as compensation for project impacts to giant garter snake and Swainson's hawk habitat.

(6) Land South of the Fisherman's Lake Area. Several privately owned field crop lands totaling approximately 400 acres located south of Fisherman's Lake and west of El Centro Road have been identified as suitable sources of borrow material for use in improving the Sacramento River east levee south of Powerline Road. The borrow operation would involve removal and stockpiling of topsoil, shallow grading to obtain borrow material, re-deposition of the topsoil, and reclamation of the borrow area to field crop production.

(7) Land in the Triangle Area. Several privately owned rice crop lands totaling approximately 400 acres located in the triangle area east of the PGCC have been identified as suitable sources of borrow material for use in improving the PGCC west levee and the NEMDC west levee. The borrow operation would involve removal and stockpiling of topsoil, shallow grading to obtain borrow material, re-deposition of the topsoil, and reclamation of the borrow area to rice crop production. This land would also serve to mitigate for the local drainage impacts caused by removal of the culverts currently located beneath the PGCC.

(8) West Lakeside School Site. The West Lakeside School Site is owned by the Natomas Unified School District and located north of Del Paso Road and east of Fisherman's Lake. The property was historically farmed, but is currently fallow. A portion of the site is planned for the West Lakeside High School. The remaining acreage could be shallow graded for borrow material prior to its development as open space. The non-developed portion of the site would be returned to agriculture or natural habitat type appropriate to the setting. Del Paso Road and El Centro Road

could be used as haul routes to transport the material to the Sacramento River east levee construction area.

Table 4-2. Existing Borrow Sources for Phase 4b

Borrow Site/Location	Status of Environmental Review	Potential Use
Natomas Boot/ Bollinger	Proposed as part of Phase 4b	Sacramento River east levee Reaches 16–19B/American River north levee
South Fisherman's Lake Borrow Area	Proposed as part of the 4b Project	Sacramento River east levee Reaches 16–19B
West Lakeside School Site, Natomas Unified School District	Proposed as part of the 4b Project	Sacramento River east levee Reaches 16–19B
Triangle Area Borrow Area	Proposed as part of the 4b Project	PGCC/NEMDC
Krumenacher/Twin Rivers Unified School District Stockpile	Previously analyzed in the Phase 4a EIS and EIR	PGCC/NEMDC

Table 4-3. Proposed Borrow Areas for Phase 4b

Borrow Site/Location	Size of Site (acres)	Amount Available for Excavation (acres)	Estimated Average Depth of Excavation (feet)	Current Use	Proposed Post-Reclamation Use
South Fisherman's Lake Borrow Area – Los Rios Community College Property	105	95	4	Row crops	Row crops
South Fisherman's Lake Borrow Area – 610 South Main, LLC Property	163	50	2	Row crops	Row crops
Triangle Properties Borrow Area	1100	290	2-6	Rice	Rice or detention basins
West Lakeside School Site	41	20	2	Fallow	Agriculture or natural habitat
Krumenacher	118	NA	NA	Grazing/Other	Grazing/Other
Twin Rivers Unified School District Stockpile	--	--	--	Stockpile	--

4-4. AGRICULTURAL IRRIGATION AND DRAINAGE INFRASTRUCTURE

The recommended plan requires relocation of Natomas Central Mutual Water Company irrigation canals currently located at the toe of the Sacramento River east levee (the Elkhorn Canal and the Riverside Canal). These canals would be replaced with new irrigation canals set back from the existing levee farther to the east. The existing and proposed irrigation canals are "highline canals," which means that the bottom of the canal is roughly equal to the surrounding ground elevation. Irrigation canals would be constructed with channel bottoms and confining

berms high enough to raise water levels above the levels of the adjacent fields to allow for gravity flow into the fields. The pumping facilities that provide water to these canals will be modified to accommodate the new height of the Sacramento River east levee.

The Natomas Central Mutual Water Company's new pumping facility along the Sacramento River east levee at Sankey Road would also need to be accommodated. The Water Company's construction of this facility in 2010 and 2011 will allow abandonment of two existing pumping facilities located along the NCC south levee. In order to service the irrigation facilities currently connected to these pumping facilities, the Water Company will also be constructing a new highline canal extending eastward from the new Sankey Diversion.

4.5 AVIATION SAFETY COMPONENTS

The Airport experiences a high rate of aircraft/bird strikes, which pose a substantial hazard to flight safety. In accordance with the Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports (FAA 2007), the Airport has been directed by the FAA to reduce wildlife attractants in the Airport Critical Zone, the area within a 10,000-foot radius from the centerline of the two parallel runways for turbine-powered aircraft. Additionally, the FAA recommends that no land uses deemed incompatible with safe airport operations be maintained in the Airport General Zone, a radius of 5 miles from the edge of the Airport Operations Area, if the attractant could cause hazardous wildlife movement into or across the approach or departure airspace. Open water and agricultural crops are recognized as being the greatest wildlife attractants in the Airport vicinity, and rice cultivation is considered the most incompatible agricultural crop because of its flooding regime. The recommended plan includes the following aviation safety components:

a. Modification of Irrigation Infrastructure. The Airport West Ditch would be dewatered and reconfigured into a shallow drainage swale to lower the risk of damage to aircraft that may slide off the nearby runway and reduce the West Ditch's current potential to attract waterfowl to the Airport Operations Area. To accommodate this modification, the current offsite irrigation and drainage functions performed by the West Ditch would be shifted to the new Drainage Canal.

b. Grading of Northern Bufferlands. Approximately 600 to 700 acres of the bufferlands north of the Airport Operations Area would be used as a source of borrow material for project improvements along the upper and middle reaches of the Sacramento River east levee. Although rice cultivation has been discontinued on these Airport lands, the idled fields are configured to hold surface water and they do not drain efficiently. This creates the potential for standing water to gather on these fields following rain storms creating a potential attraction for water fowl in areas near the Airport's runways. The borrow operation would allow the area to be graded for improved surface drainage so as to eliminate this problem.

4-6. HABITAT CONSERVATION COMPONENTS

Several goals and objectives of the Natomas Basin Habitat Conservation Plan (NBHCP) are relevant to the proposed action. In general, they address similar issues as the conservation strategy, such as establishing and managing a habitat reserve system and ensuring connectivity between reserves. Relevant habitat-specific goals and objectives include establishing a mosaic of habitats and connecting corridors to provide breeding, wintering, forging, and cover areas for wetland and upland species; and providing habitat to maintain viable populations of endangered species protected in the Natomas Basin. The Corps of Engineers is not required to comply with the NBHCP as this is a document resulting from Section 10 Consultation with non-Federal Agencies. When evaluating potential mitigation options for the project, a habitat based approach, including location of NBHCP lands, was used to allow for the maximum benefit for listed species. The recommended plan includes the following habitat conservation components.

a. Field Crop Preservation. In order to meet the borrow needs of the project, approximately 200 acres of existing field crop land would be acquired in the northern and western portions of the Natomas Basin. The top soil that supports the productivity of these lands would be removed and stockpiled; soil material for levee construction would be removed through shallow grading operations; the lands would be reconfigured for efficient irrigation and drainage; and the topsoil would be re-deposited along with soil amendments as necessary to support continued field crop production.

b. New Drainage Canal. A new drainage canal would be constructed to provide borrow material for relocation of the Elkhorn Canal and create opportunities for giant garter snake movement between Fisherman's Lake south of Interstate-5 and the North Drainage Canal in the northern Natomas Basin. The length of the entire Drainage Canal, including a portion of the West Drainage Canal, is approximately 44,000 linear feet (8.3 miles). A series of water-control structures would be constructed along the length of the canal to maintain consistent water levels in the low-flow channel of the canal during the snake's active season (April through October). Supplemental water would be provided as needed from Natomas Central Mutual Water Company's irrigation system. The low-flow channel would have a top width of approximately 50 feet and a water depth of approximately four to five feet. The canal would be part of the RD 1000 drainage system.

c. Managed Marsh Creation. Approximately 300 acres of private agricultural land in the northern portion of the Basin in the vicinity of Fisherman's Lake would be acquired to provide borrow material for levee improvements in the lower portion of the Natomas Basin. These borrow sites would be finish graded and planted with native riparian and marsh vegetation after the completion of borrow activities to create managed seasonal and perennial marsh and upland habitat. This would allow more than a doubling of the habitat complex currently under TNBC's management in this area.

d. Managed Grasslands. The levee improvements would result in landside slopes that are less steep than the existing slopes. Some reaches of the Sacramento River east levee would have adjoining 100- to 300-foot-wide earthen seepage berms with a nearly flat slope (50H:1V or less). Parallel to the landside toe of enlarged levees and seepage berms would be maintenance

access roads and seepage relief wells in some locations. Additional setback bufferland would flank some of these features, and property acquisition for the proposed project may leave remnant portions of acquired parcels that are nonessential to flood control uses. With the exception of the crown of the levee, these areas totaling approximately 800 acres would be managed as grassland. Most grassland would be mowed or grazed throughout the growing season, with an emphasis on mowing procedures and stubble height to optimize these areas for Swainson's hawk foraging habitat. However, the primary purpose and management priority of levees and seepage berms would continue to be flood protection, for which RD 1000 has principal management and maintenance responsibility.

e. Woodlands. Woodlands consisting of native species would be established at several sites. Woodland tree and shrub species would be acquired and planted on approximately 240 acres of existing cropland or fallow or currently unused sites along several reaches of the Sacramento River east levee, including the upper reach in Sutter County, the middle reach south of the Teal Bend Golf Club, and lower reach around Fisherman's Lake. Tree groves would be established in corridors adjacent to the flood control footprint throughout these areas. Depending on location constraints, these groves would generally be at least 100 feet wide and several hundred feet long and would be designed to promote successful nesting by a variety of native birds deeper within the grove canopy. At maturity, the grove structure would vary from closed canopy woodland to grassland savanna vegetation types.

4-7. REAL ESTATE REQUIREMENTS

The Real Estate Appendix discusses in detail, by reach, the real estate interests to support the construction, operation, and maintenance of the Recommended Plan. The real estate interests include the estates, number of ownerships, and estimated land values. The baseline cost estimates include a gross appraisal and the Federal and non-Federal costs associated with acquiring the lands for the project. The non-Federal administrative costs include right of way planning and management, securing rights of entry for Engineering and Environmental Studies, surveying existing roadways for plats and legal descriptions, right of way field staking, appraisal services, independent appraisal review, acquisition services, relocation assistance, title and escrow support, and condemnation support. The Federal administrative costs include Feasibility Report and Design Documentation Report level estimated costs associated with the areas and estates that are required for the construction, operation and maintenance for the project. Several of the measures included in the plans increase the footprint of the flood control system: levees would be widened on the land side as a result of construction of an adjacent levee, flattening of the waterside and/or landside slopes, and construction of seepage berms. In addition, permanent maintenance roads along the landside toe for the new levees or at the ends of new seepage berms, new utility corridors, and relocated drainage canal easements increase the Real Estate footprint of the project as well.

Other land requirements for the project include permanent woodland corridors to replace trees that are removed within the levee footprint and maintenance access areas, temporary borrow areas, permanent ditch/irrigation and drainage facility relocations, temporary construction areas, temporary staging areas, permanent mitigation sites, and new canal

construction east of the flood control features along the Sacramento River East Levee reaches. The non-Federal sponsor will acquire adjacent land for relocation of infrastructure from the flood control corridor and planned improvements outside the flood control corridor, with appropriate easements provided to utility owners upon completion of the work. To meet its project footprint needs, the non-Federal Sponsor must acquire fee title to fish and wildlife mitigation lands, permanent easements for levees, walls, and other permanent structures, flowage areas, waterway improvements, spoil and borrow areas required for future maintenance work, and right-of-way relocation of public highways and public utilities. Permits or temporary easements for excavated material or borrow areas are required during construction and adequate access thereto.

Finally, the plan requires relocations of many government owned utilities (City, County, SMUD, RD) around the Natomas basin. This project has received a waiver letter from the Assistant Secretary of the Army relating to a cost sharing issue associated with utility relocations required for construction of the American River Common Features Project in Sacramento, California. It has been determined that the removal and replacement of a utility, or other public facility, owned by the State of California, or a political subdivision thereof, and which delivers public services, should be treated as a relocation where such work is required as a direct result of the construction of the project. The Corps will include the costs incurred by the State in performing these relocations as part of shared total project costs and credit the State for such costs. Other relocations include several rural roadway intersections and a number of rural residential and nonresidential structures to accommodate the expanded project footprint along the Sacramento River east levee, Natomas Cross Canal south levee, and Pleasant Grove Creek Canal west levee. NEMDC North and South levees, the American River Levee reach. These relocations include: (1) Reclamation District 1000, Natomas Central Mutual Water Company, and private pumping facilities; (2) Natomas Mutual Water Company and private irrigation canals; (3) approximately 30 to 70 private residential and non-residential structures in reaches A, B, C, D, F, G and H; and (4) the roadway intersections with the Garden Highway and Natomas Road (5) government owned utilities to be relocated in all 9 reaches. Privately owned irrigation and infrastructure items need to be included in the lands category as a damage or severance cost, NOT a facility relocation for project cost sharing purposes.

4-8. OPERATIONS, MAINTENANCE AND REPLACEMENT CONSIDERATIONS

The Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, approved April 1948, will be supplemented for the work completed along the Sacramento River east levee and the American River north levee. New operation and maintenance manuals will be required for work completed along the Natomas Cross Canal, Natomas East Main Drainage Canal and the Pleasant Grove Creek Canal.

a. Agencies and Organizations. The agencies and organizations that would have management responsibility for proposed project features are SAFCA, RD 1000, Natomas Central Mutual Water Company, Sacramento County Airport System, and TNBC.

(1) Sacramento Area Flood Control Agency (SAFCA). SAFCA would be responsible for the design and construction of all levee improvements for those portions of the project that SAFCA will undertake under Section 408. SAFCA would also be responsible for maintenance

access and inspection, roads and rights-of-way, replacement canals and associated drainage and irrigation structures, and habitat creation sites for these and the remaining portions of the project. In addition, SAFCA would be responsible for all necessary land acquisitions and easements to construct the project features. However, once these project features are completed, most of the land or land management responsibility would be conveyed by SAFCA to the other management entities described below. SAFCA would use memoranda of agreement, land ownership transfers, or management endowments, and contracts to transfer land management responsibility to the appropriate public agency or nonprofit land management organization. At the end of the project construction period, all project lands would be in public ownership and/or would be under the permanent control of a natural resource conservation entity.

(2) Sacramento County Airport System. The Sacramento County Airport System manages the Sacramento County–owned Airport buffer lands outside the Airport Operations Area. All project components on land under airport management would remain in airport ownership.

(3) RD 1000. The mission of RD 1000 is to operate and maintain the flood control levees that surround the Natomas Basin and the internal drainage system that collects and discharges agricultural and urban stormwater runoff from the Basin. The lands acquired by SAFCA for constructing the flood control facilities included in the Adjacent Levee Alternative would be conveyed to RD 1000 either through flood control easements (in the case of the lands owned by the Sacramento County Airport System) or in fee title.

By agreement with SAFCA and the State, RD 1000 would operate and maintain the constructed facilities in accordance with the operation and maintenance requirements of the SRFCP. The lands acquired for the new Drainage Canal would also be conveyed to RD 1000 in the form of perpetual easements that would protect the habitat and related irrigation and drainage values created by the new canal. By agreement with SAFCA, RD 1000 would operate and maintain the new facility in accordance with a long-term management plan approved by U.S. Fish and Wildlife Service and California Department of Fish and Game. Typical flood control and drainage canal operation and maintenance activities would include mowing established grasslands along levee slopes, berms, and access areas; managing drainage canal bank vegetation, including noxious and invasive weeds; periodically removing sediment from the drainage canal; and maintaining and repairing levee and canal patrol roads. These efforts would be carried out under a long-term management agreement between SAFCA and RD 1000.

(4) Natomas Central Mutual Water Company. The Water Company is a nonprofit mutual water company responsible for serving irrigation water to company shareholders. The lands acquired for relocation of the Elkhorn and Riverside Canals would be conveyed by SAFCA to the Water Company in the form of perpetual easements for operation and maintenance of these facilities. The relocated canals would be maintained in the same manner as the existing canals. Typical maintenance activities include operating and repairing water control structures and barrier gates, periodically removing sediment and noxious aquatic weeds from the canals, repairing canal roads, managing bank vegetation, and mowing grassland along canal and road rights-of-way. However, compared to the existing Elkhorn and Riverside Canals, the relocated canals would have improved levees, better water control structures, and wider roads and rights-

of-way. These improvements are expected to ease annual canal management efforts, allowing for a proportionately greater focus on maintenance and operations and less need for system repair and dredging.

(5) The Natomas Basin Conservancy . TNBC is the operator for the NBHCP. To meet the mitigation goals of the NBHCP, developers of projects pay a mitigation fee to TNBC when they apply for building permits. TNBC then uses the mitigation fees to acquire, restore, and manage mitigation lands to provide habitat for protected species and maintain agriculture in the Natomas Basin. TNBC owns approximately 30 habitat preserves totaling more than 4,000 acres. All rice, field crop and other undeveloped lands acquired by SAFCA for borrow operations would be reclaimed and preserved as managed habitat lands under easements granted by SAFCA to The Conservancy. After establishment of the planned rice, field crop, marsh, upland and woodland habitats, these lands would be managed by TNBC under a long-term management agreement with SAFCA funded by annual appropriations from the Consolidated Capital Assessment District and a perpetual endowment established by SAFCA on TNBC's behalf. Pursuant to this arrangement, TNBC would also serve as a third party beneficiary of the perpetual drainage canal easements with the authority and funding to monitor RD 1000's compliance with the terms of the easements and the approved operation and maintenance plan.

(6) Flood Fighting. An imminent threat of unusual flooding must exist for the Corps to assist in a flood fight. The threat must be established by National Weather Service forecasts or by Corps determinations of unusual flooding from adverse conditions. A written request from the governor of the State of California for Corps assistance is required.

Flood fights for the project area would be conducted by the California Department of Water Resources, Division of Flood Management, the Sacramento District, and the local responsible maintaining agency, RD 1000.

When water levels reach a predetermined height, mobile patrols will be assigned to those areas for observation. Patrols will look for wave wash, boils, seepage, cracks, or sloughing and threats of overtopping. These conditions will be reported to the emergency operations center for the State of California located in Sacramento and materials and resources allocated as appropriate.

b. Monitoring and Adaptive Management. Overall, after implementation of mitigation components, the mitigation sites would be monitored throughout the year for 3–8 years depending on the type of habitat and as developed in negotiation with the appropriate resource agencies. SAFCA would be responsible for providing success monitoring, which, as required by the appropriate resource agencies, would be conducted by a qualified ecologist, botanist, or biologist. The monitor would be objective and independent from the installation contractor responsible for maintenance of the site.

All habitat types and mitigation sites would receive quantitative and qualitative monitoring. Quantitative monitoring would be performed in accordance with the performance criteria described in the following sections (e.g., percent cover). Qualitative monitoring would provide an opportunity to document general plant health, overall plant community composition,

hydrologic conditions, damage to the site, infestation of weeds, signs of excessive herbivory, signs of wildlife use, erosion problems, and signs of human disturbance and vandalism. These criteria would be assessed and noted for use in adaptive management of the mitigation sites, but they would not be used to determine project success. In addition, a complete list of all wildlife species encountered would be compiled for each mitigation site during each monitoring visit. Particular attention would be given to looking for evidence of giant garter snake, valley elderberry longhorn beetle exit holes, and Swainson's hawk.

SAFCA would prepare an annual report in conjunction with the resource managers that would be submitted to the Corps, the USFWS, DFG, and the Central Valley RWQCB by December 31 of each year during the success monitoring period, or until the agencies have verified that final success criteria have been met. The report would assess the attainment of or progress toward meeting the success criteria for the mitigation sites.

c. O&M Costs. Operations and maintenance of the selected plan will include all of the items of maintenance included in the O&M manual.

4-9. MICRO-COMPUTER AIDED COST ESTIMATING SYSTEM (MCACES) COST ESTIMATE

The Corps' Micro-Computer Aided Cost Estimating System (MCACES) is a multi-user software program used by the U.S. Army Corps of Engineers for the preparation of detailed construction cost estimates for military, civil works, and environmental projects. The system includes a project database and supporting databases. The supporting databases include a unit price book, crews, labor rates, equipment ownership, schedule costs, assemblies, and models. All databases work in conjunction with each other to produce a detailed cost estimate. Appendix G, Cost, contains the detailed MCACES cost estimate. The cost estimate prepared using MCACES for the Recommended Plan for the Natomas Basin is presented in the following table.

Table 4-4. MCACES Cost Estimate – Recommended Plan ($000)

	Item	Cost
01	Lands and Damages	223,830
02	Relocations	110,766
06	Fish & Wildlife Facilities	18,869
11	Levees & Floodwalls	388,083
13	Pumping Plants	56,135
18	Cultural Resources	6,578
	Subtotal	804,261
30	PED	148,711
31	Construction Management	158,588
	Subtotal	1,111,560
	Associated Costs	0
	Total First Cost	1,111,560
	Annual OMRR&R Cost	5,180

October 2010 price levels. Cost estimates include contingencies.

4-10. SAFETY ASSURANCE REVIEW

Section 2035 of WRDA 2007 requires that flood damage reduction projects be reviewed by independent experts where appropriate to ensure public health, safety, and welfare. In determining whether such a safety assurance review is necessary the following factors must be considered:

- The failure of the project would pose a significant threat to human life;
- The project involves the use of innovative materials or techniques;
- The project design lacks redundancy; or
- The project has a unique construction sequencing or a reduced or overlapping design construction schedule.

Safety assurance reviews must include participation by independent experts selected from among individuals who are distinguished experts in engineering, hydrology, or other appropriate disciplines, and who have not been involved in the design of the project, have no conflict of interest, and do not carry out or advocate for or against Federal water resources projects. The purpose of a review is to provide information on the adequacy, appropriateness, and acceptability of the design and construction activities so as to assure public health, safety, and welfare. The reviews should focus on whether the assumptions made for the hazards remain valid as additional knowledge is gained and the state of the art evolves. In addition, the review panel should advise whether project features adequately address redundancy, robustness, and resiliency and that the findings during construction reflect the assumptions made during design. Additional reviews should be completed periodically, on a regular schedule, until construction activities are completed.

Because failure of the proposed levee improvements around the Natomas Basin would pose a significant threat to human life, SAFCA recognized the need for independent review of its Natomas Levee Improvement Program design and construction activities based on the Safety Assurance Review standards referenced above. For this purpose a three-member Board of Senior Consultants was assembled. Board members include Dr. David Williams, Dr. Leslie Harder and Mr. George Sills; all recognized experts in flood control projects and levee design issues. Dr. Harder's and Mr. Sills' field of expertise is in geotechnical engineering and Dr. Williams' expertise is in hydraulics and hydrology. The Board of Senior Consultants has provided SAFCA with independent reviews of engineering design and construction activities at crucial points in the Natomas Levee Improvement Program design process.

4-11. RESIDUAL RISK

The Chief's Report recommending authorization of the Common Features acknowledged that the implementation of those features would leave significant residual risk in the Sacramento area. The following is from the Chief's Report:

> *"I must emphasize, however, that implementation of the common elements should not be viewed as a permanent solution addressing all flood damage reduction*

issues in the Sacramento area. Construction of the common elements leaves relatively short flood warning times, significant depths and durations of flooding in the area, in the event levees are overtopped, problems with safe egress during a flood event and significant residual risk, both in term of monetary damages and hazards to human life…I will make further recommendations concerning implementation of a more comprehensive plan for the American River."

The recommended plan would substantially lessen the probability of an uncontrolled flood in the basin due to levee failure. After implementation of the recommended plan, the Natomas Basin will, however, have a remaining chance of overtopping. The flooding depth would be greater than six feet above ground elevation, with many depths approaching 20 feet. The duration of the flooding is likely to be a few weeks after the water levels in the river have receded. This is severe and deep floodplain flooding. Shallower depths are expected to be adjacent to and possibly intermingled with the extreme depths. Large amounts of pumping are expected. The average expected residential and public displacement times are 18 months; residential evacuees will total 80,000 citizens. During a large flood, residents of the affected area either self-evacuate or are assisted. During the flood and in its immediate aftermath, many of these displaced residents would have to stay at shelters. Rivers can rise from low flow levels to damaging floods within one to three days. The average annual residual damages in the Natomas Basin are presently estimated to be $11,000,000 per year. Following is a discussion of further actions being taken to address residual risk.

a. Levee Superiority. The concept of 'superiority' was introduced as a USACE levee design profile consideration by ETL 1110-2-299 in 1986. It essentially seeks to mitigate the life-safety consequences of exceeding a project's capacity by identifying an initial overtopping reach at an acceptable location, and assuring that reach is resilient to the effects of overtopping flow. This would provide for a relatively predictable overtopping scenario with less catastrophic effects that would enable enhanced flood evacuation and response planning. Due to the disastrous effects that would likely result from an uncontrolled overtopping of one of its levees, the Natomas basin is a location where 'superiority' should be provided. However, establishing a location that would initially overtop with some certainty would require lowering the levee in that location, or raising the levee everywhere else. Lowering a levee reach would obviously increase flood risk in the Natomas basin. Raising levees is not proposed as part of the recommended plan.

A more appropriate application of the superiority concept for Natomas recognizes that the potential consequences of overtopping of its levees are so dire that overtopping should be assured to occur elsewhere in the SRFCP in order to prevent or at least reduce the possibility of overtopping in Natomas. Under without project conditions, the Natomas Basin reach of the Sacramento River would first overtop the west levee into Elkhorn before it would overtop the Sacramento River east levee into Natomas, similarly the initial overtopping locations for the Natomas Cross Canal, Natomas East Main Drain Canal, and the American River would overtop into other basins first before overtopping into the Natomas Basin.

A large enough flood to overtop the Natomas levees, though it would be rare, has not been considered. Additional Federal action will be required for the Natomas basin as part of the

GRR. This additional action will address levee raising. The issue of levee superiority for the Natomas Basin will be considered further, along with levee raising, as part of the GRR.

b. Local Sponsor Actions. In order to reduce residual risk, SAFCA has taken actions to control where development occurs. SAFCA has acquired agricultural conservation easements in the Elkhorn Basin, located west of the Natomas Basin. Figure 4-2 shows the locations of these conservation easements. The acquisition of these easements will advance regional flood protection by helping to concentrate new development in well protected urban areas. It will also help preserve the agricultural character of the property with the goal of reducing the long-term risk of flooding. The agricultural conservation easements achieve the objective of precluding development which could increase flood risks for the region. SAFCA has also acquired other conservation easements with the goal of preserving habitat, open space, agricultural land, and precluding development which could increase flood risks.

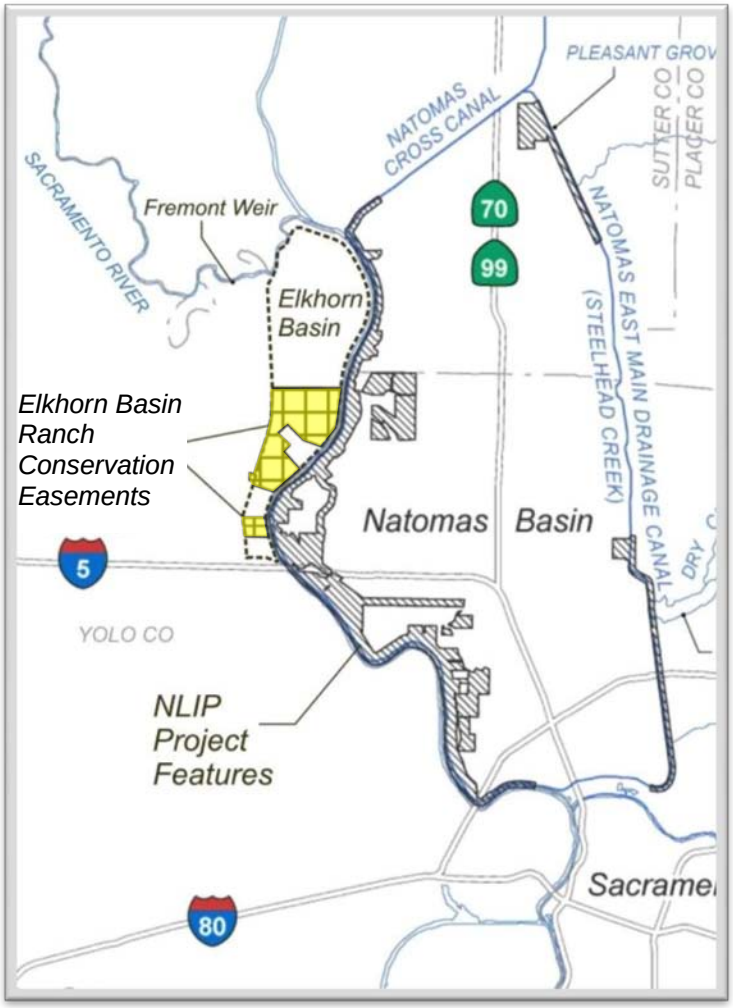


Figure 4-2. Agricultural Conservation Easements in Elkhorn Basin Acquired by SAFCA.

b. Senate Bill 5. The California State Senate, in 2007, approved Senate Bill 5. There were various features with Senate Bill 5. One feature was to identify the 100 and 200 year floodplains in the Sacramento and San Joaquin valleys. One additional feature was to establish a standard for urban areas to have a 200 year level of protection, as defined by State of California's

methodologies. Even though it is not specifically stated, the intent of these features is to provide a higher level of flood protection for urban areas than for non urban areas, thereby giving superiority to urban areas. The State continues to work on the State Plan of Flood Control, which is anticipated to be complete in 2012. Urban and non urban standard levels of protection should be included in this document and will likely address the superiority topic favoring urban areas over non urban areas.

c. SAFCA Development Impact Fee. The recommended plan would substantially lessen the probability of an uncontrolled flood in the basin due to levee failure. Nevertheless, with this protection in place, the consequences of an uncontrolled flood would increase over time as planned new development occurs in the Natomas basin in accordance with the Sacramento Area Council of Government's regional blueprint. If no additional risk reduction measures were implemented, the result would be a steady rise in the residual risk to life and property damages.

To address this likely increase in residual risk, on May 15, 2008 the SAFCA Board adopted a development fee program that will apply to new structures placed in the 200-year floodplain of SAFCA's capital assessment district. The objective of this program is to avoid any substantial increase in the expected damage of an uncontrolled flood as new development proceeds in the floodplain. The revenue generated by the fee program will be used to finance a continuing flood risk reduction program for the Natomas Basin and the Lower American and Sacramento rivers that will consist of the following measures.

(1) Waterside Levee Strengthening. This measure will consist of a long-term program of waterside bank and levee protection improvements along the Lower American and Sacramento rivers, including the Natomas area, designed to arrest retreat of the upper bank, preserve waterside berm width, and reduce the potential for destabilization of the adjacent levee foundation due to erosion or ground shaking. In addition, this measure will minimize the long-term loss of mature trees and vegetation located along the affected berms and will provide opportunities for expansion of the Central Valley's remnant riparian forest while enhancing the public safety purposes of the levee system.

(2) Landside Levee Strengthening. This measure will focus on improvements to the crown and landside slope of critical segments of the levee system along the NCC and the Lower American and Sacramento rivers to increase the resistance of these levees to overtopping and extended elevated river stages. These improvements will involve hardening the crown and landside slope of portions of the NCC south levee in Natomas and American River north and south levees between Howe Avenue and Watt Avenue.

(3) Acquisition of Agricultural Conservation Easements. This measure will focus on acquiring agricultural conservation easements from willing landowners occupying the levee-protected floodplains upstream and immediately downstream of the Fremont Weir. The purpose of these easements will be to compensate the participating landowners for abandoning the development rights associated with their property. These easements will remove the incentive to improve the levees protecting the property beyond the minimum design requirements of the Sacramento River Flood Control Project and will thus ensure that these levees are not raised above the "1957 profile" that governs the design of the SRFCP. This will reinforce the 200-year

design of the early implementation project and the Natomas Levee Improvement Program as a whole, which assumes that upstream levees are improved to the 1957 profile and overtop without failing when water surface elevations exceed this profile. It is assumed that SAFCA's development fee revenue will constitute only a portion of the revenue devoted to this measure, with the balance coming from the State and Federal governments as part of a comprehensive update of the plan of flood protection for the Sacramento Valley.

(4) Improved System Operations. This measure will focus on opportunities to improve the operation of the Sacramento River Flood Control Project to reduce water surface elevations in the Lower American and Sacramento rivers and in the drainage channels around the Natomas Basin. These opportunities may include implementing weather forecast based operations at Folsom Dam and Reservoir and improving the conveyance capacity of the Yolo and Sacramento Bypass systems. It is assumed that SAFCA's development fee revenue will constitute only a portion of the revenue devoted to this measure, with the balance coming from the State and Federal governments as part of a comprehensive update of the plan of flood protection for the Sacramento Valley.

d. Sacramento International Airport. The Sacramento International Airport is a major transportation hub for Northern California. The airport was opened in October, 1967. Since that time, Executive Order 11988, Floodplain Management, was issued in 1977. The Floodplain Management Guidelines for Implementing EO 11988 provides guidance for what is defined as a "critical action." A critical action means any activity for which even a slight change of flooding would be too great, because such flooding might result in loss of life, injury to persons, or damage to property. The critical action standard applies to structures or facilities located within the 500-year floodplain, when the structures or facilities are likely to contain occupants who may not be sufficiently mobile to avoid loss of life or injury during flood or storm events. It can be concluded that had the airport been constructed after EO 11988 was issued, it likely would not be located on its present site. Even after the construction of the recommended levee improvements, the airport will remain at risk for events smaller in magnitude than the 500-year event.

Because of the critical nature of the airport, Sacramento County has an emergency plan to move its commercial airline operations to Mather Airport in the event of a levee failure along either the Sacramento or American rivers. Sacramento County currently uses Mather Airport as a cargo shipping airport. Airport officials estimate it could cost the airport department $1 million to transfer minimal operations to Mather, allowing up to four flights per hour. Passenger ticketing and screening could be done at a ballroom at an adjacent hotel. To operate for an extended period, and 10 to 12 flights per hour, the set-up cost is estimated at $11 million, including the cost of new infrastructure and temporary buildings. Mather Airport is a U.S. Air Force base decommissioned in 1993. The Air Force transferred the base to the County of Sacramento, which in turn reopened Mather Airport for civilian use in 1995. Mather Airport is about 17 miles southeast of Sacramento International Airport and about 12 miles east of downtown Sacramento. Mather Airport sits at an elevation of 70 feet. Figure 4-3 shows the locations of the two airports.

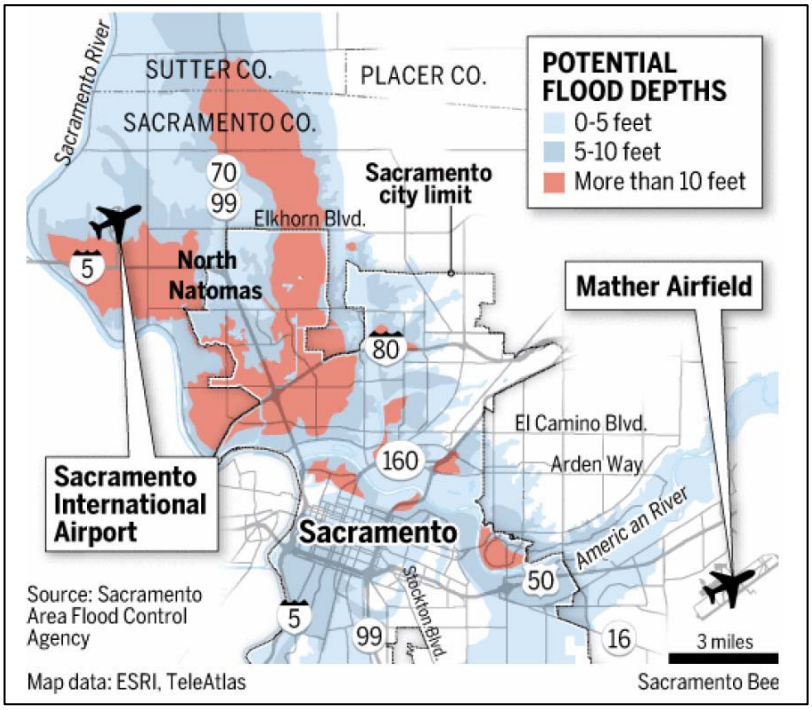


Figure 4-3. Locations of Sacramento International Airport and Sacramento Mather Airport (Source: http://www.sacbee.com/220/story/1371105-a137236-t...; accessed December 17, 2008.

e. Post-Flood Reoccupation of the Natomas Basin. The levees surrounding the basin vary from approximately 10 feet tall to approximately 25 feet tall. A levee failure anywhere in the basin would likely inundate the entire basin. Conditions in the basin, if this were to occur, would be very similar to conditions in New Orleans after Hurricane Katrina.

With 80,000 people living in the basin, considerable infrastructure is required to support this population. Key infrastructure within the basin includes power transmission lines, water supply lines, sewage lines, interior drainage canals and pump stations, phone lines, roadways, etc. In addition to the infrastructure flooding in the event of a levee failure, the dwellings of the 80,000 residents would be inundated, in many cases with up to 25 feet of depth of flooding.

In the event of significant flooding of the basin, numerous actions would have to be completed prior to reoccupation of the basin. Probably the most significant action would be reestablishment of interior drainage infrastructure. Interior drainage for the basin is accomplished with 10 pump stations. All of these pump stations would be inundated should a levee failure occur. Because of this, these pumps would not be available to dewater the basin during and immediately after the levee failure. Additionally, because the pump motors would likely be inundated for a considerable amount of time, the motors would have to either require a considerable amount of work, or would have to be completely replaced in order to restore interior drainage capability. Additionally, power to the pump stations will likely have been interrupted. In this case, generating capacity would have to be provided to operate the pumps until the power grid was reestablished. Due to these circumstances, the basin will likely be under water for a considerable period of time , most likely multiple months.

After the basin has been dewatered, considerable additional work will be necessary prior to reoccupation of the basin. Water supply infrastructure, wastewater transport facilities, and power supply infrastructure will have been inundated for a considerable period of time. Once the

water is removed, repair must be done to these facilities, including cleaning and disinfecting, prior to being usable. Roadways may be usable some time after dewatering; however, Considerable repair of these roadways would likely be necessary. Other infrastructure such as phone lines and fiber optic lines may need to be completely replaced after a flood.

Dwellings will be uninhabitable for some time after a flood. In many cases, the homes will be completely submerged. For these cases, houses will have to be completely removed and a new structure built. Buildings damaged by flooding can become contaminated with mold and fungi if they do not dry out quickly enough. These molds and fungi can pose serious health risks. When a house can be salvaged, building materials inside of the structure that could harbor mold and fungi would have to be removed, including sheet rock and insulation. Because of the paucity of contractors available to do this type of work, the duration period for rebuilding or repairing homes could be years.

4-12. FLOOD WARNING AND EVACUATION PLANS

a. Flood Warning System. With much of the area within the 100-year flood plain, Sacramento County and the City of Sacramento have developed a comprehensive flood warning system and evacuation plan. The County of Sacramento, Department of Water Resources has developed an Automated Local Evaluation in Real Time (ALERT) system website that provides Sacramento County Rainfall and Stream Level Information. This system consists of stream level gauges, rainfall gauges, and weather sensors. Gauging stations collects rainfall and stream level data and provide Web site updates every 15 minutes. Local meteorologists and television station utilize the ALERT website to keep residents informed. During a serious county wide flood emergency Sacramento County will post alerts on both local radio and television stations. The ALERT system also provides links to National Weather Service websites that provide both weather and stream flow information.

The steam level gauge system includes a total of 50 stream level gauges spread over 8 stream or river groups. Information on the web site indicates the current stream level, channel bottom, monitor stage, and flood stage.

A total of 61 rainfall gauges spread over 8 stream/river groups or areas provide current rainfall totals in durations including 30 minutes, one, three, six, twelve and twenty four hours, and five and ten days. The current rainfall totals report is updated every 15 minutes.

b. Evacuation Plan. The City and County monitor weather conditions and stream levels to determine the level of severity and evacuation triggers of potential flood events. Streams and locations that are monitored by the County to determine the level of emergency activation include the Sacramento River at the I Street Bridge, the American River at the H Street Bridge, Morrison Creek at Mack Road, Natomas East Main Drain at Arcade Creek, Arcade Creek at East Main Drain Canal, and the Consumnes River. The levels of emergency evacuation identified by the County ranging from less severe to most severe include: Situational Assessment, Low-Level Emergency, Medium-Level emergency, and High–Level emergency.

- Situational Assessment includes the following activities:
  - Initiate a meeting or conference call with emergency officials
  - Coordination of information with local, regional, state, or federal entities as needed
  - Initiation of media advisories to address threat and correct rumors
  - Notification of emergency staff of timetable and staffing needs.

- Low-Level Emergency or Evacuation Alert Stage includes the following activities:
  - Activate various agencies that may need to provide evacuation resource support including Law, Fire, Sacramento County DWR, County Department of Transportation, etc.
  - Coordination of information with State and Federal partners
  - Media Advisories to support self evacuations and correct rumors
  - Assisted evacuation of special needs persons or groups in threatened areas
  - Multiple shelters are opened to care for 1,000 evacuees
  - Traffic control and support for evacuation

- Medium-Level Evacuation Emergency includes the following activities:
  - Emergency operations staff and activities expanded
  - Activate all county departments that may provide evacuation resource support
  - Mandatory evacuation of vulnerable populations in potentially impacted areas
  - Voluntary evacuation notice to general populations in potentially impacted areas
  - Media advisories to support evacuations
  - Shelters opened to care for 5,000 people
  - Traffic operations to support the movement of up to 25,000 people from impacted area
  - Declaration of Local Emergency

- High–Level Evacuation Emergency involves:
  - Catastrophic Emergency Situation
  - Massive numbers needing to evacuate
  - Movement of greater than 25,000 people, requiring shelter, transportation and resources
  - County Emergency Operations Center activates to fullest level
  - Incident command posts are fully activated
  - Emergency plans in all county departments is required
  - Mutual aid with federal and state agencies is necessary

The following table indicates the activation triggers for the Sacramento River at the I Street Bridge and the American River at the H Street Bridge.

Table 4-5. Emergency Activation Triggers

Location	Situational Assessment	Low-Level Emergency	Medium-Level Emergency	High-Level Emergency
Sacramento River at I Street Bridge	River is rising and significant precipitation and/or Sierra snow melt is expected	I Street gauge is 19-24 feet and rising	I Street gauge is up to 27 feet	I Street gauge is up to 31 feet; levee overtopping and flooding
American River at H Street Bridge	River is rising and significant precipitation and/or Sierra snow melt is expected	H Street gauge is up to 30-39 feet and rising	H Street gauge is up to 41 feet	H Street gauge is up to 42 feet; levee overtopping and flooding

c. Public Alert and Warning. The county has established a Public Alert and Warning System to increase public awareness of an impending threat and to provide clear instructions should an emergency situation require evacuations. The various means to provide information to the public includes the following:

- Emergency Alert System that involves radio and television stations
- Fire and Law Enforcement Loudspeakers
- Media Hotline and Media Release
- Reverse 9-1-1 System
- 2-1-1 Sacramento
- Sacramento County Information Center
- Websites
- Alerting Vulnerable Populations
- Neighbors Warning Neighbors

The actual verbal or written messages that will be given are the responsibility of the Public Information Officer, the Joint Information Center, and the Emergency Operations Center.

d. Evacuation Routes. Emergency evacuation routes have been established throughout the county. Evacuation areas, evacuation routes, and rescue areas for Natomas have been established for five different levee breach locations. Evacuation route inundation times are color coded on the various levee breach location maps and vary depending on the location of the levee breach.

e. Mass Care and Shelter Management. A Mass Care and Shelter Management System has been established by the County to provide shelter, food, emergency first aid, disaster welfare information , bulk distribution of emergency relief items in the event of an evacuation. Approximately 88 sites, including schools, churches and community centers have been identified

throughout the County as Mass Care Shelters. Operation of the various shelters is dependent on where a levee break occurs and the associated flooding scenario.

f. Hypothetical Flood Depth and Rescue and Evacuation Area Maps. Hypothetical flood depth and rescue and evacuation area maps have been developed by the City/County of Sacramento for five hypothetical levee failure locations in the Natomas Basin as part of the Flood Emergency Evacuation Plan. The hypothetical flood depth maps depict both the maximum flood depths and the elapsed time from levee failure until an area is inundated with floodwaters to a depth of 1 foot for five different levee failure locations on the levees surrounding Natomas. Depending on the levee failure location the elapsed time to get to 1 foot flood depths can range from 6 minutes to 200 hours.

Portions of the Gateway Oaks community in southern Natomas are the most quickly inundated area. A levee failure on the Sacramento River levee near Discovery Park would cause flood water to reach a depth of 1 foot in portions of Gateway Oaks in six minutes; flood water depths could reach 6 feet in a portion of Gateway Oaks in one hour and twenty minutes.

A levee failure on the American River in the Truxel area of southern Natomas would cause flood water to reach a depth of 1 foot in approximately 20 minutes in portions of the Truxel area; depths could reach four feet in these areas within three hours.

The Rescue and Evacuation Area maps depict both rescue and evacuation areas and inundation times for evacuation routes for the various levee failure locations. Rescue areas are defined as areas where water has the potential to reach depths of at least one foot after two hours from the time of levee failure. Evacuation areas are defined as areas that, after 10 days from the time of levee failure, water depth will range from 15 feet at the deepest point to one foot at the flood boundary. Figures 4-1, 4-2 and 4-3 show in red the rescue areas for Truxel and for Gateway Oaks resulting from levee breaks on the NEMDC and the American River.

The maps indicate that an estimated population of 16,000 live in the Truxel area designated as a rescue area for a failure on the American River levee, and an estimated 11,000 live in the Truxel area designated as a rescue area for a failure on the NEMDC, and an estimated population of 8,000 live in the Gateway Oaks area designated as a rescue area for a failure on the Sacramento River levee, raising serious life safety concerns. The maps also depict the evacuation routes for Natomas and evacuation route inundation times ranging from 0-30 minutes to 3-4 days based on when the route is covered by one foot of water. The evacuation route inundation maps indicate that portions of Truxel and San Juan Roads near their intersection will become impassible between 0-30 minutes of a levee failure on the American River North levee in the Truxel area. This rapid inundation time and impacts to evacuation routes in the Truxel area raises serious life safety concerns.

4-13. HYDRAULIC IMPACT EVALUATION

The Natomas Basin is part of the Sacramento River Flood Control Project, an integrated system of levee protected basins. The design of the Sacramento River Flood Control Project anticipates that agricultural basins will be protected by levees that are at least high enough to

contain flood waters comparable to those produced by the floods of 1907 and 1909 and later modified to include floods that occurred in the 1920's and 1930's. The flood water elevations designated for each basin in the system were specified in a Memorandum of Understanding (MOU) between the Corps and the State of California. The MOU was originally developed in 1953 and later amended. The design specified in the MOU calls for agricultural levees to be at least equal in height to the designated water surface elevation ("1957 profile") plus three to six feet of freeboard to address hydrologic and engineering uncertainty and contain wind-driven waves.

SAFCA has performed a risk analysis, considering uncertainty in hydraulic and hydrologic inputs, evaluating the potential for these levee raises to cause adverse hydraulic impacts (or transfer of risk) to other basins in the Sacramento River Flood Control Project. This evaluation assumed the authorized profile of all agricultural project levees, while the levees protecting urban areas were assumed to be raised to the levels mandated by State law. SAFCA carried out this analysis using a UNET hydraulic model originally developed by the Corps and modified by MBK Engineers that fully incorporates the hydrologic and hydraulic data developed in connection with the Sacramento and San Joaquin rivers' Comprehensive Study. The risk analysis used the Corps' HEC-FDA software and relied on standard probability distributions to account for uncertainty in discharge and stage. The risk analysis addressed uncertainty in levee performance outside of the Natomas Basin by assuming that levees would function as weirs when water surface elevations exceed the top of levee. It is highly likely that many levees in the Sacramento River Flood Control Project will fail when water rises above the design flood elevation but prior to water reaching the top of the levee. The deterministic assumption that levees will not fail even when water exceeds the top of the levee provides a very conservative approach to estimating potential impacts of the project and probably overstates any potential risk.

For purposes of the analysis, the key indicator of risk transfer was whether levee raises around the Natomas Basin significantly increased the annual probability of levee overtopping (annual exceedance probability) at any of the several index points established for the purpose of the analysis along levees outside the Natomas Basin. In order to reflect the effects of upstream levee overtopping on downstream water surface elevations, the affected levees were converted to weirs and standard assumptions were made regarding levee/weir lengths and resulting discharge patterns. The model compared water surface elevations upstream and downstream of the Natomas Basin with and without the proposed levee raises in place under a range of flow conditions (100-year, 200-year and 500-year). Considering the uncertainty in flows and stages, annual exceedance probability values were computed for top of levee elevations at the index locations and compared system wide for with and without project conditions.

The risk analysis indicates that raising the levees around the Natomas Basin would have no significant effect on annual exceedance probabilities outside the Natomas Basin. On this basis, SAFCA concluded that raising the Natomas levees in order to meet State urban levee requirements would not result in any adverse hydraulic impacts on other basins protected by the Sacramento River Flood Control Project. This analysis was included in the review documentation supporting the Section 408 approval by the Corps.

The hydraulic modeling developed for the Comprehensive Study was based upon NGVD 29 rather than the NAVD 88 datum. As indicated in the discussion of risk and uncertainty, this results in additional uncertainty in the stage/frequency relationship. The District is presently in the process of updating and refining the hydraulic models, which will be used to confirm/refine the system analysis of hydraulic impacts as part of the GRR.

Although the Corps accepted SAFCA modeling for the Section 408 permit analysis, it was determined at that time that neither the SAFCA nor the Corps modeling was acceptable for optimizing the levee height or for project decision-making purposes. This is because the issues associated with the vertical datum could potentially affect the optimized levee height. Modeling used by SAFCA under the Section 408 approval was used as a means to compare without and with-project conditions only, and not for optimizing a specific levee height. In the SAFCA Section 408 analysis, the existing top of levee and the proposed top of levee were known with certainty using recent survey information in the NAVD88 vertical datum. The critical output for a Section 408 analysis is the relative difference in performance. It is the relative difference that helps determine if a project causes a significant impact. It was determined at the time of SAFCA's Section 408 analysis that the modeling used to perform the analysis was adequate for making a comparison and determining the relative difference. Though the model could potentially have datum issues, those issues are the same in both without- and with-project conditions models and are not critical in making a relative difference determination. In addition, a sensitivity analysis was conducted by SAFCA on the potential error associated with vertical datum. This was reviewed by the Corps and provided further reasoning for the Corps to accept SAFCA's 408 analysis.

While the design top of levee was known with certainty under the Section 408 analysis, it must be determined in the Corps decision making process. In this PAC report, because there is uncertainty about the vertical datum used in the hydraulic model, there is associated uncertainty in the n-year frequency estimates of water surface elevations. Therefore, while it appears as if raises are in the Federal interest, the amount of raise cannot be optimized. The optimization of levee raise height is a relatively refined analysis that compares the economic performance of various increments of levee raise. The cost increase in each additional levee raise increment is expected to be relatively subtle, based on the general understanding that a significant amount of the cost of raising a levee is associated with fixed type expenses such as mobilization and real estate acquisition, that are relatively insensitive to the amount of levee raising to occur. As a result, it becomes critically important to accurately assess the benefits provided by each increment of levee raise, which are also expected to differ subtly. This requires a higher order of accuracy from the hydraulic modeling that determines the benefits of each levee raise increment. The hydraulic modeling conducted is not up to the task of supporting the economic evaluation of raise increments because the vertical datum error uncertainty in it severely undermines the ability to confidently determine the federal interest in raising the levees.

For the follow-on GRR, the model will be converted to the NAVD 88 vertical datum, and the amount of raise will be optimized. At that point, a definitive analysis of hydraulic impacts due to these raises will be made, and any needed mitigation determined. In addition to the vertical datum issue, the upstream levee performance issue must be resolved in the future Common Features GRR study in order to be able to optimize the levee height. While a simple

assumption of no upstream levee failures was appropriate for the Section 408 analysis to determine hydraulic impact and for decision-making up to the top of levee as part of this document, this assumption could have direct bearing on the optimization of the levee height. This issue remains unresolved and must also be worked out before levee raise can be optimized for the Natomas Basin.

Levee fixes as part of this PAC report for below and up to the top of levee do not cause any hydraulic impact because there is no change to the water surface profiles between without project and project conditions. Further discussion on this topic is contained in Appendix C, Hydraulics.

4-14. ENVIRONMENTAL SUMMARY

Because of the volume of borrow material that must be procured and delivered, the project would result in significant temporary increases in traffic on local roadways. This impact would be minimized to the maximum extent practical by securing borrow sites that would confine the majority of haul truck traffic to off-road haul routes and little-used rural roadways west of SR 99/70. Nevertheless, due to this truck traffic and to the operation of a wide range of construction equipment, temporary emissions of reactive organic gases (ROG), oxides of nitrogen (NO_X), and particulate matter less than 10 microns in diameter (PM_{10}) during construction would result in substantial temporary air quality impacts. Moreover, due to the need to maintain continuous cutoff wall construction 24 hours per day seven days per week during the seasonally limited period available for construction, temporary short-term noise and vibration impacts affecting residents along the Garden Highway would be substantial at times.

The expansive footprint of the adjacent levee would result in the conversion of a large amount of important farmland to non-agricultural use. Moreover, because of the existence of known prehistoric resources along the Sacramento River, it is possible that project construction activities will encounter these resources as well as other undiscovered cultural resources and human remains. These impacts will be minimized to the extent possible through avoidance where feasible, recovery and preservation of resources where disturbance is unavoidable and close coordination with representatives of the tribal communities that historically occupied the area.

Because of the habitat components, including the design of the needed borrow operations, the plan would avoid any significant impacts on fish and wildlife habitat in the Natomas Basin. Rather, it would consolidate, expand and connect the habitat preserves in the basin and thus contribute significantly to the habitat enhancement goals of the Natomas Basin.

Mitigation needs for the project have been coordinated with U.S. Fish and Wildlife Service (FWS), NMFS, and the California Department of Fish and Game. This coordination has been occurring over the past 4 years as the project has been going through the 408/404 permit process. During all previous phases of the project, mitigation of project associated impacts has been compensated for sufficiently through the Section 7 Consultation at the Federal level and the

2081 Permit at the State level. No additional compensation has been recommended during coordination under the Fish and Wildlife Coordination Act.

Mitigation for the Fix-in-Place and Adjacent Levee alternatives are very similar with the exception of the waterside tree removed required under the Fix-in-Place alternative. This is due to the fact that the Fix-in-Place alternative would require the replacement of the Garden Highway on top of the levee being brought up to current road standards. The new standards require widening the existing Highway to about the same width as the adjacent levee.

In compliance with ER 1105-2-100, a Biological Assessment has been prepared and coordinated with the resource agencies. Section 7 Consultation under the Endangered Species Act has been on-going as part of the Natomas Levee Improvement Program and this Phase will be appended to the Programmatic Biological Opinion. A Biological Opinion will be received prior to the signing of the Record of Decision (ROD).

Table 4-6 is a listing of the significant environmental resources of principal national concern. Environmental commitments that are incorporated into the recommended plan are listed as follows:

Table 4-6. Effects on Natural and Cultural Resources

Types of Resources	Authorities	Measurements of Effects
Air Quality	Clean Air Act, as amended	Sacramento County Air Quality Management Board and Sutter County Air Quality Management Board Sacramento and Sutter Air basins.
Areas of Concern within the Coastal Zone	Coastal Zone Management Act, as amended	N/A
Endangered and Threatened Species	Endangered Species Act of 1973, as amended	Two Federally listed species will be affected by the project (Giant garter snake and Valley elderberry longhorn beetle One State listed species (Swainson Hawk) will be affected by the project.
Fish and Wildlife Habitat	Fish and Wildlife Coordination Act	No loss of critical habitat with mitigation implementation.
Floodplains	Executive Order 11988, Floodplain Management	No lands will be added to floodplain.
Historical and Cultural Properties	National Historic Preservation Act of 1966, as amended	In compliance with Section 106, Programmatic Agreement executed, consultation ongoing.

Types of Resources	Authorities	Measurements of Effects
Prime and Unique Farmlands	CEQ Memorandum of 1-Aug-80	1,455 acres of farmland would be lost from construction of the project and mitigation lands.
Water Quality	Clean Water Act of 1977, as amended	*(Enter length in miles for water course and area)*
Wetlands	Executive Order 11990, Clean Water Act of 1977, as amended	No net loss of wetlands
Wild and Scenic Rivers	Wild and Scenic River Act, as amended	No river is lost.

"Not present in the planning area" indicates that a type of resource is not present.
"No effect" indicates that a type of resource is not affected.

The degree to which the recommended plan complies with the applicable laws, policies and plans is summarized in Table 4-7.

Table 4-7. Degree of Compliance with Environmental Requirements

Environmental Requirement		Status
Federal		
1	National Environmental Policy Act	Full Compliance except for Signing of ROD
2	Clean Air Act	Full Compliance
3	River and Harbor Act	Full Compliance
4	Clean Water Act, Section 404(b)	Full Compliance
5	CEQ Policy on Prime and Unique Farmlands	Full Compliance
6	Federal Water Project Recreation Act	Not Applicable
7	Land and Water Conservation Fund Act	Not Applicable
8	Marine Research and Sanctuaries Act	Not Applicable
9	Watershed Protection and Flood Prevention Act	Not Applicable
10	Wild and Scenic Rivers Act	Full Compliance
11	EO 11988 – Flood Plain Management	Full Compliance
12	Archaeological and Historic Preservation Act	Full Compliance
13	EO 11593 – Protection and Enhancement to the Cultural Environment	Full Compliance
14	National Historic Preservation Act	Full Compliance
15	Coastal Zone Management Act	Not Applicable
16	Fish and Wildlife Coordination Act	Full Compliance
17	Estuary Protection Act	Not Applicable
18	Endangered Species Act	Full Compliance
19	EO 11990 – Wetlands	Full Compliance
20	Chief of Engineers Wetlands Policy	Not Applicable
State		
21	State of California Wetlands Policy	Full Compliance
22	California Environmental Quality Act	Full Compliance
Local		
23	Local Land Use Plans	Full Compliance

4-15. EXECUTIVE ORDER 11988

Executive Order 11988 requires federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by flood plains in carrying out its responsibilities."

The Water Resources Council Floodplain Management Guidelines for implementation of EO 11988, as referenced in the Corps' ER 1165-2-26, require an eight-step process that agencies should carry out as part of their decision-making on projects that have potential impacts to or within the floodplain. The eight steps reflect the decision-making process required in Section 2(a) of the Order. The eight steps and responses to them are summarized below.

1. *Determine if the proposed action is in the base flood plain.*

Yes, the project is a program of levee improvements in the Natomas Basin, which is in the 100-year floodplain.

2. *If the action is in the base flood plain, identify and evaluate practicable alternatives to the action or to location of the action in the base flood plain.*

Chapter 3 of this document has an analysis of alternatives, as well as Chapter 2 of the EIS/EIR. In order to have a complete analysis for EO 11988, the Natomas Cross Levee alternative was reevaluated. This alternative was screened out at the Feasibility Scoping Meeting (FSM) milestone because the cost of it was approximately thirty percent higher than fixing existing levees around the entire perimeter of the Natomas Basin. However, a levee across the Natomas Basin protecting just the developed area of the basin would seem to be a practical alternative to consider in regard to EO 11988. Therefore, a more detailed estimate of the Natomas Cross Levee alternative was developed to assure that the reason it was screened out at the FSM milestone was still valid.

To develop a more detailed estimate for the Natomas Cross Levee alternative, quantities of the various bid items were estimated using average end area methods, and then unit costs, as developed for the MCACES cost estimate for the recommended plan, were multiplied by the quantities for the same bid items and summed. For the recommended plan, the cost for the overall alternative is $1,111,560,000. When considering the Natomas Cross Levee, the costs for Reaches C, D, and E would be removed and replaced with the cost of the Natomas Cross Levee. The combined cost for Reaches C, D, and E in the recommended plan is estimated to be $378,503,000. Based on the analysis of estimating quantities for the Natomas Cross Levee and the application of the MCACES derived unit costs, the approximate cost of this feature is estimated to be $495,123,000. This amounts to a 31% increase in costs as compared to the costs for the Reaches C, D, and E components of the recommended plan.

Therefore, the Natomas Cross Levee alternative was not reconsidered.

3. *If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.*

Public involvement activities undertaken for the Phase 4b Project are described in Chapter 7, "Consultation and Coordination," of the EIS/EIR. NEPA- and CEQA-required notices have been mailed to affected property owners throughout the NLIP environmental review process, soliciting input on the content of the environmental documents and noticing various public meetings. Additionally, notices have also been posted in the largest local newspaper, The Sacramento Bee, announcing various public meetings. The Corps and SAFCA have also participated in numerous meetings and calls with affected property owners on an individual basis to discuss project-related concerns. Public comments received on the NOI/NOP will be considered and addressed, where appropriate in the DEIS/DEIR; public comments received on the DEIS/DEIR have been addressed in the FEIS/FEIR; and public comments received on the FEIS/FEIR will be addressed in the record of decision (ROD).

4. *Identify beneficial and adverse impacts due to the action and any expected losses of natural and beneficial flood plain values. Where actions proposed to be located outside the base flood plain will affect the base flood plain, impacts resulting from these actions should also be identified.*

Potential impacts associated with the Phase 4b Project are identified in Chapter 4, "Environmental Consequences and Mitigation Measures," of the EIS/EIR. The Phase 4b Project also includes the creation of natural habitat that would serve ecological functions associated with natural floodplains (see Section 2.3.4, "Habitat Creation and Management," of the EIS/EIR). As stated above, the Phase 4b Project would be located within the Natomas Basin; no project components would be located outside of the Natomas Basin, with the exception of the Triangle Properties Borrow Area, which is located outside of but directly adjacent to the Basin because of its proximity to the NCC, PGCC, and NEMDC.

5. *If the action is likely to induce development in the base flood plain, determine if a practicable non-flood plain alternative for the development exists.*

As described in Section 3-4 above, Measures Dropped from Consideration, the analyses of various non-floodplain alternatives led to the conclusion that the best way to address flood risk management in the Natomas Basin is to improve the Natomas levees. Therefore, a practicable non-floodplain alternative does not exist.

Within the Natomas Basin, population growth and urban development are driven by local, regional, and national economic conditions. Local land use decisions are within the jurisdiction of the cities and counties within the project area: the City of Sacramento and Sacramento and Sutter Counties. Each of these agencies has adopted a general plan consistent with state law. These general plans provide an overall framework for growth and development within the jurisdiction of each agency, including the project area.

The recommended plan would accommodate growth currently planned for undeveloped lands in the Natomas Basin. These lands have been identified in the general plans and additional planning policy documents of the City of Sacramento and Sacramento and Sutter Counties as the areas that are most suitable for urban growth.

The approximately 9,038-acre North Natomas Community Plan (NNCP) area is designated in the City of Sacramento's general plan as the city's major growth area for new housing and employment opportunities. In 2000, the estimated population of the North Natomas area of Sacramento County was 1,082 people occupying 416 housing units. At buildout (year 2016), the NNCP estimates a population of 66,495 in the NNCP area occupying approximately 9,038 acres (City of Sacramento 1996). As of September 14, 2005, the City of Sacramento had approved 12,162 lots for development of residential, commercial, and industrial land uses; 10,801 building permits; 11,599 single-family residential special permits; and 6,003 multifamily residential special permits for this area. Estimates indicate there were 14,865 persons living in the NNCP area and 5,368 housing units in the area in 2005, and projections are that 45,040 persons will occupy 17,230 housing units in the NCCP area in 2025.

Development within the NNCP started in 1999. More than 9,000 acres of the NNCP area were historically used for agriculture. While other long-term consequences of NNCP buildout would be mitigated by measures incorporated into the individual NCCP area projects, including measures to ensure consistency of development with the Natomas Basin Habitat Conservation Plan, loss of important farmland will remain a significant and unavoidable environmental impact of this growth. In addition, the 1986 NNCP EIR and the 1993 NNCP EIR Supplement found that the development of the NNCP area would itself have growth-inducing effects on the adjacent areas surrounding the NNCP area, likely leading to the conversion of additional agricultural land to urban uses.

Another indicator of anticipated future growth of the Natomas area is the City/County North Natomas Joint Vision Plan (Joint Vision). The Joint Vision is a long-term agreement between the City and County of Sacramento to collaboratively manage growth and preservation of open space and habitat in the 10,000-acre portion of unincorporated Natomas in Sacramento County. The Joint Vision anticipates that a substantial portion of the Natomas area will become urbanized. Both jurisdictions determined that it would be mutually beneficial to cooperatively plan for the urbanization of the area in accordance with smart growth principles. Concepts for development include a mixture of residential densities, an industrial park, and open spaces throughout, particularly in the northern part of Natomas to separate development from the Sutter County boundary. To date, no land use plans have been adopted.

Finally, in addition to the NNCP and the Joint Vision, Sutter County voters in 2004 passed Measure M, an advisory measure intended to provide the Sutter County Board of Supervisors with an indication of public sentiment regarding the types and level of development in the 7,500-acre area of the South Sutter County Industrial/Commercial Reserve in the northern part of Natomas. The southern boundary of the Measure M area forms the Sutter/Sacramento county line. Measure M did not approve any specific development proposals, but provides guidance for future development in the form of the following parameters for the South Sutter area:

- at least 3,600 acres for commercial/industrial development;
- at least 1,000 acres for schools, parks, other public uses, and retail; and
- no more than 2,900 acres for residential development, with a population cap of 39,000.

Regional infrastructure planning reflects these growth plans. In December 2004, SACOG, representing the Counties of El Dorado, Placer, Sacramento, Sutter, Yolo, and Yuba and their 22 constituent cities, adopted the "Preferred Blueprint Scenario" to guide land use and transportation choices over the next 50 years as the region's population grows from its current population of 2 million to include more than 3.8 million people. The Blueprint project was initiated in 2002 to study future land use patterns and their potential effects on the region's transportation system, air quality, housing, open space, and other resources.

The study found that continuing the recent practice of building large-lot, low-density housing would consume another 660 square miles of undeveloped land. Residents would face longer commutes, more vehicle trips, dirtier air, and a growing disconnect between where they live and where they work.

Through a series of Blueprint workshops at the neighborhood, city, county, and regional level, more than 5,000 residents, elected officials, business leaders, and environmental interests helped craft an alternative vision that integrates smart growth concepts such as higher-density, mixed-use developments and reinvestment in existing developed areas. The Preferred Blueprint Scenario assumes certain levels and locations of both "reinvestment" (i.e., additional development on already-built parcels) and greenfield development (i.e., large-scale development on vacant land), including development on the land in the Natomas area that would be protected by the project. An analysis of this scenario showed that following smart growth principles would shorten future commute times, reduce traffic congestion, lessen dependence on automobiles, and provide for housing choices that more closely align with the needs of an aging population. The Preferred Blueprint Scenario will become part of SACOG's long-range transportation plan for the six-county region. It also will serve as a framework to guide local government in growth and transportation planning through 2050.

Using the above information, combined with an evaluation of residual flood damage, it was concluded that there is substantial evidence that the recommended plan as a whole would accommodate anticipated growth in the project area in a manner that would be consistent with adopted local and regional growth management plans and with the state's emerging State Plan of Flood Control. There is substantial evidence that the Phase 4b Project would accommodate planned regional growth in a manner that would be consistent with emerging smart growth principles. Thus, the project, while accommodating planned regional growth, is not growth inducing itself and is compliant with EO 11988.

6. *As part of the planning process under the Principles and Guidelines, determine viable methods to minimize any adverse impacts of the action including any likely induced development for which there is no practicable alternative and methods to restore and preserve the natural and beneficial flood plain values. This should include reevaluation of the "no action" alternative.*

Mitigation measures are identified and will be implemented as part of the project to minimize the project's potentially adverse impacts. The project includes the creation of natural habitat that would serve ecological functions associated with natural floodplains. The No-Action Alternative is described in Section 2.2, "No-Action Alternative," of the EIS/EIR. Impacts of the

No-Action Alternative are identified throughout Chapter 4, "Environmental Consequences and Mitigation Measures," of the EIS/EIR.

7. *If the final determination is made that no practicable alternative exists to locating the action in the flood plain, advise the general public in the affected area of the findings.*

See response to Item 3, above.

8. *Recommend the plan most responsive to the planning objectives established by the study and consistent with the requirements of the Executive Order.*

The objective of the project is to reduce flood risk to public health, safety, and property in the Natomas Basin. The project is responsive to the EO 11988 objective of "avoidance, to the extent possible, of long- and short-term adverse impacts associated with the occupancy and modification of the base flood plain and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative" because it would not induce development in the floodplain, would reduce the hazard and risk associated with floods thereby minimizing the impacts of floods on human safety, health, and welfare, and would restore and preserve the natural and beneficial values of the base floodplain.

4-16. PERMITS

Over the course of project planning and environmental review for SAFCA's NLIP Landside Improvements Project and the preparation of this Post-Authorization Change Report, the Corps and SAFCA have coordinated with USFWS), the National Marine Fisheries Service (NMFS), CDFG, and TNBC. Table 4-8 includes permits and other resource agency coordination activities for past and current project phases.

Table 4-8. NLIP Resource Agency Coordination

Agency	Permit/Authorization/Approval	Status
Programmatic		
USFWS	Programmatic Biological Opinion	Issued October 2008; Amendment issued May 2009; Appendage issued October 2010
CDFG, Central Valley RWQCB, Corps, and USFWS	Long-Term Management Plan Approval	Granted May 2009
Phase 2 Project		
Corps	Section 408 Permission	Granted January 2009
Corps	Section 404 Permit	Issued January 2009; amendment issued May 20092; 2nd amendment issued August 2009; 3rd amendment anticipated February 2010
Central Valley RWQCB	Section 401 Water Quality Certification	Issued January 2009
CDFG	Section 2081 Incidental Take Authorization	Issued May 2009
NMFS	Concurrence of Determination of Not Likely to Adversely Affect	January 2009
CDFG	Section 1602 Streambed Alteration Agreement	Issued January 2009
USFWS	Biological Opinion	Issued October 2008; Amendment issued May 2009
USFWS	Fish and Wildlife Coordination Act Report	October 2008
Sacramento County	SMARA Exemption	Granted February 2009
Sutter County	SMARA Exemption	Granted February 2009
CDFG, Central Valley RWQCB, Corps, and USFWS	Mitigation and Monitoring Plan	Approval granted May 2009
SWRCB	Section 402 NPDES General Construction Permit	Notice of Intent filed March 2009
Phase 3 Project		
Corps	Section 408 Permission	Permission anticipated March 2010
Corps	Section 404 Permits	Phase 3a permit received October 2009; Phase 3b permit anticipated March 2010
Corps	Section 10 Permit	Phase 3a permit received October 2009; Phase 3b permit anticipated March 2010
Central Valley RWQCB	Section 401 Water Quality Certifications	Certifications received in September 2009 for Phase 3a and January 2010 for Phase 3b
CDFG	Section 2081 Incidental Take Authorization	In preparation, authorization anticipated March 2010

Agency	Permit/Authorization/Approval	Status
CDFG	Section 1602 Streambed Alteration Agreement	Landside canal footprint agreement received September 2009; later stages anticipated February–April 2010
USFWS	Biological Opinion	Issued September 2009
NMFS	Concurrence of Determination of Not Likely to Adversely Affect (Phase 3b and 4a combined)	January 2010
USFWS	Fish and Wildlife Service Coordination Act Report	Draft received June 2009; final received October 2009
Sacramento County	SMARA Exemption	Exemption granted November 2009
DFG, Central Valley RWQCB, Corps, and USFWS	Mitigation and Monitoring Plan	Approved by Corps September 2009; approved by all other agencies October 2009
SWRCB	Section 402 NPDES General Construction Permit	Notice of Intent submitted November 2009
Phase 4a Project		
Corps	Section 408 Permission	Anticipated late 2010
Corps	Section 404 Permits	Anticipated late 2010
Corps	Section 10 Permit	Anticipated late 2010
Central Valley RWQCB	Section 401 Water Quality Certifications	Anticipated late 2010
CDFG	Section 2081 Incidental Take Authorization	Anticipated late 2010
CDFG	Section 1602 Streambed Alteration Agreement	Anticipated late 2010
USFWS	Biological Opinion	May 2010
NMFS	Concurrence of Determination of Not Likely to Adversely Affect (Phase 3b and 4a combined)	January 2010
USFWS	Fish and Wildlife Service Coordination Act Report	May 2010
Sacramento County	SMARA Permit and Exemption	Exemption granted November 2009 for most of the Fisherman's Lake Borrow Area, including Novak; Sacramento County determined that the northeastern corner of the Fisherman's Lake Borrow Area (called the Natomas Urban Development site) would require a SMARA permit
CDFG, Central Valley RWQCB, Corps, and USFWS	Mitigation and Monitoring Plan	Anticipated early 2011
SWRCB	Section 402 NPDES General Construction Permit	Anticipated late 2010
Phase 4b Project		
Central Valley RWQCB	Section 401 Water Quality Certifications	Anticipated late 2010
CDFG	Section 2081 Incidental Take Authorization	Anticipated late 2010
CDFG	Section 1602 Streambed Alteration Agreement	Anticipated late 2010
USFWS	Biological Opinion	October 2010

Agency	Permit/Authorization/Approval	Status
NMFS	Concurrence of Determination of Not Likely to Adversely Affect (Phase 3b and 4a combined)	October 2010
USFWS	Fish and Wildlife Service Coordination Act Report	October 2010
Sacramento County	SMARA Permit and Exemption	Anticipated 2012
CDFG, Central Valley RWQCB, Corps, and USFWS	Mitigation and Monitoring Plan	Anticipated early 2011
SWRCB	Section 402 NPDES General Construction Permit	Anticipated 2012

Notes: USFWS = U.S. Fish and Wildlife Service; NMFS = National Marine Fisheries Service; DFG = California Department of Fish and Game; RWQCB = Regional Water Quality Control Board; Corps = U.S. Army Corps of Engineers; SMARA = Surface Mining and Reclamation Act; SWRCB = State Water Resources Control Board; NPDES = National Pollutant Discharge Elimination System
Source: Data compiled by AECOM in 2009

4 -17. MEETING FEMA REQUIREMENTS BY NON-FEDERAL SPONSOR

The building moratorium in Natomas will persist until the area meets the criteria for a FEMA A-99 map designation. They are currently designated as an AE. A-99 designation shows that adequate progress has been made in the area to reach 100-year floodplain designation. Requirements for an A-99 designation include the following:

- 100 percent of the total financial cost of the completed flood protection system has been authorized
- At least 50 percent of the total financial project cost of the completed flood protection system has been extended;
- At least 60 percent of the total financial cost of the of the completed flood protection system has been appropriated;
- All critical features of the flood protection system, as identified by FEMA, are under construction, and each critical feature is 50 percent complete, as measured by the actual expenditure of the estimated construction budget funds; and the community has not been responsible for any delay in the completion of the system.

  Achievement of these requirements could take between two to six years.

The City of Sacramento, County of Sacramento, and Sutter County will submit a request to FEMA for a new mapping designation. The request must contain a complete statement of all relevant facts relating to the flood protection system including, supporting technical data, cost schedules, budget appropriation data, extent of Federal funding of system construction, Full and Precise Statement of purpose of system, carefully detailed description of the project, including construction completion target dates, and true copies of all contracts, agreements, leases, instruments, and other documents.

In the absence of a Federal project it is likely that the State of California will improve the levees surrounding Natomas to comply with California Senate Bill 5, signed into law in October 2007. The legislation establishes the minimum standard for urban areas at a 200-year level of flood protection. It also establishes a deadline of 2025 to achieve 200-year flood protection if the

urban area is protected by State-Federal project levees. The risk of flooding in the Natomas Basin is so significant that State and Local action would be given priority for this area. This would result in removal of the Natomas Basin from FEMA 100-year regulations.

4-18. VIEWS OF NON-FEDERAL SPONSORS AND OTHER AGENCIES

The State of California and SAFCA have expressed the desire for implementing the project and sponsoring project construction in accordance with the items of local cooperation that are set forth in the recommendations chapter of this report. The financial analysis indicates that the non-Federal sponsor is financially capable of participating in the selected plan.

The California Legislature has approved State participation with funding made available through voter approval of the Infrastructure Improvement, Smart Growth, Economic Reinvestment and Emergency Preparedness Financing Act of 2006. Local participation is authorized under the provisions of the Sacramento Area Flood Control Agency Act of 1990 based on property owner approval of SAFCA's Consolidated Capital Assessment District in 2007.

4-19. POTENTIAL ADDITIONAL INCREMENTS

Because of the reasons stated, the recommended plan does not include levee raising. Raises will be evaluated further in follow-on reevaluation studies for a potential finding of federal interest.

The non-federal interests desire a plan that meets the State standard of the mean 200-year event plus three feet of freeboard and that will build upon the features that have been approved by the Corps under Section 408 and permitted through the Section 404 permit program. Portions of this project have been completed by SAFCA and other portions have been approved under Section 408 and are presently under construction or design. The addition of these increments would increase the first cost of the Natomas project to $1,164,100,000 and would increase the total first cost of the Common Features project to $1,442,080,000. These increments are also fully addressed in the Environmental Impact Statement. Table 4-9 shows the costs of these additional increments. Appendix G, Cost, contains the details of this estimate.

Table 4-9. Costs of Potential Additional Increments

Potential Additional Increments	Total
Lands and Damages	0
Relocations	16,934
Fish & Wildlife Facilities	0
Levees & Floodwalls	29,267
Pumping Plants	0
Cultural Resource Preservation	0
Subtotal	46,201
PED	3,753
Construction Management	2,586
Total	52,540

CHAPTER 5 –CHANGES TO THE COMMON FEATURES PROJECT

The chapter integrates the revaluated Natomas Basin portion of the Common Features Project with the other previously authorized and constructed portions of the project to describe proposed changes to the authorized Common Features Project. While changes in design and location are specific to the Natomas portion of the project, the economics, cost apportionment, cost allocation, crediting, fully funded cost estimate and implementation schedule must be determined for the integrated project to establish the changes.

5-1. UNCONSTRUCTED AMERICAN RIVER FEATURES

The Common Features project has installed roughly 23 miles of slurry wall up to depths of 80-feet, raised levees to provide adequate levee height, addressed slope stability issues and corrected some erosion problems along the American River. The majority of levee work along the American River has been completed. However, several reaches of levee need additional work. Table 5-1 provides an overview of this work by reach.

Table 5-1. Common Features Project Work Sites and Status

Levee Reach	Overview and Status
Mayhew Levee upstream of the Mayhew Drain	The levee improvement portion of the project was completed in 2008. This consisted of installing a slurry wall in the levee, raising the levee by three feet, and widening the top of the levee. Construction of the Closure Structure across the Mayhew Drain is scheduled to be completed in May 2010. The purpose of the Closure Structure in the Mayhew Drain is to prevent the American River from backing up into the drain.
North Levee upstream of Watt Avenue (Jacobs Lane)	This project has been divided into three sections. Construction of Section A was completed in 2009 and Section B will be completed in July 2010. Construction of Section C will be determined after vegetation on levee issues have been addressed. The work consists of reshaping the levee in spots and increasing the height of the levee up to a foot.
Chicken Ranch/Strong Ranch Slough Outfall	Summer 2009–Strengthening the concrete along the outfall from the pump station to the river.
North Levee Raise Upstream of Howe Avenue	This project consists of raising the levee up to a foot in height for about 4,000-feet. Design will be completed in December 2010 with the construction date to be determined.
North Levee Strengthening between NEMDC and Business I-80	This project consists of strengthening the levee in this reach through reshaping the levee and providing more stable levee slopes. Design will be completed in 2011 with the construction date to be determined.
Additional Locations	Summer 2009/2010–There are approximately 18 locations in the levee that do not have a slurry wall in them due to conflicts with existing infrastructure. While the levee can safely withstand the 100-year event, it may not be able to protect against the design flow of 160,000 cfs. These sites are being evaluated to see if remediation is required. Two sites have been constructed and five more sites will be constructed in 2010. Design of the remaining sites will be completed in 2011, with the construction date to be determined.

In addition, the authorized Common Features Project includes modifying the north levee of the Natomas Cross Canal for a distance of 5 miles to ensure that the height of the levee is equivalent to the height of the south levee. This levee raising will be considered in additional reevaluation studies.

5-2. ECONOMIC SUMMARY.

The estimated first costs, along with total annual costs, annual benefits, net economic benefits and the benefits-to-cost ratios are shown on the following table. These values are based on October 2010 price levels, an interest rate of 4.375% and a 50-year period of economic analysis, assuming initiation of Corps construction in FY 2011.

Table 5-2. Economic Analysis of the Selected Plan ($000)

Estimate of First Costs				
Act	**Item**	**Natomas Features of Recommended Plan**	**Existing Authorized Common Features Project[1]**	**Total Common Features Recommended Plan**
01	Lands and Damages	223,830	17,173	241,003
02	Relocations	110,766	381	111,147
06	Fish and Wildlife Facilities	18,869	2,075	20,944
11	Levees & Floodwalls	388,083	169,497	557,580
13	Pumping Plants	56,135	0	56,135
18	Cultural Resources	6,578	1,190	7,768
	Subtotal	804,261	190,316	994,577
30	PED	148,711	71,604	220,315
31	Construction Management	158,588	16,060	174,648
	Subtotal First Cost	1,111,560	277,980	1,389,540
	Associated Cost	0	0	0
	Interest During Construction	158,591	17,998	176,589
	Total First Cost	1,263,573	294,788	1,588,361
Estimate of Annual Costs				
	Interest and Amortization	62,644	14,615	77,259
	OMRR&R	5,180	85	5,265
	Total Annual Costs	67,824	14,700	82,524
Average Annual Benefits				
	Flood Risk Management (Structure and Contents	443,000	59,500	502,500
	Total Annual Benefits	443,000	59,500	502,500
Net Annual Benefits		375,176	44,800	419,976
Benefit to Cost Ratio		6.5	4.0	6.1

[1] Authorized Cost is as reflected in the 2001 Limited Reevaluation Report, and authorized by Congress in 2002. This is the last authorization by Congress on the Common Features project. The Authorized Cost adjusted for inflation to 2010 is $254,274,000.

5-3. CREDIT PROVISIONS

Section 104 of WRDA 1986 provides guidelines for crediting the cost of work carried out by non-Federal interests against the non-Federal share of the cost of an authorized project for flood control. Work that is carried out after the end of the reconnaissance study and before the submission to Congress of the final report of the Chief of Engineers on the project and that is determined by the Secretary to be compatible with the project will be included as part of the project and will be recommended by the Secretary in the final report for credit against the non-Federal share of the cost of the project. Work that is carried out after submission of the final report of the Chief of Engineers to Congress and that is determined by the Secretary to be compatible with the project will be considered as part of the project and will be credited by the Secretary against the non-Federal share of the cost of the project. The credit does not relieve the non-Federal sponsor of the requirement to pay 5 percent of the project costs in cash during construction of the remainder of the project. This legislative authority also provides that benefits and costs of compatible work be considered in the economic evaluation of the Federal project. The crediting provisions of Section 104 are applicable only to non-Federal work started after the reconnaissance phase of Corps preauthorization studies but prior to project authorization. No credit is available under Section 104 for non-Federal work started after project authorization.

A credit recommendation is made in response to a specific request from a State, city, municipality or public agency that is the prospective local sponsoring agency for the contemplated Federal plan. The maximum amount creditable equals the actual expenditures made by non-Federal entities (not limited solely to the project sponsor's specific efforts and expenditures) for work that meets the criteria set forth in Engineering Regulation (ER) 1165-2-29, General Credit for Flood Control, dated November 18, 1987.

The procedures for applying for credit are described in ER 1165-2-29. Non-Federal entities desiring credit confer with the District Engineer and submit a written application to him/her. The application must include a full description of planned work, plans, sketches, and similar engineering data and information sufficient to permit analysis of the local proposal. The District Engineer reviews the engineering adequacy of the local proposal and its relation to the Federal plan and determines what part of the proposed local improvement would be eligible for credit. The District Engineer forwards his/her recommendations through the Division Engineer and the Chief of Engineers to the Assistant Secretary of the Army (Civil Works) and provides information on the basis for concluding the local plan is appropriate in relation to the prospective Federal plan, the total estimated cost and benefits of creditable work, the environmental effects of the local work (including a brief statement of both beneficial and detrimental effects to significant resources), and the urgency for proceeding with the local plan. Upon being informed of the Secretary's decision, the District Engineer replies by letter stating to the local applicant what local work and costs can reasonably be expected to be recommended for credit under the provisions of Section 104 (assuming that the final plan for a Federal project, when it is ultimately recommended, remains such as to preserve the local work as a relevant element).

Regardless of the total amount creditable on this basis, the amount actually credited will not exceed the amount that is a reasonable estimate of the reduction in Federal project expenditures resulting from substitution of the local work for authorized project elements or, in the case of compatible work outside the scope of the project as originally authorized, a

reasonable estimate of what Federal expenditures would have been if that work had been Federally constructed.

Upon completion of local work, local interests provide the District Engineer details of the work accomplished and the actual costs directly associated therewith. The claimed costs are audited to ascertain and confirm those costs properly creditable. Upon completion of the audit, the District Engineer informs the non-Federal entity of the audit results.

The CVFPB and SAFCA have submitted requests for credit under Section 104 for several phases of their NLIP project. All of the requests have been approved. Section 104 elegibility requests for NLIP Phases 1, 2, and 3 were approved on 19 July 2007, 7 April 2009, and 4 May 2010, respectively, for estimated costs of $35,400,000, $170,000,000, and $181,830,000. NLIP Phase 1 work included construction of a seepage cutoff wall through the south levee of the Natomas Cross Canal beginning at the confluence of the Sacramento River, and extending upstream approximately 12,500 feet. NLIP Phase 2 included work along the Natomas Cross Canal, Sacramento River east levee, and relocation and mitigation features. NLIP Phase 3 work includes modifying 6.2 miles of the Natomas East Main Drain Canal west levee, 3.2 miles of the Pleasant Grove Creek Canal west levee, and 5.9 miles of the Sacramento River east levee.

In addition, the CVFPB and SAFCA have submitted a Section 104 credit eligibility request for Phase 4A with an estimated cost of $132,000,000. Credit eligibility for this work has not yet been approved. The work, consisting of modifying 3.5 miles of the Sacramento River east levee and several relocation and mitigation features, has not been initiated.

Table 5-3 summarizes the project features covered by SAFCA's Section 104 credit requests.

Table 5-3. Project Features Covered by Section 104 Credit Requests

Location	Project Features	Description	Status
Reach D	Levee Strengthening	Strengthen approximately 5.3 miles of the Natomas Cross Canal south levee by flattening the landside levee slope and installing seepage cut-off walls	104 credit request approved for entire 5.3 mile reach. 4.3 miles of levee strengthening completed with the remainder under construction. Borrow operation substantially completed and restoration of rice field underway. ROW acquisition substantially completed.
	Mitigation	Acquire 200-acre rice field to be used as a borrow site and then restored to rice production under a long-term habitat management agreement with The Natomas Basin Conservancy (TNBC)	
	Right-of-Way	Acquire 67 acres in fee title or easements to support levee strengthening and relocation features	
Reach C	Levee Strengthening	Strengthen approximately 5.0 miles of the Sacramento River east levee from Verona to Elverta Road by constructing a landside adjacent levee and installing seepage cut-off walls and landside seepage berms	104 credit request approved for entire 5.0 mile reach. 2 miles of levee strengthening completed with 2.9 miles under construction. Power pole relocations completed. Canal relocation and roadway reconstruction work under way. Woodland preservation/creation substantially completed. Canal construction under way. ROW acquisition completed.
	Relocations	Relocate 61 electrical power poles and power distribution lines into a new utility corridor Relocate approximately 1 mile of the Elkhorn Irrigation Canal Reconstruct three roadway intersections along the Garden Highway at Sankey, Riego and Elverta Roads	
	Mitigation	Preserve and create 60 acres of woodlands Construct approximately 1 mile of new drainage canal to provide open water and aquatic habitat	
	Right-of-Way	Acquire 229 acres in fee title or easements to support levee strengthening and relocation features	
Reach B	Levee Strengthening	Strengthen approximately 7.7 miles of the Sacramento River east levee from Elverta Road past Powerline Road by constructing a landside adjacent levee and installing seepage cut-off walls and landside seepage berms	104 credit request approved for upper 3.9 miles of 9.5 mile reach. Request pending for remainder. 3.9 miles of levee strengthening under way with an additional 3.7 miles to be awarded in December 2010. Power pole and canal relocations underway in the upper 4 mile area with additional relocation work to be awarded in December 2010. Drainage canal construction, 27 acres of woodland creation and 100 acres of cropland borrow/restoration underway in the upper 4 mile area with additional borrow/restoration and woodland creation contracts to be awarded in December 2010. ROW acquisition substantially completed
	Relocations	Relocate 224 electrical power poles and power distribution lines into a new utility corridor Relocate approximately 3 miles of the Elkhorn Irrigation Canal Reconstruct the roadway intersection along the Garden Highway at Powerline Road	
	Mitigation	Construct 4 miles of new drainage canal to provide open water and aquatic habitat Preserve and create 60 acres of woodlands Acquire 350 acres of cropland to be used as borrow sites and then restored to crop production or converted to marsh habitat or woodlands under long-term habitat management agreements with TNBC	
	Right-of-Way	Acquire 884 acres in fee title or easements to support levee strengthening and relocation features	

Additionally, in the event that new authorization is not required for some of the work, Section 130 of the Consolidated Appropriations Act of 2008 allows the non-Federal sponsor to receive credit for work performed. The pertinent text follows:

> SEC. 130. AMERICAN AND SACRAMENTO RIVERS, CALIFORNIA.
> Section 101(a)(1)(B) of the Water Resources Development Act of 1996 (Public Law 104–303: 110 Stat. 3662) is modified to read as follows:
> ‘‘(B) CREDIT TOWARD NON-FEDERAL SHARE.—The non- Federal interest shall receive credit toward the non-Federal share of project costs for expenses that the non-Federal interest incurs for design or construction of any authorized project feature, including credit for work commenced before the date of execution of a cooperation agreement for the affected feature. The amount of the credit shall be determined by the Secretary.’’.

Section 130 Memoranda of Understanding were executed for Phase 2 (March 24, 2009), Phase 3A (October 15, 2009), Phase 3B (May 4, 2010), and Phase 4a (August 16, 2010).

5-4. COST APPORTIONMENT

Cost apportionment for the existing authorized Common features project, the Natomas Recommended Plan, and the Total Common Features Recommended Plan is shown in accordance with the authorized percentages.

Table 5-4. Cost Apportionment ($000)

Existing Authorized Common Features Plan	Federal	Non-Federal	Total
Lands and Damages	2,227	14,946	17,173
Relocations	0	381	381
Fish & Wildlife Facilities	2,075	0	2,075
Levees & Floodwalls	169,497	0	169,497
Pumping Plants	0	0	0
Cultural Resource Preservation	1,190	0	1,190
Subtotal	174,989	15,327	190,316
PED	71,409	195	71,604
Construction Management	16,049	11	16,060
Subtotal	262,447	15,533	277,980
Minimum 25% Share	-	69,495	-
5% Cash	-	13,899	-
Additional Cash Required	-	40,063	-
Total Required Cash	-53,962	53,962	-
Total	208,485	69,495	277,980
Cost Sharing (%)	75	25	100
Natomas Recommended Plan			
Lands and Damages	18,492	205,338	223,830
Relocations	0	110,766	110,766
Fish & Wildlife Facilities	18,869	0	18,869
Levees & Floodwalls	388,083	0	388,083
Pumping Plants	56,135	0	56,135
Cultural Resource Preservation	6,578	0	6,578
Subtotal	488,157	316,104	804,261
PED	129,097	19,614	148,711
Construction Management	151,033	7,555	158,588
Subtotal	768,287	343,273	1,111,560
Minimum 35% Share	-	389,046	-
5% Cash	-	55,578	-
Additional Required Cash	-	0	-
Total Required Cash	-55,578	55,578	-
Total	712,709	398,851	1,111,560
Cost Sharing (%)	64	36	100
Total Common Features Recommended Plan			
Lands and Damages	20,719	220,284	241,003
Relocations	0	111,147	111,147
Fish & Wildlife Facilities	20,944	0	20,944
Levees & Floodwalls	557,580	0	557,580
Pumping Plants	56,135	0	56,135
Cultural Resource Preservation	7,768	0	7,768
Subtotal	663,146	331,431	994,577
PED	200,506	19,809	220,315
Construction Management	167,082	7,566	174,648
Subtotal	1,030,734	358,806	1,389,540
Minimum Adjusted Share	-	458,541	-
5% Cash	-	69,477	-
Additional Required Cash	-	40,063	
Total Required Cash	-109,540	109,540	-
Total	921,194	468,346	1,389,540
Cost Sharing (%)	66.3	33.7	100

5-5. FULLY FUNDED COST ESTIMATE

With the NLIP project, the sponsor has already started construction of part of the recommended plan. As described previously, the sponsor has made several requests for credit under Section 104. Table 5-5 below shows the estimated costs of the constructed and unconstructed portions of the recommended plan. The costs for the constructed portions reported in Table 5-5 are based on the fully funded cost estimate contained in Appendix G, Cost.

Table 5-5. Constructed and Unconstructed Parts of Recommended Plan ($000)

	Constructed (Non-Federal)	Unconstructed	
		Federal	Non-Federal
Lands and Damages	7,772	18,492	197,566
Relocations	47,422	0	63,344
Fish & Wildlife Facilities	1,943	16,926	0
Levees & Floodwalls	104,495	283,588	0
Pumping Plants	0	56,135	0
Cultural Resource Preservation	0	6,578	0
Subtotal	161,632	381,719	260,910
Preconstruction Engineering and Design	92,076	47,343	9,292
Construction Management	123,437	28,156	6,995
Subtotal	37,7145	457,218	277,197
Minimum 35% Share	NA	-	257,045
5% Cash	NA	-	36,721
Additional Required Cash	NA	-	0
Total Required Cash	NA	-36,721	36,721
Total	NA	420,497	313,918
Cost Sharing	NA	57.3	42.7

Taking into consideration the sponsor's construction, the required funding by fiscal year has been determined for those segments of the project not yet constructed. Table 5-6 shows the estimated project funding requirements by fiscal year for the recommended plan. This estimate of funding includes price escalation using Office of Management and Budget inflation factors. The funding requirements listed in this table consider that portions of the project have already been constructed, and do not consider any possible crediting that the local sponsor for which the non-Federal sponsor may be eligible for under Section 104.

Table 5-6. Funding by Fiscal Year ($000)

Federal	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	Total
Preconstruction Engineering and Design	5,090	0	20,993	11,288	9,939	4,661	0	51,971
Construction Management	0	0	0	12,169	9,028	8,062	2,993	32,252
Construction	0	0	0	144,997	95,064	86270	32,700	359,031
Fish and Wildlife Facilities	0	0	0	1,694	8,845	7,233	225	17,997
Cultural Resources	0	6,839	0	0	0	0	0	6,839
Federal LERRD	0	0	3,142	7,225	3,044	1,894	4,321	19,626
Total Federal	5,090	6,839	24,135	177,373	125,920	108,120	40,239	487,716
Non-Federal Up Front Cash	1,782	2,206	0	13,030	10,047	8,646	3,232	38,943
Net Federal	**3,308**	**4,633**	**24,135**	**164,343**	**115,873**	**99,474**	**37,007**	**448,773**
Non-Federal	**FY 2010**	**FY 2011**	**FY 2012**	**FY 2013**	**FY 2014**	**FY 2015**	**FY 2016**	**Total**
Preconstruction Engineering and Design	0	0	940	3,128	4,695	1,045	0	9,808
Construction Management	0	288	0	1,387	2,114	2,092	1,563	7,444
Relocations	0	0	0	14,046	0	52,983	0	67,029
Non-Federal LERRD	0	0	28,972	56,764	47,690	54,642	18,802	206,870
Total Non-Federal	0	288	29,912	75,325	54,499	110,762	20,365	291,151
Non-Federal Up Front Cash	1,782	2,206	0	13,030	10,047	8,646	3,232	38,943
Total Non-Federal	**1,782**	**2,494**	**29,912**	**88,355**	**64,546**	**119,408**	**23,597**	**330,094**
Total Project	**5,090**	**7,127**	**54,047**	**252,698**	**180,419**	**218,882**	**60,604**	**778,867**

The Sacramento District is planning to prepare two crediting documents in accordance with the requirements of Engineering Regulation (ER) 1165-2-29, General Credit for Flood Control in order to evaluate the actual credit that may be afforded to the non-Federal sponsor. The first document is expected to be ready in the second quarter of FY 2011. This document will address the features constructed by the non-Federal sponsor up through the first quarter of FY 2011. A second crediting document will be prepared upon completion of all construction by the non-Federal sponsor. This document is anticipated to be ready in FY 2012. Therefore, based upon these anticipated actions, an estimate of the funding requirements including credit for the non-Federal sponsor is shown in Table 5-7. These are preliminary estimates and do not reflect a determination by the Administration on specific credit amounts.

Table 5-7. Funding by Fiscal Year Considering Potential Section 104 Crediting ($000)

	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Federal Contribution	3,308	4,633	24,135	164,343	115,873	99,474	37,007
Non-Federal Contribution	1,782	2,494	29,912	88,355	64,546	119,408	23,597
Potential Credit for Non-Federal Construction	0	0	29,912	88,355	64,546	119,408	23,597
Total Adjusted Federal Cost	**3,308**	**4,633**	**54,047**	**252,698**	**180,419**	**218,882**	**60,604**
Total Adjusted Non-Federal Cost	**1,782**	**2,494**	**0**	**0**	**0**	**0**	**0**

5-6. INSTITUTIONAL REQUIREMENTS

The schedule for project implementation assumes reauthorization of the Common Features Project in the proposed WRDA 2010. After reauthorization, the project would be eligible for additional construction funding. The project would be considered for inclusion in the President's budget based: on national priorities, magnitude of the Federal commitment, economic and environmental feasibility, level of local support, willingness of the non-Federal sponsor to fund its share of the project cost and the budget constraints that may exist at the time of funding. Once Congress appropriates Federal construction funds, the Corps and the non-Federal sponsor would enter into a project partnership agreement (PPA). This agreement would define the Federal and non-Federal responsibilities for implementing, operating and maintaining the project.

Even though SAFCA continues to acquire real estate for the project, the Corps would officially request the non-Federal partner to acquire the necessary real estate immediately after the signing of the project partnership agreement. The advertisement of the first construction contract by the Corps would follow the certification of the real estate. The final acceptance and transfer of the project to the non-Federal sponsor would follow the delivery of an O&M manual and as-built drawings. The estimated schedule for project implementation is shown in the following table:

Table 5-8. Implementation Schedule

Item	Completion Date
Plans and Specifications for First Contract Complete	August 2011
PPA Signed	March 2011
Real Estate Acquisitions Completed for First Contract	August 2011
Advertise First Construction Contract	October 2011
Completion of All Construction	October 2016

CHAPTER 6 - PUBLIC INVOLVEMENT, REVIEW, AND CONSULTATION

6-1. PUBLIC INVOLVEMENT PROGRAM

To announce the start of the Common Features General Reevaluation Study, a notice of intent (NOI) to prepare the American River Common Features General Re-evaluation Report (GRR) Environmental Impact Statement (EIS) was posted in the Federal Register (Vol. 73, No. 41) on February 29, 2008. The recipients were invited to comment on the results of the earlier completed reconnaissance study and to provide input to the feasibility study, including the scoping of the environmental issues that should be address throughout the study. The notice in 2008 announced a group of public workshops, where the public was given the opportunity to comment. The meeting locations, dates, and times were as follows:

- March 5, Scottish Rite Center—6 151 H Street, Sacramento (5-7pm)
- March 10, Library Galleria—828 I Street, Sacramento (3-6pm)
- March 12, Elk's Lodge— 6446 Riverside Boulevard, Sacramento (5-7pm)
- March 13, Sierra Health Foundation— 1321 Garden Highway, Sacramento (5-7pm)

A joint National Environmental Policy Act (NEPA)/California Environmental Quality Act (CEQA) public scoping meeting was held on November 18, 2009 from 4:30 to 6:30 p.m. at the South Natomas Community Center in Sacramento, California, to brief interested parties on the Natomas PACR/Phase 4b Project and obtain the views of agency representatives and the public on the scope and content of the EIS/EIR.

6-2. PUBLIC FEEDBACK

There were 46 people in all who attended the four meetings. Comments were solicited through the use of court reporters at the meetings. Additionally, comments could be submitted through mail or electronic mail. Oral and written comments were made throughout the series of meetings by 12 local, State, and Federal agencies, two community organizations, and 26 individuals. The comments and the responses to them are summarized in the Public Involvement Section of the FEIS/EIR (Appendix I of the FEIS/EIR).

6-3. OTHER PUBLIC INVOLVEMENT

To help the community stay informed about current project activities, information is provided in a variety of ways:

- The Corps and SAFCA each maintain Web sites (http://www.spk.usace.army.mil and http://www.safca.org/Programs_Natomas.html, respectively) that contain public documents related to the NLIP. Additionally, SAFCA's Web site contains public notices, project maps, schedule updates, news articles, SAFCA Board of Directors meeting agendas and meeting summaries, and other project-related materials;

- SAFCA periodically mails Executive Director Updates to property owners located adjacent to the NLIP project footprint;

- NLIP updates are provided at the monthly SAFCA Board of Directors meetings, which typically occur on the third Thursday of each month. These meetings are held at the Sacramento County Board of Supervisors Chambers at 700 H Street, Sacramento, California, 95814 and begin at 3:00 p.m.; and

- SAFCA has held several meetings with landowner groups and other interest groups during conceptual project design and will continue to meet with these groups to address concerns and interests.

6-4. INSTITUTIONAL INVOLVEMENT

a. Study Team. During the revaluation study, staff from the State of California and SAFCA participated along with the Corps as members of the study team. They participated directly in the study effort and on the Executive Committee. This involvement has led to support for the early implementation of the Natomas portion of the authorized project.

b. Agency Participation. During the general reevaluation study, coordination with the USFWS was conducted in accordance with the Fish and Wildlife Coordination Act. USFWS has provided the Corps with a draft Coordination Act Report that includes their views on the selected plan. USFWS had no mitigation recommendations beyond those described through the Section 7 consultation. Coordination under Section 7 of the Endangered Species Act has been completed and a Biological Opinion was received in October 2010. All USFWS recommendations will be given full consideration.

The project has been coordinated with National Marine Fisheries Service and the CDFG.

For the interim evaluation of the Natomas portion of the authorized project, these agencies have been participating through the Section 408 approval process, the Section 404 permitting process, and the NEPA/CEQA process.

The project has been coordinated with the FAA as portions of the project are located within the Sacramento County Airport flight zone. The FAA has been a cooperating agency on all phases of the NLIP.

6-5. GENERAL ACCOUNTING OFFICE (GAO) AUDIT

In 2002, the Corps reported that the cost of this work, known as the Common Features Project, had increased significantly. GAO was asked to determine why costs increased, the extent to which the Corps analyzed and reported the potential cost increases to Congress in a timely manner, and whether the Corps correctly estimated economic benefits. In the report of their audit, the GAO made six recommendations in order to keep Congress better informed about the

costs and benefits of flood risk management projects in Sacramento. These six recommendations were:

- For the American River levee improvements authorized in 1999 and for the planned Natomas Basin work, GAO recommended that the Secretary of the Army direct the Corps of Engineers to:
  - determine whether it is appropriate to conduct risk analyses of project costs and document the basis for that decision in its project files;
  - report information to Congress on the range of potential project benefits and the probability of achieving those benefits, as called for in the Corps' guidance, in future benefit-cost analyses;
  - arrange for a credible, independent review of the completeness and accuracy of the revised benefit-cost analyses.

- For the American River project component, we also recommend that the Secretary of the Army direct the Corps of Engineers to:
  - reanalyze the benefits of the improvements authorized in the 1999 WRDA, correcting for the mistakes made in counting and valuing properties and the inappropriate methodology used to calculate flood damages.

- Additionally, for the Natomas Basin project component, we recommend that the Secretary of the Army direct the Corps of Engineers to:
  - analyze the costs and benefits of alternatives to the current levee improvement plan and identify the flood protection plan that provides the greatest net benefits;
  - submit a report to Congress that includes a cost estimate for all of the planned Natomas Basin work and wait until Congress authorizes funding based on the report before beginning construction of any Natomas Basin levee improvements.

This report complies with all of these recommendations. Regarding the analysis of other alternatives to the current levee improvement program, the GAO report specifically mentioned the evaluating the alternative of diverting water to the Yolo Bypass via the Fremont Weir. The following is from the GAO report:

> *(O)ne possible alternative method for flood protection identified by the Sacramento Area Flood Control Agency as well as the Corps involves lowering the water level in the Sacramento River during floods by diverting water through the Fremont Weir and into the Yolo Bypass located at a point just before the Sacramento River flows past the Natomas Basin. The Fremont Weir is a low dam that controls the movement of large volumes of flood water from the Sacramento River by diverting it into the Yolo Bypass. The Yolo Bypass is a continuous, 40-mile open space corridor that is protected from urban development pressure by flood easements.*

Improvements to the Fremont Weir and the Yolo Bypass were evaluated early in the formulation process and eliminated from consideration. The reason for their elimination was that

they did not provide enough reduction in the flood water surface elevations to offset the need to alleviate seepage and stability problems with the levees in the Natomas Basin.

6-6. ADDITIONAL REQUIRED COORDINATION

Environmental Protection Agency: The FEIS/EIR has been submitted to EPA for the 30-day wait period.

Federal Aviation Administration (FAA) and Sacramento County Airport System: Coordination with these agencies has resulted in compliance with the FAA regulation that will reduce the potential for bird strikes. This includes moving compensation habitat outside of the flight pattern and re-grading borrow sites so that water does not pond and attract waterfowl. Coordination will continue as the project design is developed in detail.

California Department of Fish and Game (CDFG): Coordination with CDFG has been on-going. A 2081 permit application will be submitted by the local sponsor for approval prior to construction.

Other Federal, State, local agencies, and interested individuals: The FEIS/EIR will be made available for 30 days prior to a final decision and a Record of Decision being completed.

6-7. PUBLIC VIEWS AND RESPONSES

Federal, State, County, local and regional agencies, environmental organizations, and interested groups and individuals have reviewed and commented on the series of environmental impact statements that supported the non-Federal implementation of the Natomas improvements. This report is accompanied by the last in this series of environmental impact statements. A complete list of public comments on this last EIS and responses are contained in Appendix I to the EIS.

6-8. IMPACT ON RECOMMENDATIONS

Coordination with the EPA and the Sacramento Air Quality Management Board has resulted in expanding the construction schedule to reduce air emissions.

Coordination with a local Homeowners Association has resulted in modifications in designs to prevent unwanted project features that would result in aesthetic impacts, and changes in construction schedule to reduce traffic impacts and community disruption.

Coordination with FAA has resulted in compliance with the FAA regulation that will reduce the potential for bird strikes. This includes moving compensation habitat outside of the flight pattern and re-grading borrow sites so that water does not pond and attract waterfowl.

Coordination with the State Historic Preservation Office and local Indian Tribes resulted in design refinements to prevent effects to potential burial grounds and archeological sites.

The project has been designed to reduce impacts to listed species through coordination with USFWS, NMFS, and CDFG. Compensation designed into the project will be sufficient to cover any recommendations associated with the Fish and Wildlife Coordination Act.

Coordination with TNBC has assisted in design refinements that allow TNBC to continue their mission of creating and managing habitat for endangered species. Some project features actually increase the value of the habitat based on coordinating the location of sites adjacent to existing TNBC lands.

This page left intentionally blank.

CHAPTER 7 - RECOMMENDATIONS

I recommend modifying the authorized American River Common Features project to include the following improvements to the levees in the Natomas Basin:

- Sacramento River:
  - Widening of 18.3 miles of the existing levee a minimum of 15 feet through construction of an adjacent levee
  - Installation of approximately 12.3 miles of soil bentonite cutoff wall
  - Installation of approximately 8.3 miles of seepage berms
- Natomas Cross Canal
  - Widening of 5.0 miles of the existing levee
  - Installation of 5.0 miles of soil bentonite cutoff wall
  - Bridge Remediation at State Route 99
- Pleasant Grove Creek Canal
  - Widening of 3.2 miles of the existing levee
  - Installation of 3.2 miles of soil bentonite cutoff wall
  - Culvert remediation
  - Bank protection
- Natomas East Main Drain Canal
  - Widening of 12.8 miles of the existing levee
  - Installation of 10.7 miles of soil bentonite cutoff wall
  - Bank protection
- American River
  - Widening of 2.0 miles of the existing levee
  - Installation of 2.0 miles of soil bentonite cutoff wall
- Other
  - Right-of-way acquisition
  - Relocations
  - Agricultural irrigation and drainage improvements, including construction of a new Giant Garter Snake/Drainage Canal
  - Habitat creation and management in connection with project borrow activities
  - Aviation safety components, including relocation of irrigation and drainage infrastructure in the Airport Operation Area and grading of the Airport's northern bufferlands to improve surface drainage and reduce the risk of bird strikes

The estimated first cost of these recommended improvements is $1,111,560,000. Adding the cost of these improvements to the Common Features project makes a total project first cost of $1,389,540,000. The estimated annual Operation and Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) cost is $5,265,000. The Federal portion of the estimated total first cost is $921,194,000. The total first cost of the Common Features project of $1,389,540,000 includes costs already incurred implementing previously authorized Common Features elements. The previously authorized and constructed projects were cost shared at 75% Federal and 25% non-Federal. New Natomas elements will be cost shared in accordance with WRDA 1986. Applying these requirements results in cost sharing for the Recommended Plan (authorized features plus new Natomas features) at 66.3% Federal and 33.7% non-Federal.

The Assistant Secretary of the Army for Civil Works (ASA(CW)) has conditionally approved credit under Section 104 of the Water Resources Development Act of 1986, for Phases 1, 2, and 3 of the SAFCA project corresponding to Reach D, Reach C, and a portion of Reach B as described in Table 5-3 herein. The remainder of Reach B is included in a request for Section 104 credit that is under consideration by the ASA(CW). The estimated cost of the Section 104 credits conditionally approved to date is $387,230,000 with an additional $132,000,000 pending for Phase 4a (portion of Reach B). The non-Federal sponsor does not plan to construct all of the work conditionally approved for credit. The work described in Table 5-3 is all of the work constructed or planned to be constructed that is integral to the plan for the Natomas Basin recommended in this report. The actual credit will be limited to 45 percent of project cost and be based on the audited cost incurred by the non-Federal sponsor limited to the cost of the work if the work had been accomplished by the Government. The credit will be based on the design and construction costs associated with the Section 104 work and will be applied as follows:

First, to any additional cash contribution, over and above the required 5 percent cash share, to achieve a minimum 35 percent non-Federal share of project costs.

Second, any remaining credit may be realized by the Corps of Engineers, subject to availability of funds and at its sole discretion, acquiring on behalf of the non-Federal sponsor, any remaining lands, easements, and rights- of- way, required for the project; performing any remaining relocations necessary for the project; or constructing any remaining improvements required on lands, easements, or rights-of-way to enable the disposal of dredged or excavated material required for the project.

Third, for any remaining credit, the Corps of Engineers, subject to the availability of funds, may reimburse the non-Federal sponsor an amount equal to the unafforded credit amount.

The non-Federal sponsor shall, prior to implementation, agree to perform the following items of local cooperation:

a. Provide a minimum of at least 25 percent of total project costs for the lower American River portion of the project and at least 35 percent for the Natomas Basin portion of the project but not to exceed 50 percent of total project costs as further specified below:

    1. Provide a cash contribution equal to five percent of total project costs.

    2. Provide 25 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

    3. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs;

    4. Provide all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material, and the disposal of dredged or excavated material; perform or ensure the performance of all relocations; and construct all improvements required on

lands, easements, and rights-of-way to enable the disposal of dredged or excavated material all as determined by the Government to be required or to be necessary for the construction, operation, and maintenance of the project;

5. Provide, during construction, any additional funds necessary to make its total contribution equal to at least 25 percent of total project costs for the lower American River portion of the project and at least 35 percent for the Natomas Basin portion of the project;

b. Provide 100 percent of all costs for local betterments.

c. Shall not use funds from other Federal programs, including any non-Federal contribution required as a matching share therefore, to meet any of the non-Federal obligations for the project unless the Federal agency providing the Federal portion of such funds verifies in writing that expenditure of such funds for such purpose is authorized;

d. Not less than once each year, inform affected interests of the extent of protection afforded by the project;

e. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

f. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal interest to prepare a floodplain management plan within one year after the date of signing a project cooperation agreement, and to implement such plan not later than one year after completion of construction of the project;

g. Publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with protection levels provided by the project;

h. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) such as any new developments on project lands, easements, and rights-of-way or the addition of facilities which might reduce the level of protection the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;

i. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal

of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

j. For so long as the project remains authorized, operate, maintain, repair, rehabilitate, and replace the project, or functional portions of the project, including any mitigation features, at no cost to the Federal Government, in a manner compatible with the project's authorized purposes and in accordance with applicable Federal and State laws and regulations and any specific directions prescribed by the Federal Government;

k. Give the Federal Government a right to enter, at reasonable times and in a reasonable manner, upon property that the non-Federal sponsor owns or controls for access to the project for the purpose of completing, inspecting, operating, maintaining, repairing, rehabilitating, or replacing the project;

l. Hold and save the United States free from all damages arising from the construction, operation, maintenance, repair, rehabilitation, and replacement of the project and any betterments, except for damages due to the fault or negligence of the United States or its contractors;

m. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of three years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

n. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 106 of the National Historic Preservation Act of 1966, Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army"; and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.) and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);

o. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be

required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

p. Assume, as between the Federal Government and the non-Federal sponsor, complete financial responsibility for all necessary cleanup and response costs of any hazardous substances regulated under CERCLA that are located in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project;

q. Agree, as between the Federal Government and the non-Federal sponsor, that the non-Federal sponsor shall be considered the operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and

r. Comply with Section 221 of Public Law 91-611, Flood Control Act of 1970, as amended (42 U.S.C. 1962d-5b), and Section 103(j) of the Water Resources Development Act of 1986, Public Law 99-662, as amended (33 U.S.C. 2213(j)), which provides that the Secretary of the Army shall not commence the construction of any water resources project or separable element thereof, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

The recommendations contained herein reflect the information available at this time and current departmental policies governing formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Congress as proposals for authorization and implementation funding. However, prior t transmittal to the Congress, the sponsor, the States, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

WILLIAM J. LEADY
Colonel, Corps of Engineers
District Engineer

This page left intentionally blank.

CHAPTER 8 - REFERENCES

American Canoe Association, 2009. Boating, Shock and Hypothermia http://www.enter.net/~skimmer/coldwater.html

California Department of Conservation. 1977. Geologic Map of California. California Department of Conservation, Division of Mines and Geology.

California Department of Water Resources (DWR). 2008. FloodSAFE California. http://water.ca.gov/floodsafe/

Centers for Disease Control and Prevention, National Institutue for Occupational Safety and Health. 2009 http://www.cdc.gov/niosh/docs/94-123/

Federal Aviation Association (FAA). 2008a. Airport Wildlife Mitigation – Overview. http://wildlife.pr.erau.edu/Overview.htm

Federal Aviation Association (FAA). 2008b. Airport Wildlife Hazard Mitigation. http://wildlife-mitigation.tc.faa.gov/public_html/index.html

Jonkman, S.N., Maaskant, B., Boyd, E., and Levithan, M. 2008. Loss of Life caused by the Flooding of New Orleans after Hurricane Katrina: A Preliminary Analysis of the Relationship between Flood Characteristics and Mortality. http://www.hkv.nl/documenten/Loss_of_life_caused_by_the_flooding_of_New_Orleans_after_hurricane_Katrina_BM(1).pdf

Kelley, R. 1989. Battling the Inland Sea. University of California Press. Berkeley and Los Angeles, CA.

Loudon County. 2007. Preventing Disease and Injury in a Flood. Loudon County, Virginia Home Page. http://loudoun.vhost.vipnet.org/general/healthissues.htm

Natomas Basin Conservancy. 2008. Natomas Basin Habitat Conservation Plan. http://www.natomasbasin.org/content/view/23/113/

Occupational Health & Safety Administration (OSHA). 2004. Emergency Preparedness and Response: Safety and Health Guides – Floods. http://www.osha.gov/SLTC/emergencypreparedness/guides/floods.html

Roos, Maurice. July 2006. Irrigation and Drainage, Volume 55 Issue S1 July 2006, **"**Flood management practice in northern California".

Rss Weather.com. 2010. http://www.rssweather.com/climate/California/Sacramento/

Sacramento Area Flood Control Agency. 2007. Natomas Levee Improvement Program Bank Protection Project DEIR. Prepared by Jones & Stokes. Sacramento, CA.

Sacramento Area Flood Control Agency (SAFCA). 2008. Flooding History and Development Impact Fee. http://www.safca.org/

Sacramento County Historical Society. 2008. Flooding History. http://www.sachistoricalsociety.org/journal_VI.cfm

Sacramento International Airport. 2010. http://www.sacairports.org/int/

State of Georgia. 2006. Epidemiology Issues Associated with Flooding. Georgia Department of Human Resources, Division of Public Health. http://health.state.ga.us/epi/katrina/Flood%20-%20Epidemiology%20Issues.doc

U.S. Army Corps of Engineers. 1992. Sacramento Metropolitan Area, California. Feasibility Report and Environmental Impact Statement/Environmental Impact Report. Sacramento District. Sacramento, CA.

U.S. Army Corps of Engineers. 2002. American River Watershed Project (Common Features), California, Second Addendum to the Supplemental Information Report SIR. Sacramento District. Sacramento, CA.

U.S. Army Corps of Engineers. 2007. Treatment of Vegetation within Local Flood Damage Reduction Systems. Draft White Paper.

U.S. Army Corps of Engineers. August 2009. Louisiana Coastal Protection and Restoration, Final Technical Report and Comment Addendum. New Orleans District, New Orleans, LA.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Weather Service, Spokane Weather Forecast Office. 2008. Pineapple Express. http://www.wrh.noaa.gov/otx/outreach/ttalk/pinaplx.php