1. Administrative Details

Proposal Name: American River Watershed Common Features General Re-evaluation Report

by Agency: Sacramento District of the U.S. Army Corps of Engineers (USACE) is preparing the GRR

Locations: CA

POC Name:

POC Phone:

POC Email:

Date Submitted: 09/24/2015

Confirmation Number: b3e9a582-4e1d-4b1e-9e20-a7f85611dfd0

Supporting Documents

File Name	Date Uploaded
ARCF GRR Section 7001.pdf	09/24/2015
ARCF-Draft-GRR-Mar2015.pdf	09/24/2015
Section 7001 Letter.pdf	09/24/2015

2. Provide the name of the primary sponsor and all non-Federal interests that have contributed or are expected to contribute toward the non-Federal share of the proposed feasibility study or modification.

Sponsor	**Letter of Support**
State of California Central Valley Flood Protection Board(Primary)	The non-Federal sponsors, CVFPB and the SAFCA, are active participants in the GRR. CVFPB and SAFCA view the modifications identified in the GRR as critical components of the flood damage reduction system and are fully supportive of its implementation. CVFPB and SAFCA have the ability to provide for the required cost share of the recommended plan.
Sacramento Area Flood Control Agency	The non-Federal sponsors, CVFPB and the SAFCA, are active participants in the GRR. CVFPB and SAFCA view the modifications identified in the GRR as critical components of the flood damage reduction system and are fully supportive of its implementation. CVFPB and SAFCA have the ability to provide for the required cost share of the recommended plan.

3. State if this proposal is for a feasibility study, a modification to an authorized USACE feasibility study or a modification to an authorized USACE project. If it is a proposal for a modification, provide the authorized water resources development feasibility study or project name.

[x] Modification to an Authorized USACE Project : American River Watershed Common Features Project

4. Clearly articulate the specific project purpose(s) of the proposed study or modification. Demonstrate that the proposal is related to USACE mission and authorities and specifically address why additional or new authorization is needed.

The GRR recommends a plan for further improving levee performance and further reducing the risk of levee failure along the Lower American and Sacramento Rivers and their tributaries in the North Sacramento area.

The basic authority for USACE to study water resource related issues in the American and Sacramento Rivers is in Section 209 of the Flood Control Act of 1962 (Pub. L. No. 87-875, § 209, 76 Stat. 1180, 1196-98 (1962)), which authorizes studies for flood control in northern California. The current report is being prepared as a general reevaluation study of the American River Watershed Common Features Project, which was authorized by Section 101(a) (1) of the Water Resources Development Act (WRDA) 1996. The recommended plan includes levee improvements to reduce seepage, stability and erosion problems along with widening the Sacramento Weir and Bypass. This plan however, is more expensive than the National Economic Development (NED) plan. Project costs up to the identified NED cost would be cost shared per WRDA 1986 direction.

5. To the extent practicable, provide an estimate of the total cost, and the Federal and non-Federal share of those costs, of the proposed study and, separately, an estimate of the cost of construction or modification.

	Federal	**Non-Federal**	**Total**
Study	$7,450,000	$7,450,000	$14,900,000
Construction	$865,351,000	$604,164,000	$1,469,515,000

Explanation (if necessary)

The Draft GRR was released for public review in March 2015. The cost estimate presented above came from the recommended plan in the Draft GRR.

6. To the extent practicable, describe the anticipated monetary and nonmonetary benefits of the proposal including benefits to the protection of human life and property; improvement to transportation; the national economy; the environment; or the national security interests of the United States.

Reducing flood risk in the Sacramento area is the primary purpose of the Common Features project. The City of Sacramento is the capital of California, a state that by itself has the eighth largest economy in the world and a population of 38 million. Many state offices, including the State Capital building, are located in downtown Sacramento in areas that could be affected by flood events. Flooding could disrupt government services, affect emergency services and disrupt transportation corridors. The major highways in the study area include Interstate 5, Interstate 80, U.S. Highway 50, and U.S. Highway 99. Union Pacific Railroad and Burlington Northern Santa Fe (BNSF) Railroad carry freight on two main line railroad tracks that run through the Sacramento area while AMTRAK provides passenger service. California State University, Sacramento is also located in the floodplain. The population within the 0.5% (1/200) annual chance exceedance floodplain of the study area south of the American River is approximately 440,000 people and the population in the floodplain of the study area north of the American River is approximately 60,000 people.

The recommended plan improves levee performance and reduces the risk of levee failure, thereby increasing the level of flood protection for 500,000 people in these areas. The net annual benefits for the recommended plan are $315,800 and the B/C ratio is 4.3:1.

7. Does local support exist? If 'Yes', describe the local support for the proposal.

[x] Yes

Local Support Description

The non-Federal sponsors, CVFPB and SAFCA, are active participants in the GRR. CVFPB and SAFCA view the modifications identified in the GRR as critical components of the flood damage reduction system and are fully supportive of its implementation.

8. Does the primary sponsor named in (2.) above have the financial ability to provide for the required cost share?

[x] Yes

Primary Sponsor Letter of Support

(As uploaded)

Section 7001 Letter.pdf

Sacramento
Area Flood
Control
Agency

August 24, 2015

U.S. Army Corps of Engineers
Attn: CECW-CE (Lisa Kiefel)
441 G Street, NW
Washington, DC 20314-1000

Subject: Proposals from Non-Federal Interests to be Included in the February 2016 U.S. Army Corps of Engineers Annual Report to Congress on Future Water Resources Development

Dear Ms. Kiefel:

It is requested that the proposal identified in this letter be included in the February 2016 U.S. Army Corps of Engineers (USACE) Annual Report to Congress on Future Water Resources Development. This proposal has been submitted online as required at http://www.wrrda7001proposals.us/.

The Sacramento District of the USACE is preparing the American River Watershed Common Features General Reevaluation Report (GRR). The non-Federal sponsors for the GRR are the State of California Central Valley Flood Protection Board (CVFPB) and the Sacramento Area Flood Control Agency (SAFCA).

The proposal is a request for a modification of an authorized USACE project. The proposal meets all the criteria for inclusion in the Annual Report, not the appendix. The five criteria set forth in Section 7001 of Public Law 113-121 are met as follows:

> *(A) CRITERIA FOR INCLUSION IN REPORT. - The Secretary shall include in the annual report only those feasibility reports, proposed feasibility studies, and proposed modifications to authorized water resources development projects and feasibility studies that:*
>
> *(i) are related to the missions and authorities of the Corps of Engineers;*
>
> The USACE is preparing the GRR to recommend modifications of the American River Watershed Common Features Project. The basic authority for the USACE to study water resource related issues in the American and Sacramento Rivers is in Section 209 of the Flood Control Act of 1962 (Pub. L. No. 87-875, § 209, 76 Stat. 1180, 1196-98 (1962)), which authorizes studies for flood control in northern California. The current report is being

Office 916-874-7606
Fax 916-874-8289

1007 - 7th Street, 7th Floor
Sacramento, CA 95814-3407

prepared as a general reevaluation study of the American River Watershed Common Features Project, which was authorized by Section 101(a) (1) of the Water Resources Development Act (WRDA) 1996, (Pub. L. No. 104-303, § 101(a)(1), 110 Stat. 3658, 3662-3663 (1996)) and amended by Section 366 of WRDA of 1999, (Pub. L. 106-53, § 366, 113 Stat. 269, 319-20 (1999)); and Section 130 of the Energy and Water Development Appropriations Act (EWDAA) of 2008, (Pub. L. No. 110-161, § 130, 121 Stat. 1844, 1947 (2003)). Significant changes to the authorized project cost were recommended in the Second Addendum to the Supplemental Information Report of March 2002. This report was submitted to the Assistant Secretary of the Army for Civil Works (ASA(CW)), but Congress acted to raise project costs before the 2002 report could be forwarded to Congress. (See Section 129 of the EWDAA of 2004, Pub. L. No. 108-137, §129, 117 Stat. 269, 1839 (2004))

(ii) require specific congressional authorization, including by an Act of Congress;

The USACE has concluded that the modifications to the authorized project require specific authorization from Congress. As such, the USACE will be preparing a Chief's Report for the American River Watershed Common Features Project GRR, currently scheduled to be completed by April 2016.

(iii) have not been congressionally authorized;

The modifications being proposed in the GRR have not been previously authorized.

(iv) have not been included in any previous annual report; and

This proposal was not included in the 2014 Annual Report. It was included in the appendix.

(v) if authorized, could be carried out by the USACE.

The USACE clearly has the authority and capability to execute the project upon authorization by Congress.

The GRR recommends a plan for further improving levee performance and further reducing the risk of levee failure along the Lower American and Sacramento Rivers and their tributaries in the North Sacramento area.

The recommended plan would build on the accomplishments of previously authorized projects in the American River watershed including the American River Watershed Common Features Project features authorized in 1996 and 1999, the Folsom Dam Joint

Federal Project, the Folsom Dam Raise Project, and the recently authorized American River Watershed Common Features Project Natomas Basin features.

The recommended plan includes:

- Levee seepage and underseepage remediation along the Sacramento River east levee, the Natomas East Main Drainage Canal (NEMDC) east levee, the Arcade Creek north and south levees, and the Dry/Robla Creek south levee;
- Erosion control along the American River north and south levees and the Sacramento River east levee;
- Raising and strengthening the Magpie Creek Diversion Channel west levee; and
- Widening the Sacramento Weir and Bypass, which is located along the west bank of the Sacramento River, upstream of the confluence of the Sacramento and American Rivers, to reduce the risk of levee overtopping along the Sacramento River east levee, the NEMDC east levee, the Arcade Creek north and south levees; and the Dry/Robla Creek south levee.

Reducing flood risk in the Sacramento area is the primary purpose of the Common Features project. The City of Sacramento is the capital of California, a state that by itself has the eighth largest economy in the world and a population of 38 million. Many state offices, including the State Capital building, are located in downtown Sacramento in areas that could be affected by flood events. Flooding could disrupt government services, affect emergency services and disrupt transportation corridors. The major highways in the study area include Interstate 5, Interstate 80, U.S. Highway 50, and U.S. Highway 99. Union Pacific Railroad and Burlington Northern Santa Fe (BNSF) Railroad carry freight on two main line railroad tracks that run through the Sacramento area while AMTRAK provides passenger service. California State University, Sacramento is also located in the floodplain.

The population within the 0.5% (1/200) annual chance exceedance floodplain of the study area south of the American River is approximately 440,000 people and the population in the floodplain of the study area north of the American River is approximately 60,000 people.

The Draft GRR was released for public review in March 2015. The Agency Decision Milestone conference on the GRR was held June 30, 2015. The GRR Civil Works Review Board is scheduled for December 8, 2015. The Chief's Report is scheduled to be completed by April 2016. It is anticipated that the Chief's Report would then be transmitted to Congress with a recommendation for authorization.

The cost estimate for the recommended plan as presented in the Draft GRR is $1,469,515,000 with the Federal share of $865,351,000 and the non-Federal share of $604,164,000.

The recommended plan improves levee performance and reduces the risk of levee failure, thereby increasing the level of flood protection for 500,000 people in these areas. The net annual benefits for the recommended plan are $315,800 and the B/C ratio is 4.3:1.0.

The non-Federal sponsors, CVFPB and SAFCA, are active participants in the GRR. CVFPB and SAFCA view the modifications identified in the GRR as critical components of the flood damage reduction system and are fully supportive of its implementation. CVFPB and SAFCA have the ability to provide for the required cost share of the recommended plan. Enclosure 1 is a copy of the letter the CVFPB sent to the USACE expressing support for the recommended plan in the GRR. Enclosure 2 is a copy of the resolution passed by the SAFCA Board of Directors indicating SAFCA's intent to serve as the local sponsor for the project described in the American River Watershed Common Features General Reevaluation Report. The Central Valley Flood Protection Board is scheduled to adopt a similar resolution August 28, 2015.

Please let me know if any additional information is required. I can be contacted at (916) 874-7606 or at johnsonr@saccounty.net.

Thank you,

Richard M. Johnson
Executive Director

Enclosures (2)
cc:

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army
Department of the Army, Civil Works
108 Army Pentagon, Room 3E446
Washington, DC 20310-0108

Steven L. Stockton, Director of Civil Works
Headquarters, U.S. Army Corps of Engineers
441 G Street NW
Washington, DC 20314-1000

Honorable Jim Inhofe
Chairman, Committee on Environment and
Public Works U.S. Senate
410 Dirksen Senate Office Building
Washington, DC 20510-6175

Honorable Bill Shuster
Chairman, Committee on Transportation and
Infrastructure
and U.S. House of Representatives
2251Rayburn House Office Building
Washington, DC 20515-6256

Honorable Doris O. Matsui
House of Representatives
Rm. 222 Cannon House Office Building
Washington, DC 20515

Enclosure 1

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY EDMUND G. BROWN JR., GOVERNOR

CENTRAL VALLEY FLOOD PROTECTION BOARD
3310 El Camino Ave., Rm. 151
SACRAMENTO, CA 95821
(916) 574-0609 FAX: (916) 574-0682
PERMITS: (916) 574-2380 FAX: (916) 574-0682

November 14, 2014

Colonel Michael J. Farrell
District Commander
Sacramento District
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Non-federal Sponsor's Request for A Locally Preferred Plan (LLP) for the
American River Common Features General Reevaluation Report (GRR)

Dear Colonel Farrell:

This letter is in response to the U.S. Army Corps of Engineers (USACE) request for a statement of non-federal intent to financially support the incremental difference between the LPP and the National Economic Development (NED) plan, as defined in the subject study.

The LPP consists of improvements to the existing Sacramento and American River levees and widening the Sacramento Bypass. We strongly support the LPP because it includes the bypass widening, which is consistent with the Central Valley Flood Protection Plan (CVFPP) of 2012. We believe that from a resiliency standpoint, the LPP will better align the region to prepare for the future for such things as climate change. We encourage USACE to continue to consider allowing other benefits to factor in to federal interest decision-making.

The GRR serves as the vehicle for identifying the levee and related improvements which, in combination with the authorized Folsom Dam Modifications (Joint Federal Project) and Folsom Dam Raise Project, would provide the Sacramento area with higher level of protection consistent with State law.

We understand that the Draft GRR will be released for public review with a recommendation that the LPP be the Tentatively Selected Plan, with the federal share calculated based on the NED increment. While we would prefer federal cost-share in the LPP increment between the NED and the LPP, the State will work with the Sacramento Area Flood Control Agency towards financing that critically important increment. We recognize that the Non-federal cost for the increment has been estimated to cost up to $160,000,000 and that this amount will change as assumptions are scrutinized and design and estimates are refined during finalization of the study. The CVFPB is supportive of this project and the Board intends to enter into design and construction agreements with the federal cost share requirements and financing options for project implementation. Please note that this letter of intent is not an obligation of future appropriations of State funds by the State Legislature.

SAFCA '14 NOV 18 PM2:40

If you have any questions, please contact Michael Sabbaghian, Chief, Local Assistance Programs Branch, at (916) 574-1404 or Mahyar.Sabbaghian@water.ca.gov.

Sincerely,

Leslie M. Gallagher
Acting Executive Officer
Central Valley Flood Protection Board

cc: Richard Johnson
Executive Director
Sacramento Area Flood Control Agency
1007 7th Street, 7th Floor
Sacramento, California 95814

Pete Ghelfi
Director of Engineering
Sacramento Area Flood Control Agency
1007 7th Street, 7th Floor
Sacramento, California 95814

Dan Tibbitts
Project Manager
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Nicole Ortega
Program Manager
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Department of Water Resources
Division of Flood Management
3310 El Camino Avenue
Sacramento, California 95821

Mr. Keith E. Swanson, Chief
Division of Flood Management

Department of Water Resources
Division of Flood Management
Flood Projects Office
3464 El Camino Avenue, Suite 200
Sacramento, California 95821

Mr. Eric S. Koch, Chief
Flood Projects Office

Mr. Michael Sabbaghian, Chief
Local Assistance Programs Branch

Mr. Robert E. Scarborough, Chief
USACE/CVFPB Projects Section
Federal Programs Branch

Mr. Ajala I. Ali, Project Manager
USACE/CVFPB Projects Section
Federal Programs Branch

Enclosure 2

RESOLUTION NO. 2015-089
Adopted by the Sacramento Area Flood Control Agency

INDICATING SAFCA'S INTENT TO SERVE AS THE LOCAL SPONSOR FOR THE PROJECT DESCRIBED IN THE AMERICAN RIVER WATERSHED COMMON FEATURES GENERAL REEVALUATION REPORT

WHEREAS, the American River Watershed Common Features Project (Common Features Project) authorized in the Water Resources Development Acts of 1996 and 1999 calls for construction of levee improvements along the Lower American River and around portions of the Natomas Basin (or Basin) in Sacramento and Sutter Counties; and

WHEREAS, construction of the authorized improvements along the American River has been underway since 1998 under the terms of a Project Cooperation Agreement (PCA) between the Department of the Army acting through the U.S. Army Corps of Engineers (USACE) and the State of California (State) acting through the California Reclamation Board and its successor the Central Valley Flood Protection Board (CVFPB) and under the terms of a Local Project Cooperation Agreement between the State and SAFCA; and

WHEREAS, in 2014, Congress authorized the American River Watershed Common Features - Natomas Basin which identifies improvements to the Natomas Basin levee system and raised the cost ceiling of the American River Common Features program to over $1.3 billion; and

WHEREAS, the parties are seeking Congressional approval for expanding the scope of the Common Features Project in the Sacramento Area and have cooperated in preparing the General Reevaluation Report (GRR) for the American River Watershed Common Features Project which evaluates deficiencies in the existing levee system around the Sacramento Area, describes alternative plans to address these deficiencies, and identifies a tentatively selected plan of improvements; and

WHEREAS, the parties have also prepared a Draft Environmental Impact Statement/Draft Environmental Impact Report (DEIS/EIR) analyzing the environmental effects of the various plans considered in the Main Report and issued the GRR and DEIS/DEIR in March 2015; and

WHEREAS it is appropriate and a requirement for the SAFCA Board to communicate SAFCA's support for the tentatively selected plan evaluated in the GRR and to indicate the Agency's preparedness to provide the required elements of local cooperation for the plan that is ultimately authorized by Congress based on the following considerations:

- For purposes of evaluating the alternative plans described in the Main Report, the USACE divided the proposed improvements into the North Area Streams, the Sacramento River levee system south of the confluence with the American River, erosion protection along the American River, and Sacramento Bypass and Weir improvements.

- The tentatively selected plan considered in the GRR consists of levee strengthening, erosion protection, levee raising, and widening the Sacramento Weir and Bypass. The report calls out improvements for the North Area Streams including levee strengthening along Arcade Creek and the Natomas East Main Drainage Canal/Steelhead Creek; levee strengthening along the Sacramento River from the mouth of the American River down to Freeport; addressing erosion along the American and Sacramento Rivers; and expanding the Sacramento Weir and Bypass. Along with physical levee improvements to the levee system, the report also identifies the need to address encroachments and vegetation under a system wide improvement framework that allows time for the levees to meet USACE levee standards; and

WHEREAS, to maintain the current schedule for processing the GRR, SAFCA's willingness to serve as the local sponsor for the tentatively selected plan should be promptly communicated to the State through the CVFPB. The State is the non-Federal sponsor of the American River Watershed Common Features Project and will be expected to provide the required assurances of non-Federal cooperation if Congress decides to approve the plan. The State's willingness to provide these assurances needs to be communicated in a timely way to the USACE. This action is dependent on the State's receipt of SAFCA's assurances of local cooperation as set forth herein.

NOW, THEREFORE, BE IT RESOLVED BY THE SACRAMENTO AREA FLOOD CONTROL AGENCY BOARD OF DIRECTORS THAT:

1. SAFCA intends to serve as the local sponsor for the American River Watershed Common Features General Reevaluation Report as a Federal flood control project, including, but not limited to the improvements to the Sacramento Area levees that are being recommended for Congressional approval based on the information provided in the General Reevaluation Report. Toward that end, SAFCA is prepared to cooperate with the State, through the CVFPB, in providing the commitments of local support listed in Exhibit A, attached hereto and incorporated herein by this reference, once the environmental review process is complete and Congress has adopted the plan.

2. The Executive Director is hereby directed to work with the State, through the CVFPB, to secure a Letter of Intent from the State indicating the State's support for the recommended plan and the State's willingness to provide the assurances of non-Federal cooperation that will be required to implement the plan.

ON A MOTION BY Director Harris, seconded by Director Shiels, the foregoing resolution was passed and adopted by the Board of Directors of the Sacramento Area Flood Control Agency, this 20th day of August 2015, by the following vote, to wit:

AYES:	Directors:	Ashby, Barandas, Harris, Holloway, Jennings, MacGlashan, McKee, Nava, Nottoli, Peters, Shah and Shiels
NOES:	Directors:	(None)
ABSTAIN:	Directors:	(None)
RECUSE:	Directors:	(None)
ABSENT:	Directors:	LeVake

Don Nottoli

Chair of the Board of Directors of the
Sacramento Area Flood Control Agency

(SEAL)

ATTEST:

Lynnette Russell

Clerk of the Board of Directors

PGlr/SAFCA'sIntenttoServasLocalsponsor
Attachment

Exhibit A

ASSURANCES OF LOCAL COOPERATION

Prior to implementation of any Federally authorized element of the American River Watershed Common Features General Reevaluation Report, SAFCA shall provide to the State the following assurances of local cooperation in connection with the project:

a. Provide the local share of the total project costs for the authorized Project elements.

b. Cooperate with the State in providing all lands, easements, and rights-of-way, including those required for relocations, the borrowing of material; performing or ensuring the performance of all relocations; and constructing 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;

c. Avoid use of 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 State, 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 local 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 State and 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 State, 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 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 investigation in accordance with such written direction;

p. Assume, as between the State and the local 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 State and the local sponsor, that the local 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 therefore, until each non-Federal interest has entered into a written agreement to furnish its required cooperation for the project or separable element.

Additional Proposal Information

(This is as uploaded, a blank page will show if nothing was submitted)

ARCF GRR Section 7001.pdf

STATE OF CALIFORNIA – CALIFORNIA NATURAL RESOURCES AGENCY EDMUND G. BROWN JR., GOVERNOR

CENTRAL VALLEY FLOOD PROTECTION BOARD
3310 El Camino Ave., Rm. 151
SACRAMENTO, CA 95821
(916) 574-0609 FAX: (916) 574-0682
PERMITS: (916) 574-2380 FAX: (916) 574-0682

September 23, 2015

U.S. Army Corps of Engineers
Attn: CECW-CE (Lisa Kiefel)
441 G Street, NW
Washington, DC 20314-1000

Subject: Proposals from Non-Federal Interests to be Included in the February 2016 U.S. Army Corps of Engineers (USACE) Annual Report to Congress on Future Water Resources Development

Dear Ms. Kiefel:

This letter documents the non-Federal support by the State of California Central Valley Flood Protection Board (CVFPB) for inclusion of a proposal for construction authorization of the project recommended in the American River Common Features General Reevaluation Report (GRR). Include the recommended project in the Annual Report to Congress directed in Section 7001 of the Water Resources Reform and Development Act of 2014. We recognize that the GRR must be approved by the USACE in a Chief of Engineers Report before the project can be authorized for construction.

This proposal has been submitted online as required at http://www.wrrda7001propsals.us/ and meets all the criteria for inclusion in the Annual Report. The five criteria set forth in Section 7001 of Public law 113-121 are met as follows:

(A) CRITERIA FOR INCLUSION IN REPORT.—The Secretary shall include in the annual report only those feasibility reports, proposed feasibility studies, and proposed modifications to authorized water resources development projects and feasibility studies that—

(i) are related to the missions and authorities of the Corps of Engineers;

USACE is preparing the GRR to recommend modifications of the American River Watershed Common Features Project. The basic authority for the USACE to study water resource related issues in the American and Sacramento Rivers is in Section 209 of the Flood Control Act of 1962 (Pub. L. No. 87-875, § 209, 76 Stat. 1180, 1196-98 (1962)), which authorizes studies for flood control in northern California. The current report is being prepared as a general reevaluation study of the American River Watershed Common Features Project, which was authorized by Section 101(a) (1) of the Water Resources Development Act (WRDA) 1996, (Pub. L. No. 104-303, § 101(a)(1), 110 Stat. 3658, 3662-3663 (1996)) and amended by Section 366 of WRDA of 1999, (Pub. L. 106-53, § 366,

113 Stat. 269, 319-20 (1999)); and Section 130 of the Energy and Water Development Appropriations Act (EWDAA) of 2004, (Pub. L. No. 110-161, § 130, 121 Stat. 1844, 1947 (2003)). Significant changes to the authorized project cost were recommended in the Second Addendum to the Supplemental Information Report of March 2002. This report was submitted to the Assistant Secretary of the Army for Civil Works (ASA), but Congress acted to raise project costs before the 2002 report could be forwarded to Congress. (See Section 129 of the EWDAA of 2004, Pub. L. No. 108-137, §129, 117 Stat. 269, 1839 (2004))

(ii) require specific congressional authorization, including by an Act of Congress;

USACE has concluded that the modifications to the authorized project require specific authorization from Congress. As such, USACE will be preparing a Chief's Report for the American River Watershed Common Features Project GRR, currently scheduled to be completed by April 2016.

(iii) have not been congressionally authorized;

The modifications being proposed in the GRR have not been previously authorized.

(iv) have not been included in any previous annual report; and

This proposal was included in the 2014 Annual Report.

(v) if authorized, could be carried out by the Corps of Engineers.

USACE has the authority and capability to execute the project upon authorization by Congress and with full support of non-federal sponsors.

The GRR recommends a plan for further improving levee performance and further reducing the risk of levee failure along the Lower American and Sacramento Rivers and their tributaries in the North Sacramento area.

The recommended plan would build on the accomplishments of previously authorized projects in the American River watershed including the American River Watershed Common Features Project features authorized in 1996 and 1999, the Folsom Dam Joint Federal Project, the Folsom Dam Raise Project, and the recently authorized American River Watershed Common Features Project Natomas Basin features.

The recommended plan includes:

- Levee seepage and underseepage remediation along the Sacramento River east levee, the Natomas East Main Drainage Canal (NEMDC) east levee, the Arcade Creek north and south levees, and the Dry/Robla Creek south levee;
- Erosion control along the American River north and south levees and the Sacramento River east levee;
- Raising and strengthening the Magpie Creek Diversion Channel west levee; and
- Widening the Sacramento Weir and Bypass, which is located along the west bank of the Sacramento River, upstream of the confluence of the Sacramento and American Rivers, to reduce the risk of levee overtopping along the Sacramento River east levee, the NEMDC east levee, the Arcade Creek north and south levees; and the Dry/Robla Creek south levee.

Reducing flood risk in the Sacramento area is the primary purpose of the Common Features project. The City of Sacramento is the capital of California, a state that by itself has the eighth largest economy in the world and a population of 38 million. Many state offices, including the State Capital building, are located in downtown Sacramento in areas that could be affected by flood events. Flooding could disrupt government services, affect emergency services and disrupt transportation corridors. The major highways in the study area include Interstate 5, Interstate 80, U.S. Highway 50, and U.S. Highway 99. Union Pacific Railroad and Burlington Northern Santa Fe (BNSF) Railroad carry freight on two main line railroad tracks that run through the Sacramento area while AMTRAK provides passenger service. California State University, Sacramento is also located in the floodplain.

The population within the 0.5% (1/200) annual chance exceedance floodplain of the study area south of the American River is approximately 440,000 people and the population in the floodplain of the study area north of the American River is approximately 60,000 people.

The Draft GRR was released for public review in March 2015. The Agency Decision Milestone conference on the GRR was held June 30, 2015. The GRR Civil Works Review Board is scheduled for December 8, 2015. The Chief's Report is scheduled to be completed by April 2016. It is anticipated that the Chief's Report would then be transmitted to Congress with a recommendation for authorization.

The cost estimate for the recommended plan as presented in the Draft GRR is $1.47 billion with the Federal share of $866 million and the non-Federal share of $604 million.

The recommended plan improves levee performance and reduces the risk of levee failure, thereby increasing the level of flood protection for 500,000 people in these areas. The net annual benefits for the recommended plan are $315,800 and the B/C ratio is 4.3:1.

The recommended plan includes levee improvements to reduce seepage, stability and erosion problems along with widening the Sacramento Weir and Bypass. This plan however, is more expensive than the National Economic Development (NED) plan. Project costs up to the identified NED cost would be cost shared per WRDA 1986 direction.

USACE leadership to complete this study is appreciated and we look forward to the Chief's Report and eventual Congressional authorization of a project for this urban area. SAFCA and CVFPB have been the non-Federal sponsors for the GRR and intend to continue to provide the non-Federal cost share for the GRR and the recommended alternative.

Central Valley Flood Protection Board

Leslie Gallagher,
Central Valley Flood Protection Board
Executive Officer

cc: (see attached page)

Additional Proposal Information

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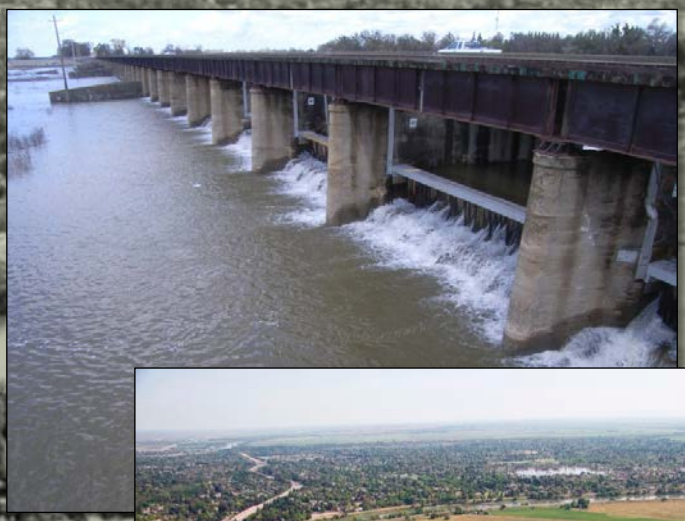
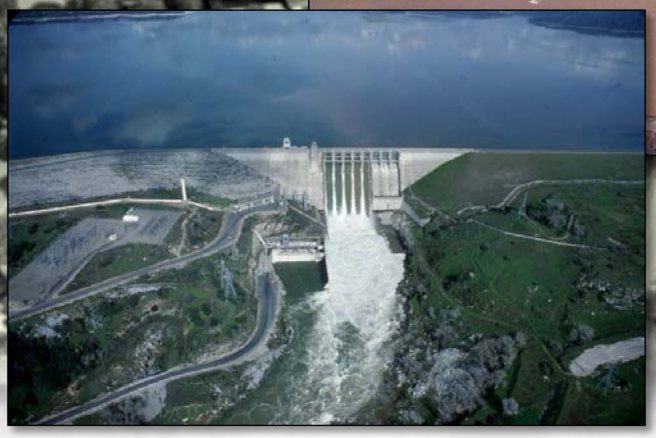
American River Watershed

Common Features
General Reevaluation Report





Draft Report

March 2015

US Army Corps of Engineers ®
Sacramento District

Cover Photos courtesy of the Sacramento District:

Sacramento Weir during operation

Sacramento River facing south near the Pocket and Little Pocket neighborhoods

High flows on the American River at the Highway 160 overcrossing

Folsom Dam releasing high flows

AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

Draft Report for Public Review

U.S. Army Corps of Engineers
Sacramento District

March 2015

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AMERICAN RIVER, CALIFORNIA
COMMON FEATURES PROJECT
GENERAL REEVALUATION REPORT

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LIST OF ACRONYMS

ARN ..... American River North

ARS ..... American River South

ASA(CW) ..... Assistant Secretary of the Army for Civil Works

CDFG ..... California Department of Fish and Game

CEQA ..... California Environmental Quality Act

CERCLA ..... Comprehensive Environmental Response, Compensation, and Liability Act

CFR ..... Code of Federal Regulations

cfs ..... Cubic Feet per Second

CVFPP ..... Central Valley Flood Protection Plan

CVIFMS ..... Central Valley Integrated Flood Management Study

DPR ..... Detailed Project Report

DWR ..... California Department of Water Resources

EIR ..... Environmental Impact Report

EIS ..... Environmental Impact Statement

EO ..... Executive Order

ER ..... Engineering Regulation

ERR ..... Economic Reevaluation Report

ESA ..... Endangered Species Act

ETL ..... Engineering Technical Letter

EWDAA ..... Energy and Water Development Appropriations Act

FAA ..... Federal Aviation Administration

FEIS ..... Final Environmental Impact Statement

FEMA ..... Federal Emergency Management Agency

Framework ..... Central Valley Flood System Improvement Framework

FRM ..... Flood Risk Management

GAO ..... General Accounting Office

GRR ..... General Reevaluation Report

IDC ..... Interest during Construction

JFP ..... Folsom Dam Joint Federal Project

LCM ..... Life Cycle Management

MCDC ..... Magpie Creek Diversion Channel

MOA ..... Memorandum of Agreement

MSL ..... Mean Sea Level

NAT ..... Natomas Basin

NBCHP ..... Natomas Basin Habitat Conservation Plan

NCC ..... Natomas Cross Canal

NED ..... National Economic Development

NEMDC ..... Natomas East Main Drain Canal

NEPA ..... National Environmental Policy Act

NGVD29 ..... National Geodetic Vertical Datum of 1929

NMFS ..... National Marine Fisheries Service

NOI ..... Notice of Intent

NRHP ..... National Register of Historic Places

OMRR&R ..... Operation and Maintenance, Repair, Replacement and Rehabilitation

PAC ..... Post-Authorization Change Report

PED ..... Preconstruction Engineering and Design

PGCC ..... Pleasant Grove Creek Canal

PL ..... Public Law

RD ..... Reclamation District

RM ..... River Mile

ROD ..... Record of Decision

Sac Bank ..... Sacramento River Bank Protection Project

Sac Urban ..... Sacramento Urban Levee Improvement Project

SAFCA ..... Sacramento Area Flood Control Agency

SCB ..... Soil Cement Bentonite

SPF ..... Standard Project Flood

SR ..... State Route

SRA ..... Shaded Riverine Aquatic

SRFCP ..... Sacramento River Flood Control Project

USBR ..... United States Bureau of Reclamation

USFWS ..... U.S. Fish and Wildlife Service

VELB ..... Valley Elderberry Longhorn Beetle

WRDA ..... Water Resources Development Act

WRRDA ..... Water Resources Reform and Development Act

AMERICAN RIVER COMMON FEATURES PROJECT, POST AUTHORIZATION CHANGE SUMMARY

INTRODUCTION

This post authorization change report has been prepared to document a general reevaluation study of the American River Common Features (ARCF) project for the City of Sacramento and surrounding areas, which is one of the most at risk areas for flooding in the United States due to its location at the confluence and within the floodplain of the American and Sacramento rivers. This General Reevaluation Report (GRR) addresses the flood risk management system for the American and Sacramento Rivers and five other smaller channels.

1. DESCRIPTION OF AUTHORIZED PROJECT

The authorized study is located in the general vicinity of the confluence of the Sacramento and American Rivers, and includes the City of Sacramento and surrounding areas. This consists of the north and south banks of the American River downstream of Folsom Dam, the Natomas Basin, the east bank of the Sacramento River and areas surrounding five other smaller waterways which are sources of potential flooding. Each area is at risk of flooding from multiple sources.

1.1 Authorized Project Features

The authorized project features were developed to work in conjunction with the authorized Folsom Dam modifications and the increased flow releases that would be anticipated. These features included seepage remediation along approximately 22 miles of the American River and construction of levee strengthening and raising of 12 miles of Sacramento River levee in Natomas. Additionally, the authorization includes construction of seepage remediation and levee raises along four stretches of the American River and construction of levee strengthening and raising of 5 miles of the Natomas Cross Canal levee in Natomas. The authorized project features are listed in Table PAC-1. The table also provides the authorization, project overview and status.

Table PAC-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 1996. Overview: Approximately 24 miles of slurry wall for seepage and stability improvements in the levees along the lower 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.
2	12 miles of levee improvements, Sacramento River east levee in Natomas.	Authorization: WRDA 1996. Overview: Approximately 12 miles of seepage, stability, and height levee modifications along the east bank of the Sacramento River downstream from the Natomas Cross Canal. Status: completed by SAFCA as part of Natomas Levee Improvement Project (NLIP).
3	3 telemetry streamflow gages u/s of Folsom Dam	Authorization: WRDA 1996. Overview: Installation of three telemetry stream flow gauges upstream from Folsom Dam and Reservoir. Status: complete.
4	Modification of the existing flood warning system	Authorization: WRDA 1996. Overview: Modifications to the flood warning system along the Lower American River for the City of Sacramento. Status: completed by non-Federal sponsor.
5	Mayhew Levee upstream of the Mayhew Drain	Authorization: WRDA 1999. Overview: Seepage and stability improvements and raising by and average of 2.5 feet the left bank of the non-Federal levee upstream of the Mayhew Drain for a distance of 4,500 feet and installing 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 1999. Overview: Raising the right bank of the American River levee in the vicinity of Howe Avenue by an average of 1 foot. Status: complete.
7	5 miles of levee improvement, Natomas Cross Canal (NCC) south levee in Natomas	Authorization: WRDA 1999. Overview: Modifying the south levee of the NCC for a distance of 5 miles for seepage, stability, and 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. Status: completed by SAFCA as part of NLIP.
8	5 miles of levee improvement, NCC north levee across from Natomas	Authorization: WRDA 1999. Overview: Modifying the north levee of the NCC for a distance of 5 miles for seepage, stability, and to ensure that the height of the levee is equivalent to the height of the south levee. Status: not complete. No sponsor has been identified to cost share this feature.
9	North Levee Strengthening between Natomas East	Authorization: WRDA 1999. Overview: Installing a slurry wall in the north levee of the American River from the east levee

Item	Feature	Authorization, Overview, and Status
	Main Drainage Canal (NEMDC) and Business I-80	of the NEMDC upstream for a distance of approximately 1.2 miles. Status: Complete.
10	North Levee upstream of Watt Avenue (Jacobs Lane)	Authorization: WRDA 1999. Overview: Installing a slurry wall in the north levee of the American River in the vicinity of Jacob Lane north for a distance of approximately 1 mile to the upstream end of the existing levee. Status: Complete.
11	Pocket Geotech Reaches 2 and 9, and Pioneer Reservoir	Authorization: 2006 Post-Authorization Change. Overview: Installing a total of 3.6 miles of discontinuous slurry wall at two levee sites on the Sacramento River in the Pocket Area and installing six relief wells and collector drains and appurtenant features and a landside berm on the Sacramento River at the levee toe in the Pioneer Reservoir area. Status: complete.
12	American River adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 2.0 miles of levee in place and install seepage cutoff wall through levee and foundation on the Lower American River. Status: In design.
13	Sacramento River adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: 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. Status: 13 miles of adjacent levee, 9 miles of deep seepage cutoff walls, and 4 miles of seepage berm constructed by SAFCA as part of NLIP. Remaining construction to be completed by Corps, and schedule is under development.
14	Pleasant Grove Creek Canal adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen the existing levee in place and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet on the Pleasant Grove Creek Canal. Status: Construction to be completed by Corps, and schedule is under development.
15	NEMDC adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 12.8 miles of existing levee and installation of 10.7 miles of soil bentonite cutoff wall on NEMDC. Status: Lowest 5 miles under design for construction in 2017. Remaining construction to be completed by Corps and schedule is under development.
16	NCC adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 5.5 miles of existing levee in-place and install deep seepage cutoff walls on south bank of NCC. Status: Completed by SAFCA as part of NLIP with exception of 3 windows. Windows to be completed by Corps and schedule is under development

1.2 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 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.

2. AUTHORIZATION

The American River Common Features Project was authorized by Section 101(a)(1) of WRDA 1996, (Pub. L. No. 104-303, § 101(a)(1), 110 Stat. 3658, 3662-3663(1996)). Additional authority was provided in Section 366 of WRDA of 1999, (Pub. L. No. 106-53, § 366, 113 Stat. 269, 319-20 (1999)). Significant changes to the project cost were recommended in the Second Addendum to the Supplemental Information Report of March 2002. This report was submitted to the Assistant Secretary of the Army for Civil Works, but before it could be forwarded to Congress, Section 129 of the Energy and Water Development Appropriations Act of 2004, (Pub. L. No. 108-137 § 129, 117 Stat. 269, 1839 (2004)) increased the authorized total cost of the project.

In 2006, several features were approved 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 on the Sacramento River 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 Sacramento River 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.

In December 2010, the Natomas Interim General Reevaluation Report (GRR) was completed. This report was prepared in order 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, 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 sponsor's Natomas Levee Improvement Plan (NLIP) to establish the degree of Federal financial participation in this plan, building upon the Section 408 approved features being implemented by SAFCA. The levee improvements recommended in the Natomas Interim GRR were authorized by Water Resources Reform and Development Act (WRRDA) 2014 (Pub. L. No. 113-121, § 7002, 128 Stat. 1193, 1366 (2014)). These levee improvements are a future without-project condition for the study contained herein.

3. FUNDING SINCE AUTHORIZATION

Since the project's authorization as part of WRDA 1996 and WRDA 1999, portions of the project have been implemented by the Corps of Engineers under a Project Cooperation Agreement (PCA) executed with the California Reclamation Board (now the Central Valley Flood Protection Board) in July 1998. Work sites are shown above in Table PAC-1.

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

Table PAC-2: History of Federal and Non-Federal Funding.

Fiscal Year	Federal Funding				Non-Federal Funding	Use of Funds (Items listed in Table PAC-1)
	General Investigation	Construction General Appropriated	American Recovery and Reinvestment Act	Construction General Allocated (Actual)		
1996	$864,000					Completion of feasibility study
1997	$1,662,000					PED for Item 1
1998	$125,000	$9,400,000		$ 5,828,000	$1,418,000	PED for Item1
1999		$15,000,000		$ 6,738,000	$6,130,100	PED & Construction for Item 1
2000		$17,000,000		$ 13,179,000	$1,075,000	PED & Construction for Item 1
2001		$10,000,000		$ 26,622,000	$7,372,434	PED & Construction for Item 1
2002		$14,000,000		$16,322,000	$6,699,881	PED & Construction for Item 1
2003		$22,280,000		$13,499,900	$2,330,000	PED & Construction for Item 1
2004		$4,000,000		$4,908,000	$667,750	PED for Items 1 and 11;

Fiscal Year	Federal Funding				Non-Federal Funding	Use of Funds (Items listed in Table PAC-1)
	General Investigation	Construction General Appropriated	American Recovery and Reinvestment Act	Construction General Allocated (Actual)		
						Construction of Item 1
2005		$5,000,000		$4,142,000	$808,643	PED Items 1, 5, and 11; Construction of Item 1
2006		$4,405,000		$4,361,000	$5,822,990	PED for Items 1 and 5; Construction Items 1, 11
2007		$19,400,000		$19,400,000	$0	PED Items 1, 5, and 10; Construction Items 1, 5
2008		$7,872,000		$9,372,000	$3,863,000	PED Items 1, 5, 6, 9, 10; Construction - 1, 5, 10
2009		$13,000,000	$13,700,000	$14,000,000	$4,206,670	PED Items 1, 5, 6, 9, 10; Construction - 1, 5, 10
2010		$6,300,000	$2,700,000	$7,330,000	$5,270,000	PED Items 1, 6, 9, 10; Construction Items 1, 5
2011		$15,000,000	($230,000)	$14,824,985	$9,400,000	PED Items 1, 6, 9, 10; Construction Items 1, 5
2012		$25,037,000	($111,405)	22,037,000	$0	PED Items 1,9,10 Construction Items 1,9,10
2013		$13,572,800		$13,572,800	$8,500,000	PED Items 1,9,10 Construction Items 1,9,10
2014		$25,538,000	($2,000)	$$26,108,000	$6,987,468	PED Items Construction Items
2015		$		$		PED Items Construction Items
Total	**$2,651,000**	**$226,804,800**	**$16,056,595**	**$196,136,685**	**$70,551,936**	

4. CHANGES IN SCOPE OF AUTHORIZED PROJECT

ER 1105-2-100, Appendix G, paragraph G-12 defines changes in scope as increases or decreases in the outputs for the authorized purposes of a project. Outputs are the project's physical effects which have associated benefits. Change in the degree of reduction in flood stages is a change in project outputs. In spite of previous and ongoing work to reduce the risk of flooding in the study area, the Sacramento Metropolitan area remains one of the most at risk areas for flooding in the United States. There is a high probability that flows in either the American or Sacramento Rivers will stress the network of levees protecting the study area to the point that levees could fail. The effects of such a levee failure would be catastrophic since the inundated area is highly urbanized and the flooding would be up to 20 feet deep. The scope of the authorized project is not adequate to cost-effectively address the residual flood risk for the greater Sacramento area. Therefore, the current GRR recommends a significant increase in the

scope of the authorized project. The recommended changes in the authorized project scope are discussed in Table PAC -3 and in Table PAC-4.

Table PAC-3: Changes in Scope of the Authorized Project.

Location	Authorized Project	GRR Recommended Plan
American River	22 miles of seepage and stability levee improvements	11 miles of rock erosion protection to convey flows from Folsom reservoir
Sacramento River	12 miles of levee improvements in Natomas	9 miles of levee improvements in the city of Sacramento to reduce probability of levee failure
	5 miles of levee modifications to the Natomas Cross Canal	
Tributaries	None	4 miles of seepage and stability improvements and 7.5 miles of levee raises to reduce probability of levee failure
Sacramento Bypass	None	Widen Sacramento Weir and bypass to divert increased flows to bypass to reduce the water surface elevation in the Sacramento River

At the request of the non-Federal sponsor, three specific modifications to existing features of the Federally-authorized levee systems constructed along the American River as part of the Sacramento River Flood Control Project, will be evaluated as part of this GRR. These segments are (1) the west levee of the Mayhew drain upstream of the closure structure; (2) the approximately 0.7 miles of the American River right bank (north) levee upstream of Arden Way; and, (3) the American River left bank (south) floodwall near river mile 2.7. The sponsor has requested that these segments be removed from the Federally authorized project because they believe these segments are no longer integral to the functionality of the project. This is being verified now. If it is determined that removing these levee segments from the authorized flood management system is in the Federal interest, this recommendation will be included in the final report.

The Sacramento Area Flood Control Agency (SAFCA) has submitted a notice to USACE that they intend to request a Section 408 permission to modify a portion of the Federally authorized flood management system within the study area. SAFCA has indicated that the Section 408 permission will include improvements to portions of the Sacramento River East Levee, the Arcade Creek North and South Levees and the NEMDC East Levee to address identified levee seepage and embankment and foundation stability problems. The Section 408 permission would also include bank protection improvements along several segments of the Sacramento River East Levee totaling approximately 3,000 feet to address erosion that is undermining the stability of the waterside slope of the levee. Further, the Section 408 permission will include the removal of high hazard levee vegetation and encroachments along portions of the American River North and South Levees, the Sacramento River East Levee, the Arcade Creek North and South Levees, Dry Creek North Levee, Robla Creek South Levee and the NEMDC East Levee, as well as implementation of a conservation strategy that would compensate for the effects of the levee

improvements on fish and wildlife habitat and includes an integrated flood conveyance and habitat improvement plan for managing vegetation in the NEMDC. It is further anticipated that SAFCA, in conjunction with the CVFPB as the ARCF sponsor, would seek Section 221 credit approval for the portions of the ARCF project they construct after release of this draft GRR but prior to authorization.

Table PAC-4: Changes in the Authorized Project.

Location	Authorized Features	Recommended New Features
Lower American River	Modify 12 miles of north bank levee on American River to reduce chance of seepage through the existing levee. (WRDA 1996) Construct slurry wall down centerline of existing levee to better withstand hydraulic forces during higher water stages	Rock bank protection and launchable rock trenches to address erosion problems along 4 miles of the American River north bank levees
	Modify 12 miles of south bank levee on American River to reduce chance of seepage through the existing levee. (WRDA 1996) Construct slurry wall down centerline of existing levee to better withstand hydraulic forces during higher water stages	Rock bank protection and launchable rock trenches to address erosion problems along 7 miles of the American River south bank levees
	Installation of three telemetry stream flow gauges upstream from Folsom Dam and Reservoir (WRDA 1996)	None.
	Modification to the flood warning system along the Lower American River for the city of Sacramento. (WRDA1996)	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 1999) 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 1999) Install gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates. (WRDA 1999) 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 1999) 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 1999) Widen 2.0 miles of levee in place and install seepage cutoff wall through levee and foundation on the Lower American River	Rock bank protection and launchable rock trenches to address erosion problems along 4 miles of the American River north bank levees

Location	Authorized Features	Recommended New Features
	adjacent to Natomas basin. (WRRDA 2014)	
Natomas – Sacramento River	Modify 12 miles of levee on east (left) bank of Sacramento River below Natomas Cross Canal. (WRDA 1996) 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 (WRRDA 2014).	None.
Natomas – Pleasant Grove Creek Canal	Widening of the existing levee in place and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet (WRRDA 2014).	None.
Natomas - Natomas East Main Drain	Widening of 12.8 miles of the existing levee and installation of 10.7 miles of soil bentonite cutoff wall (WRRDA 2014).	None.
Natomas – Natomas Cross Canal	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 1999) Widening of 5.5 miles of existing levee using in-place construction and install deep seepage cutoff walls on south bank of Natomas Cross Canal (WRRDA 2014).	None.
	Modify north levee of Natomas Cross Canal for 5 miles in parity with south levee. (WRDA 1999)	None
Pioneer Site – Sacramento River	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	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) (Chief's Discretionary Authority)	None
Sacramento River		Construct about 9 miles of slurry cutoff walls to address levee seepage and stability problems and about 10 miles of rock bank protection to address erosion problems along east levee, as well as about 2.5 miles of geotextile stabilized slope and 2 miles of slope flattening to address levee stability and less than 1 mile of levee raise.
NEMDC		Construct 1.5 miles of slurry cutoff wall and 3 miles of levee raise and floodwall.

Location	Authorized Features	Recommended New Features
Arcade Creek		Construct 1.3 miles of slurry cutoff wall, raise 2 miles of floodwall and remove ditch on landside toe.
Dry/Robla Creeks		Raise .5 mile of floodwall.
Magpie Creek		Purchase floodplain easement, raise 2,100 feet of levee and construct 1,000 feet of new levee.
Sacramento Weir and Bypass		Widen Weir and Bypass by 1,500 feet to reduce the water surface elevation in the Sacramento River and allow more water to flow into the Bypass system

5. 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 reevaluation study.

6. CHANGES IN LOCAL COOPERATION REQUIREMENTS

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

The project was originally authorized with cost sharing of 75% Federal and 25% non-Federal 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% non-Federal. Any new project components recommended in this report would be cost-shared at 65% Federal and 35% non-Federal with the exception of any additional costs for a Locally Preferred Plan (LPP) which would be a 100% non-Federal cost.

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. The non-Federal sponsors have certified that they are financially capable of participating in the tentatively selected plan.

7. CHANGE IN LOCATION OF PROJECT

There is no change in the project location.

8. DESIGN CHANGES

The draft report describes the recommended design changes. These design changes consist of construction of cutoff walls that are significantly deeper than originally envisioned. In addition, compliance with Engineer Technical Letter (ETL) 1110-2-583 (Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures) regarding vegetation, encroachments and access will be achieved through a combination of construction actions associated with implementation of the recommended plan and formal agreements (such as a Systemwide Improvement Framework, known as a SWIF as well as a vegetation variance).[1] These changes are shown in Table PAC-5.

Table PAC -5: Design Changes.

Feature	Authorized Project	GRR Recommended Plan
Erosion Protection	none	Need for erosion protection was previously not well understood. Analysis informed the need for 11 miles on the American and 10 miles on the Sacramento River due to high velocities
Seepage and Stability	Shallow cutoff walls were designed to address levee through seepage.	Additional analysis showed problems with deep underseepage under the levees requiring much deeper and more expensive cutoff walls
Overtopping	Need for levee raises identified along the American River	Additional needs for levee raises identified along the Sacramento River and the Tributaries
Sacramento Bypass	None	This feature addresses overtopping concerns by diverting flows into the bypass and thereby lowering the water surface elevation in the Sacramento River.

9. CHANGES IN TOTAL PROJECT FIRST COSTS

Table PAC-6, Authorized Project First Cost, is a tabulation of the comprehensive project authorized by Congress and the authorized project updated to current price levels. Table PAC-7, Project First Cost, is a comparison of the estimated cost for the recommended plan and the authorized project updated to current price levels.

[1] WRRDA 2014 (Pub.L. No. 113-121) contains language that will affect the guidelines presented in ETL 1110-2-583; implementation guidance is expected within one year

Table PAC-6: Authorized Project First Cost ($1,000s).

	WRDA 1996/1999 Features			Natomas PACR Authorized Cost (WRRDA 2014) [4]	Total Current Estimate Authorized Cost[5]
Construction Item	**Authorized Cost (2004) [1]**	**Reported to Congress (2010) [2]**	**Current Project Cost Estimate (2014) [3]**		
Lands and Damages	$5,750	$17,173	$15,668	$235,522	$251,190
Relocations	$460	$381	$381	$118,967	$119,348
Fish & Wildlife Facilities	$1,730	$2,075	$3,952	$18,956	$22,908
Levees & Floodwalls	$153,760	$169,497	$189,075	$396,462	$585,537
Pumping Plants	$0	$0	$0	$56,884	$56,884
Cultural Resource Data Recovery	$750	$1,190	$0	$6,701	$6,701
Subtotal	**$162,450**	**$190,316**	**$209,076**	**$833,492**	**$1,042,568**
Planning Engineering & Design (PED)	$35,380	$71,604	$96,953	$152,609	$249,562
Construction Management	$7,170	$16,060	$14,671	$161,179	$175,850
Total Costs	**$205,000**	**$277,980**	**$320,700**	**$1,147,280**	**$1,467,980**

[1] Authorized Cost is as reflected in the 2002 American River Watershed Project (Common Features), CA, Second Addendum to the Supplemental Information Report and authorized by Congress in 2004 (EWDAA). This is the last authorization by Congress for the WRDA 1996/1999 features. Authorized costs are in October 2001 prices.
[2] The Authorized Cost, adjusted for inflation, and last reported to Congress was in 2010 in the Natomas PACR. October 2010 prices.
[3] The Authorized Cost, adjusted for inflation to 2014 price level is $320,700,000.
[4]The recommended plan contained in the Natomas PACR was authorized by WRRDA 2014 (Pub.L. No. 113-121). This GRR assumes the features described in the Natomas PACR are constructed.
5 Natomas PACR Authorized Cost Estimate (totaling $1,147,280,000) plus the current Project Cost Estimate for the WRDA 1996/1999 Authorized Project (totaling $320,700,000) for a total of $1,467,980,000.

Table PAC-7: Project First Cost ($1,000s).

Construction Item	GRR Recommended Plan	Total Current Estimate Authorized Cost	Recommended Plan [1]
Lands and Damages	$96,938	$251,190	$348,128
Relocations	$63,040	$119,348	$182,388
Fish & Wildlife Facilities	$55,472	$22,908	$78,380
Levees & Floodwalls	$961,754	$585,537	$1,547,291
Pumping Plants	$0	$56,884	$56,884
Cultural Resource	21,435	0	21,435
Cultural Resource Data Recovery	$4,730	$6,701	$11,431
Subtotal	$1,203,369	$1,042,568	$2,245,937
Planning Engineering & Design (PED)	$171,555	$249,562	$421,117
Construction Management	$94,591	$175,850	$270,441
Total Costs	**$1,469,515**	**$1,467,980**	$2,937,495

[1] Recommended Plan reflects the American River Common Features Project GRR as reported in this document (totaling $1,469,515,000) plus the current Project Cost Estimate for the Authorized Project (totaling $1,467,980,000) for a total of $2,937,495,000.

The changes in cost are a result of the following findings and recommendations:

1. Sacramento River: Previous estimates for the authorized project assumed shallow cutoff walls would address the levee seepage and stability problems. It has since been determined that much deeper (and more expensive) cutoff walls will be required to address the problem that is comprised of not only levee through seepage, but deep underseepage as well. Additional erosion protection has also been identified. The levee is also very steep in certain areas and will require slope stabilization and flattening that was not included in previous estimates. Finally, about 1 mile of new levee raise will be needed that was not previously recommended.
2. American River: The extent of the erosion problem was not well understood when the documents for the earlier authorized projects were being prepared. A subsequent erosion analysis has been used to develop the current recommendation of 11 miles of erosion protection along the American River.
3. Eastside Tributaries: Deep slurry cutoff walls are recommended to address levee seepage and stability problems that were not previously included as well as levee raises to address potential overtopping of floodwaters along the NEMDC, Arcade Creek, and Dry Creek levees.
4. Sacramento Bypass: the previously authorized project does not include this feature.

10. CHANGES IN PROJECT BENEFITS

Table PAC-8 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. An extensive structure inventory was conducted and non-residential content valuations were developed using depth-percent damage curves. Other updated data that helped refine the benefit calculations included the number of sources of flooding (American River, Sacramento River, Natomas East Main Drainage Canal, Arcade Creek and Dry/Robla Creeks) used to estimate flood risk, the consequence area considered, the levee fragility curves (geotechnical), the Folsom Dam routings (hydrology) and the rating curves and Floodplains (hydraulics).

Table PAC-8: Benefit Comparison ($1,000s).

	WRDA 1996/1999 Features			Authorized Natomas PACR Benefits (WRRDA 2014)	Total Project Benefits
	Authorized Project Benefits(2004) [1]	Benefits last Reported to Congress (2010)	Current Project Benefits (2014)		
Benefits	$42,300	$59,500	$59,500	$443,000	$502,500

[1] Benefits for the Authorized Project reflects the 2001 Limited Reevaluation Report, and authorized by Congress in 2004 (EWDAA) which is the last authorization by Congress for the WRDA 1996/1999 features, adjusted for inflation to 2014 along with the recommended plan contained in the Natomas GRR which was authorized by WRRDA 2014 (Pub.L. No. 113-121).

11. BENEFIT-COST RATIO

Table PAC-9 shows the benefit-to-cost ratio of the Recommended Plan. It also shows a comparison of the benefit-cost ratios for the Recommended Plan and the authorized project updated to current price levels and the current discount rate. The estimated total annual benefits are calculated at a discount rate of 3.375 percent, over a 50-year period of economic evaluation.

Table PAC-9: Benefit – Cost Ratio.

	WRDA 1996/1999 Features			Authorized Natomas PACR (WRRDA 2014)	Total Project
	Authorized Project (2004)	Project last Reported to Congress (2010)	Project Updated to Current Price Levels (2014)		
Benefit-Cost Ratio	**NA**	**4.0**	**NA**	**7.6**	**8.6**

12. 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.

13. CHANGES IN COST APPORTIONMENT

Table PAC-10, Changes in Cost Apportionment, shows the Federal and non-Federal costs of the authorized project and the recommended plan at current price levels Table PAC-11, Funding Requirements, shows the Federal and non-Federal costs of the recommended project at current price levels. For those areas along the lower American River, the improvements authorized in WRDA 1996 and WRDA 1999, the cost share is 75% Federal and 25% non-Federal. For those areas in the Natomas Basin, the improvements authorized in WRRDA 2014, the cost share is 65% Federal and 35% non-Federal. For any improvements recommended as a result of this GRR, the cost share is 65% Federal and 35% non-Federal.

Table PAC-10: Changes in Cost Apportionment ($1,000s, Oct. 2014 Price Levels).

Item	Federal Cost	Non-Federal Cost	Total Cost
Authorized Common Features Project (includes WRDA 1996, WRDA 1999, and EWDAA 2004)			
Construction	$193,027	$0	$193,027
LERRD	$2,263	$13,786	$16,049
PED	$96,953	$0	$96,953
Construction Management	$14,671	$0	$14,671
Subtotal	$306,914	$13,786	$320,700
Minimum 5% cash contribution	-$16,035	$16,035	
Additional cash contribution	-$50,354	$50,354	
Subtotal FRM First Cost	$240,525	$80,175	$320,700
Percent of Total FRM	75.0%	25.0%	
Cultural Resources Data Recovery	$0	$0	$0
Total FRM First Cost	$240,525	$80,175	$320,700
Authorized Common Features Project (includes WRRDA 2014)			
Construction	$472,302	$0	$472,302
LERRD	$19,572	$334,917	$354,489
PED	$132,370	$20,239	$152,609
Construction Management	$153,240	$7,939	$161,179
Subtotal	$777,484	$363,095	$1,140,579
Minimum 5% cash contribution	-$57,029	$57,029	
Additional cash contribution	$0	$0	
Subtotal FRM First Cost	$720,455	$420,124	$1,140,579
Percent of Total FRM	63.4%	36.6%	
Cultural Resources Data Recovery	$6,701	$0	$6,701
Total FRM First Cost	$727,156	$420,124	$1,147,280
GRR Recommended Plan			
Construction	$1,017,226	$0	$1,017,226
LERRD	$9,225	$150,753	$159,978
PED	$177,230	$15,760	$192,990

Item	Federal Cost	Non-Federal Cost	Total Cost
Construction Management	$88,287	$6,304	$94,591
Subtotal	$1,291,968	$172,817	$1,464,785
Minimum 5% cash contribution	-$73,239	$73,239	
Additional cash contribution	-$358,107	$358,107	
Subtotal FRM First Cost	$860,621	$604,164	$1,464,785
Percent of Total FRM	58.8%	41.2%	
Cultural Resources Data Recovery	$4,730	$0	$4,730
Total FRM First Cost	$865,351	$604,164	$1,469,515
Total Recommended Plan			
Construction	$1,682,555	$0	$1,682,555
LERRD	$31,060	$499,456	$530,516
PED	$406,553	$35,999	$442,552
Construction Management	$256,198	$14,243	$270,441
Subtotal	$2,376,366	$549,698	$2,926,064
Minimum 5% cash contribution	-$146,303	$146,303	
Additional cash contribution	-$408,461	$408,461	
Subtotal FRM First Cost	$1,821,602	$1,104,463	$2,926,064
Percent of Total FRM	62.3%	37.7%	
Cultural Resources Data Recovery	$11,431	$0	$11,431
Total FRM First Cost	$1,833,033	$1,104,463	$2,937,495

Table PAC-11: Federal Appropriations Funding Requirements ($1,000s).

	Federal Appropriations
Authorized Common Features Protect (includes WRRDA 2014)	$727,156
GRR Recommended Plan	$$856,351
Total Appropriations	$1,583,507

14. ENVIRONMENTAL CONSIDERATIONS IN RECOMMENDED CHANGES

The effects to the environment have been considered throughout the planning phase of the project and opportunities have been evaluated to reduce effects to resources within the study area. A vegetation variance will be sought for the project area, which will allow vegetation to remain on the lower half of the waterside levee slope. The waterside vegetation is valuable shaded riverine aquatic (SRA) habitat for many State and Federally listed fish species and State-listed Swainson's hawk.. The non-Federal sponsor has sent a Letter of Intent to apply for a System Wide Improvement Framework (SWIF) which would allow landside vegetation and encroachments to be deferred and addressed as a part of long term operation and maintenance. Additional information on environmental effects is located in Chapter 4 of the GRR and in the accompanying EIS/EIR. The EIS for the authorized project was determined to not be adequate to address the additional work in the recommended plan and therefore a new EIS/EIR has been developed.

USACE has determined that the recommended plan may adversely affect listed species including salmonids, steelhead, green sturgeon, Delta smelt, valley elderberry longhorn beetle, vernal pool fairy shrimp, vernal pool tadpole shrimp, and giant garter snake. A Biological Assessment (BA) which is appended to the EIS/EIR discusses these effects as well as mitigation measures.

Additionally, air quality emissions associated with construction of the project would be above *de minimus* levels, however, the implementation of mitigation measures will reduce the emissions to less than significant levels. There is also the potential for significant effects to local residents from increased noise during construction. In order to mitigate for these effects, USACE would coordinate with local residents and implement Best Management Practices (BMPs) to reduce noise effects.

The recommended plan would require discharge of fill material into Waters of the U.S., therefore a draft Section 404(b)(1) analysis has been conducted and appropriate mitigation measures have been identified. A Section 401 water quality certification will be requested from the Central Valley Regional Water Quality Control Board. In addition, construction of the project would require a National Pollutant Discharge Elimination System permit and a Stormwater Pollution Protection Plan. With the completion of these requirements, and the issuance of a Section 401 water quality certification, this project would be in full compliance with the Clean Water Act.

The recommended plan would likely result in adverse effects to historic properties. USACE has developed a Programmatic Agreement (PA) to provide the legal commitment by USACE as the lead Federal Agency to comply with Section 106 of the National Historic Preservation Act.

The recommended plan would also require the acquisition of properties for construction and flood control easements, resulting in the conversion of agricultural lands to flood control easements. The project would comply with the Relocation Assistance and Real Property Acquisition Policies Act to mitigate for these effects.

15. PUBLIC INVOLVEMENT

The USACE published a Notice of Intent (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. On November 5, 2009, SAFCA issued a Notice of Preparation (NOP) for the EIS/EIR.
The draft GRR will be circulated for public comment and a series of Public Workshops are planned during the public comment period. Public input will be taken into consideration and the comments received will be included in the EIS/EIR appendices. Additional information on public involvement is located in Chapter 6 of the GRR and in the accompanying EIS/EIR.

16. HISTORY OF PROJECT

In February 1986, the Sacramento area experienced a very large storm event which rapidly filled Folsom reservoir just upstream from the city of Sacramento. Because of the rapid inflow, the Dam operators agreed that the release from Folsom Dam needed to be raised above the objective release of 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.

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.

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.

Congress authorized improvements for Folsom Dam in 1999. 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 1999 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 1999 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 the Energy and Water Development Appropriations Act for 2004.

Major construction components for Common Features in the WRDA 1996 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 1999 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 miles of Natomas Cross Canal levee in Natomas. Note that there are other construction components for both WRDA 1996 and 1999 that are not described here.

All American River features authorized in WRDA 1996 and 1999 will be completed by fall 2015. Natomas features authorized in WRDA 1996 and 1999 were 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 1999 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 (Pub. L. No. 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 issues consisted primarily of erosion concerns on the American River and seepage, stability, erosion, and height issues on the Sacramento River below the American River. However, the full extent of these levee issues 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 were also needed to include the additional two basins comprising the City of Sacramento, as well as the Natomas Basin. Natomas features were analyzed in the Natomas PACR completed in 2010. The recommendations included in that report were authorized in WRRDA 2014 and design work has begun.

1 - STUDY INFORMATION

This chapter provides basic background for the reevaluation of the American River Common Features (ARCF or Common Features) Project. It also lists the steps in the Federal planning process and relates them to the organization of this report.

1.1 PURPOSE AND SCOPE

This report presents the findings of a general reevaluation study of the authorized American River Common Features Project. The study was conducted to determine whether there is a Federal interest in modifying the authorized project for flood risk reduction in the Greater Sacramento Area at the confluence of the Sacramento River and the American River. Flooding in the City of Sacramento and surrounding urban areas would have devastating economic, social, political, and demographic consequences for the region, and for the State of California as a whole. Existing flood risk management structures are not capable of safely passing large flood flows on the American and Sacramento Rivers. This study proposes additional measures to reduce the risk of flooding in the Sacramento area. These measures are evaluated in the context of current and planned flood risk reduction measures elsewhere in the watersheds of both rivers.

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 flood management system in place in the Sacramento Valley since the early 1900s known as the Sacramento River Flood Control Project. 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, West Sacramento, Yuba City, and Marysville, as well as to numerous other small communities. Although the Sacramento River Flood Control Project levees were often constructed of poor materials such as dredged river soils that would not meet today's engineering standards, the levees are still relied upon to provide flood protection during major storms to over 2 million people in approximately 50 communities with an estimated $39 billion in urban and agricultural development.

1.2 STUDY AUTHORITY

The basic authority for the Corps to study water resource related issues in the American and Sacramento Rivers is in Section 209 of the Flood Control Act of 1962 (Pub. L. No. 87-875, § 209, 76 Stat. 1180, 1196-98 (1962)), which authorizes studies for flood control in northern California. This report was prepared as a general reevaluation study of the American River Common Features Project, which was authorized by Section 101(a) (1) of the Water Resources Development Act (WRDA) 1996, (Pub. L. No.

104-303, § 101(a)(1), 110 Stat. 3658, 3662-3663 (1996)) and amended by Section 366 of WRDA of 1999, (Pub. L. 106-53, § 366, 113 Stat. 269, 319-20 (1999)); and Section 130 of the Energy and Water Development Appropriations Act (EWDAA) of 2004, (Pub. L. No. 110-161, § 130, 121 Stat. 1844, 1947 (2003)). Significant changes to the authorized project cost were recommended in the Second Addendum to the Supplemental Information Report of March 2002. This report was submitted to the Assistant Secretary of the Army for Civil Works (ASA(CW)), but Congress acted to raise project costs before the 2002 report could be forwarded to Congress. (*See* Section 129 of the EWDAA of 2004, (Pub. L. No. 108-137, §129, 117 Stat. 269, 1839 (2004)) raising the authorized total cost of the project to $205,000,000.) The current estimated cost of the authorized project is $320,700,000. Pertinent sections of these Congressional authorizations are provided below.

1.2.1 Water Resources Development Act of 1996 (P. L. 104-303)

Section 101(a)(1) authorized the American River Watershed , California project, as follows:

> *(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.*
>
> *(C) [Interim Operation of Folsom Dam and Reservoir – Omitted]*
>
> *(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*

(ii) 25 percent of the costs incurred for the variable flood control operation of the Folsom Dam and Reservoir during the 4-year period beginning on the date of the enactment of the Act and 100 percent of such costs thereafter.

1.2.2 Water Resources Development Act of 1999 (Pub. L. 106-53)

Section 366 of WRDA 1999 modified the Common Features Project to include:

(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 effect 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).

1.2.3 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.*

1.2.4 Chief of Engineers' Discretionary Authority

In 2006 it was determined that several additional levee stabilization features would be required. Since the location of these features was within the project area, and necessary for the project as authorized to function as intended, they were approved under the Chief of Engineers' discretionary authority[1] :

- 3.6 miles of discontinuous slurry wall at nine levee sites beginning at Levee Mile 2.9 and ending at Levee Mile 10.3 on the Sacramento River in the Pocket Area extending from river mile 53.6 to 45.3. The levee sites are located 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.
- Six relief wells, collector drains and appurtenant features, and a landside berm on the levee toe on the Sacramento River in the Pioneer Reservoir area. The Pioneer Reservoir project area is located adjacent to the Sacramento River in the City of Sacramento; just upstream of the Pioneer Bridge (U.S. Highway 50). 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.

1.2.5 Natomas Post Authorization Change Report (NPACR)

The Natomas PACR was approved in December 2010 with a Chief's Report and transmitted to Congress. Recommendations included in the NPACR were authorized by the Water Resources Reform and Development Act of 2014 (WRRDA 2014) (Pub. L. No. 113-121, § 7002, 128 Stat. 1193, 1366 (2014)). Levee overtopping concerns were analyzed but not addressed or authorized by the NPACR; these levee overtopping concerns have been analyzed as part of the ARCF GRR but seepage and stability work authorized by WRRDA 2014 has not been reevaluated in this document.

[1] USACE, 2006

1.3 LOCATION AND DESCRIPTION OF THE STUDY AREA

1.3.1 Location

The study area is located within the Sacramento and American River Watersheds, with the focus being on the vicinity of the confluence of these two rivers where they meet within the City of Sacramento (Figure 1-1). The project area includes approximately 12 miles of the north and south banks of the American River immediately upstream from the confluence with the Sacramento River; approximately 18 miles of the east bank of the Sacramento River immediately downstream of the Natomas Cross Canal (NCC) to the confluence with the American River; and approximately 5 miles of the north and south bank of the NCC immediately upstream of the confluence with the Sacramento River. The study area also includes the improvements to the Natomas East Main Drainage Canal (NEMDC) and Pleasant Grove Creek Canal (PGCC). These features collect flows from Pleasant Grove, Dry, Robla, and Arcade Creeks (collectively referred to as the east side tributaries). The study area also includes approximately 14 miles of levees along the east bank of the Sacramento River downstream from the American River to just below the town of Freeport, at which point those levees tie into the Morrison Creek Beach Lake Levee which protects the south side of Sacramento.

The study area has been divided into three subareas that correspond to basins defined by either levees or high ground:

- Natomas Basin (NAT) - The Natomas Basin is located in the northern portion of the project area. The basin is bordered by the Sacramento River to the west, the Natomas Cross Canal to the north, the Natomas East Main Drainage Canal and Pleasant Grove Creek Canal to the east, and the American River to the south.
- American River North Basin (ARN) – This area is located north of the American River and east of the Natomas Basin. The basin is bordered by the NEMDC to the west and the American River to the south.
- American River South Basin (ARS) – This area is located south of the American River. It is bounded on the north by the American River and on the west by the Sacramento River. This basin includes downtown Sacramento and surrounding neighborhoods.

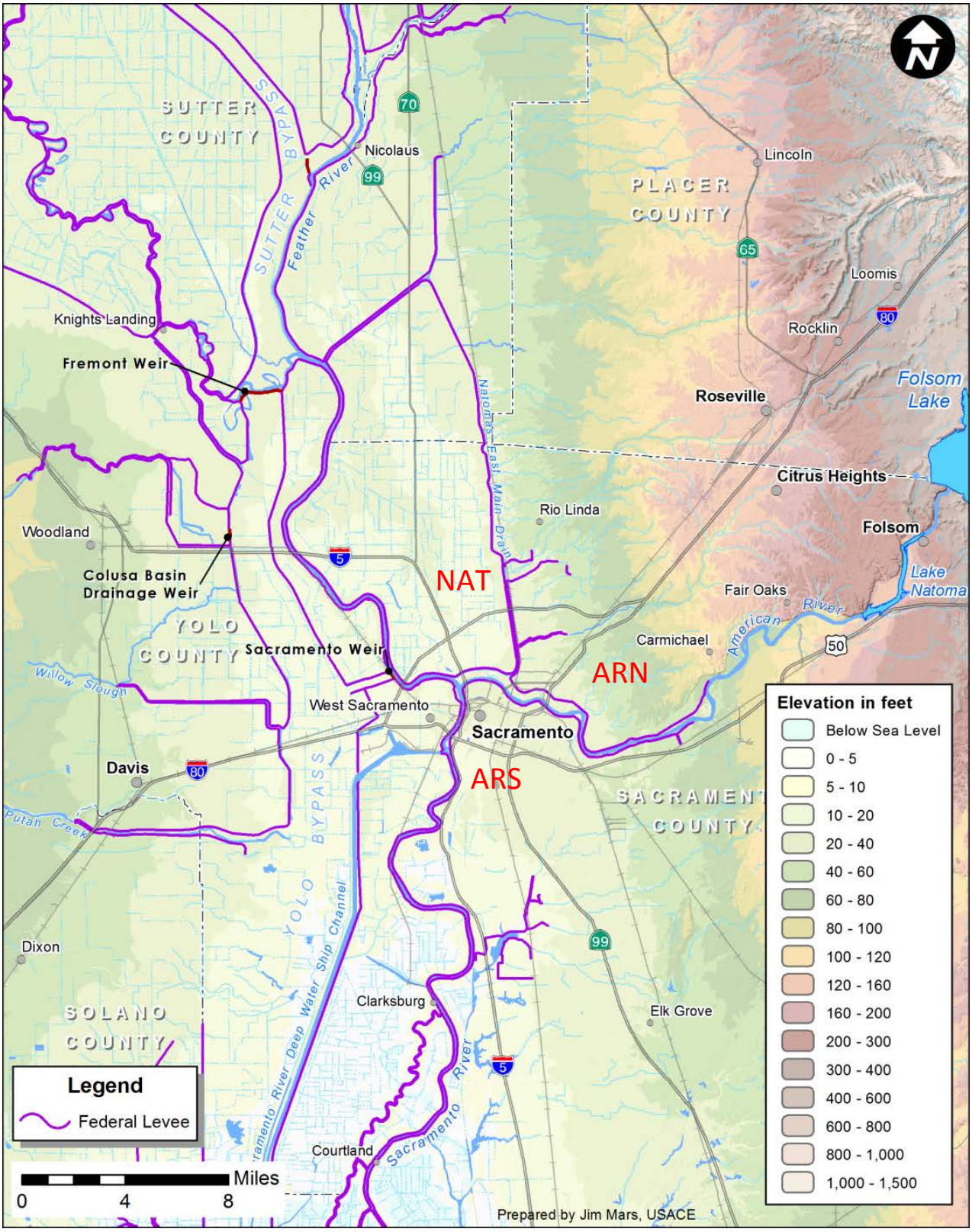

Figure 1-1: Study Area at the Confluence of the Sacramento and American Rivers.

1.3.2 Watershed Setting

The study area is located at the southern end of the Sacramento River Basin (Figure 1-2). The Sacramento River is the largest river and watershed system in California and transports 31% of the state's total surface runoff. The upper watershed is drained by three rivers; the upper Sacramento River, the McCloud River, and the Pit River, which join at Lake Shasta, a 4.5 million acre foot reservoir formed by Shasta Dam. The Sacramento River then flows south through the northern Central Valley of California. The Sacramento River watershed covers an area of approximately 27,000 square miles. Major tributaries of the Sacramento River include the Feather River, the Yuba River, and the American River.

The American River watershed covers approximately 2,100 square miles northeast of the City of Sacramento and includes portions of Placer County, El Dorado County, Alpine County, and Sacramento County. The major flood risk reduction structure on the American River is Folsom Dam, which impounds Folsom Lake. Streams flowing into Folsom Lake include the north, south, and middle forks of the American River. At their confluence in the Sacramento area, the Sacramento River and American River floodplains cover approximately 110,000 acres and include most of the developed portions of the City of Sacramento.

Figure 1-2: Location of the Study Area within the Sacramento River Watershed.

1.3.3 Physical Setting of the Study Area

The study area is located in the Central Valley of California, west of the Sierra Nevada Mountains. The elevation of the study area ranges from approximately 5 feet above mean sea level (MSL) near the town of Freeport to approximately 400 feet MSL near Folsom Dam, with the majority of the study area lower than 100 feet MSL. 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 floodplain soils consisting of unconsolidated deposits of clay, silt, and sand that occurred as floodplain deposits.

The climate of the study area is Mediterranean, characterized by cool, wet winters and hot, dry summers. In the valley portions of Sacramento County, approximately 85 percent of the annual rainfall occurs between October and March; approximately 95 percent falls between October and April. The City of Sacramento's average annual rainfall is approximately 18 inches. The 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 Sierra Nevada mountains rise above 14,000 feet (MSL) and are the first major barrier crossed by cyclonic storm systems moving east from the Pacific Ocean. Consequently, precipitation in the Sierra Nevada Mountains typically exceeds 30 inches per year[2], with most of this falling as snow. The largest flood events in the Sacramento area typically result from winter rain-on-snow events caused by atmospheric rivers, week-long, heavy precipitation events known as a "Pineapple Express" because the moisture originates over the tropical Pacific Ocean.

1.3.4 Land Use and Development

The study area consists primarily of agriculture and urban land uses. The primary urbanized area is the City of Sacramento, with suburban cities such as Rancho Cordova, Carmichael, and Folsom located in the eastern portion of Sacramento County and Elk Grove located in the southern portion of the county.

Reducing flood risk in the Sacramento area is the primary purpose of the Common Features project. The City of Sacramento is the capital of California, a state that by itself has the eighth largest economy in the world[3] and a population of 38 million[4]. Many state offices, including the State Capital building, are located in downtown Sacramento in areas that could be affected by flood events. Flooding could disrupt government services, affect emergency services and disrupt transportation corridors. The major highways in the study area include Interstate 5, Interstate 80, U.S. Highway 50, and U.S. Highway 99. The Garden Highway parallels the Sacramento River on the western side of the study area. Union Pacific

[2] For example, Tahoe City averages 31.46 inches of precipitation per year (Western Regional Climate Center, COOP data for Tahoe City, online at: http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?ca8758, accessed 26 February 2013).
[3] "California Economy Ranking in the World," EconPost.com, February 3, 2011, accessed July 28, 2011.
[4] United States Census : http://quickfacts.census.gov/qfd/states/06000.html.

Railroad and Burlington Northern Santa Fe (BNSF) Railroad carry freight on two main line railroad tracks that run through the Sacramento area. AMTRAK also serves the Sacramento area and this service includes the Capital Corridor route that connects Sacramento with the San Francisco Bay area.

The Natomas Basin is completely surrounded by levees; most development is located in the southern part of the Natomas basin, with most of the rest of the basin devoted to agriculture. Natomas has undergone very rapid development since approximately 1998 when the area was removed from the Federal Emergency Management Agency (FEMA) 100-year regulatory floodplain. Natomas was subsequently remapped into the FEMA 100-year flood plain in 2008. Land use within the Natomas Basin includes commercial, medium- and low-density residential, public recreation, open space, educational, and municipal facilities. The Natomas Basin currently has an estimated population of 100,000. Sacramento International Airport is located in the western portion of the Natomas Basin, north of Interstate 5 and west of U.S. Highway 99.

As further described in the Future Development in the Floodplain section of Chapter 2, the Sacramento Area Flood Control Agency (SAFCA) in cooperation with the State of California has constructed urgently needed improvements to address seepage problems in the Natomas Basin levees as part of the Natomas Levee Improvement Program (NLIP). These levee improvements constructed as part of the NLIP program, along with the authorized improvements in the Natomas PACR have allowed the local governmental agencies to jointly apply for a Physical Map Revision (PMR) to replace the Zone AE with the A99 Zone designation. FEMA has determined that adequate progress has been made on the flood protection system project to warrant a change in zone designation to Zone A99 as defined by Paragraphs 61.12(b) of the National Flood Insurance Program (NFIP) regulations.

The population within the 0.5% (1/200) Annual Chance Exceedance (ACE) floodplain of the American River North Basin is approximately 60,000 people. Interstate 80 is located in this area, as well as the Cal Expo Fairgrounds, which is the site of the California State Fair. In addition to the American River, several streams including Dry Creek, Robla Creek, Arcade Creek, Magpie Creek, and the Natomas East Main Drainage Canal contribute to flooding problems in this area.

The population within the 0.5% (1/200) ACE floodplain of the American River South Basin is approximately 440,000 people. The Capitol is located in the downtown area of Sacramento, within this basin. Interstate 5 and U.S. Highway 99 cross the area. In addition to concentrated areas of government, residential, and business use, the area is also home to Sacramento State University, the Sacramento Executive Airport, and the Sacramento Zoo.

1.3.5 Ecological Setting

Five habitat types dominate the study area: wetlands, riparian forest, aquatic, shaded riverine aquatic (SRA), and ruderal herbaceous and nonnative grassland. The study area is within the Pacific Flyway migratory bird route, the westernmost of North America's four flyways. Urbanization over the years has constrained vegetation to limited areas and consequently has inhibited the diversity and range of wildlife in the Sacramento region. Wildlife is restricted predominantly to the American River Parkway corridor and the less-developed regions adjacent to the levees along the Sacramento River (Figure 1-3).

Figure 1-3: Floodwaters in Discovery Park, at the Confluence of the American and Sacramento Rivers.

The banks and overflow areas of the American River are dominated by riparian forest and an extensive network of freshwater forested/shrub and freshwater SRA, and grasslands. In addition, the American River Parkway corridor provides nearly continuous, narrow riparian woodland from Folsom Dam to the confluence of the American and Sacramento Rivers.

Along the Sacramento River in the American River South Basin, riparian vegetation occurs in narrow, fragmented stretches (Figure 1-4). SRA habitat has been declining due to loss resulting from levee system maintenance, erosion, and emergency rock placement to prevent levee failure during high flood events.

Figure 1-4: Typical Levee Section along the Sacramento River.

1.4 BACKGROUND AND PROJECT HISTORY

1.4.1 The Sacramento River Flood Control Project

Development of flood management features in the Sacramento Valley began around 1850. Up until the flood of 1909, all flood management activities focused on confining flow to the main rivers. This was a trial and error period with frequent levee failures, including failures in the 1909 event. After this event, the State of California and the Federal Government decided on the need for the bypass system. The State approved the bypass system and the overall Sacramento River Flood Control Project in 1911 and the Federal Government authorized it in 1917. The bypass system and overflow weirs were then constructed over the next 15 years.

The flood of 1909 and a flood that occurred in 1907 were the only significant flood events for which detailed streamflow gage data was available. Initial design of the State and Federally authorized flood control system was developed around the floods of 1907 and 1909. In 1927, a new flood of record

occurred for a portion of the Sacramento River system. The larger magnitude flow on these reaches was incorporated into the overall design of the entire flood control system. The entire Sacramento River Flood Control Project was completed in the mid 1950s (Figure 1-5).

The Sacramento River's bypass system starts approximately 100 miles above the Natomas basin where flow spills out of the Sacramento River to the east upstream of the project levees and into the Butte Basin. Flow in the Butte Basin feeds into the Sutter Bypass. The Sutter Bypass then flows into and across the Sacramento River and is then called the Yolo Bypass. The Fremont Weir sits at the very upper limit of the Yolo Bypass and controls when flow starts to spill into the Yolo Bypass. Continuing downstream, the Yolo Bypass passes just to the west of the city of West Sacramento.

Further down the Sacramento River in the city of Sacramento, the American River comes into the Sacramento River from the east. The Sacramento Weir and Bypass is located approximately three miles upstream of the American River. The primary purpose of the Sacramento Weir and Bypass is to take high flows from the American River over to the Yolo Bypass.

Below the greater Sacramento urban area, the Yolo Bypass and the Sacramento River come back together near the town of Rio Vista. Combined flow then continues out to San Francisco Bay and the Pacific Ocean.

Throughout the SRFCP, the frequency at which flow starts to divert from the Sacramento River to the bypass system varies between a 33% (1/3) ACE to a 20% (1/5) ACE flood event.

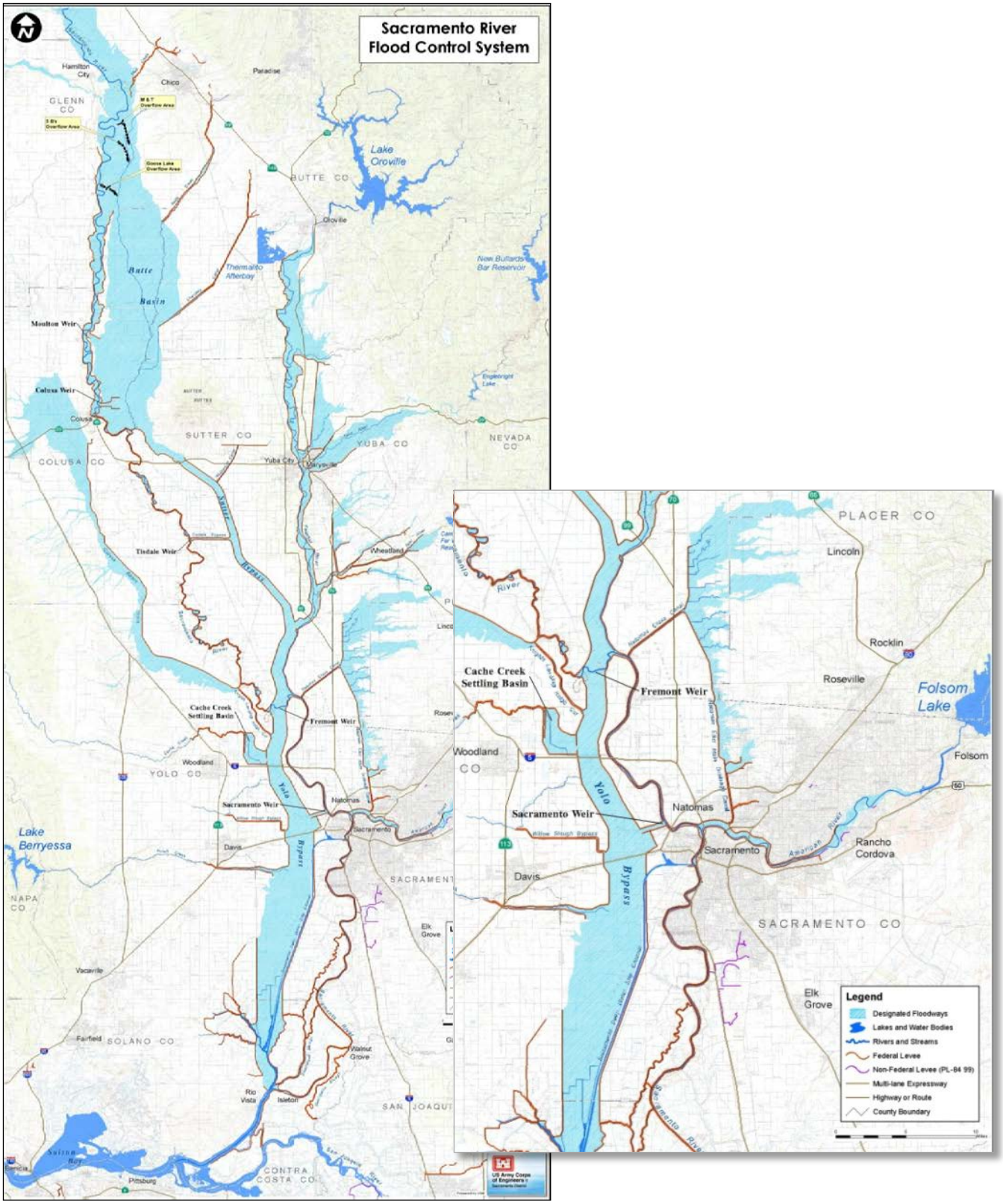

Figure 1-5: Features of the Sacramento River Flood Control System.

Locations where flow is allowed to spill from the Sacramento River into the bypass system include three overflow locations upstream of the project levees, and five weirs within the project levees including Moulton Weir, Colusa Weir, Tisdale Weir, Fremont Weir, and Sacramento Weir (Figure 1-1). The Sacramento Weir is shown in Figure 1-8.

Flow from these weirs (or overflow locations) enters the Butte Basin, the Sutter Bypass, the Yolo Bypass, the Tisdale Bypass, or the Sacramento Bypass. Flows from the Feather River and the American River are also diverted into the bypass system near where they intersect the Sacramento River. The bypass system directly receives outflows from many smaller tributaries.

The Sacramento River Flood Control Project, including the portion within the greater Sacramento urban area, was constructed using either a clamshell dredge or a suction dredge retrieving material from the adjacent river and piling it up along the levee alignment . Figure 1-6 and Figure 1-7 show typical levee construction by both clamshell dredge and suction dredge methodology.

Figure 1-6: Typical Suction Dredge Levee Construction on the Sacramento River System.

The material dredged from the adjacent river was predominately sand with very little silt that tends to be non-cohesive. Additionally, the land on which the levees were constructed tended to be materials similar to the material dredged from the adjacent river. These materials are very poor for levee safety. Water is able to freely move through and under the levee causing severe seepage problems. Water seeping through the levee tends to carry levee material with it, weakening the levee. Additionally, in much of the study area, the levees have narrower crown widths and steeper side slopes than current engineering standards. In some locations, the waterside slope is steeper than 2 to 1 and the landside slope approaches 1 to 1, which coupled with the nature of the levee fill material, causes a significant stability issue as well.

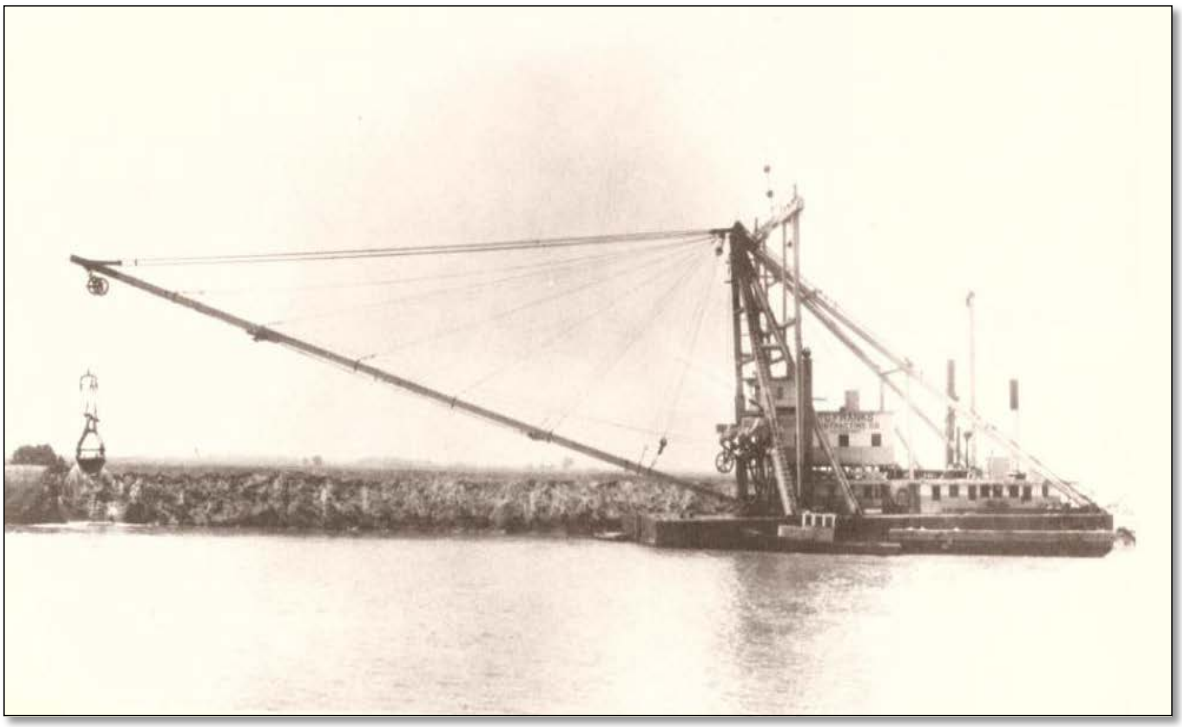

Figure 1-7: Typical Clamshell Dredge Levee Construction on the Sacramento River System.

In addition to the inherent seepage and stability issues of the levees and levee foundations, the potential for erosion induced levee failure is significant. In many cases, the levees were built somewhat set back from the main channel of the adjacent river. Over the course of about a hundred years, much of the waterside berm left during initial construction has eroded away. This occurred because flow was confined between the levees to much higher stages and velocities than would have occurred prior to the levee construction. In some locations, 100 feet of berm has eroded away making it necessary to armor the waterside levee slope to stop additional erosion into the levee foundation and undermining of the levee.

The Fremont Weir is perhaps the most significant overflow location in the system because it controls the distribution of flows between the Sacramento River and the Yolo Bypass downstream. The Sacramento River crosses from the center of the Sacramento Valley toward the east near the north end 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.

The Sacramento Weir was completed in 1916. It is the only weir that is manually operated – all others overflow by gravity on their own. It is located along the right bank of the Sacramento River approximately 3 miles upstream from the confluence with the American River. Its primary purpose is to protect the City of Sacramento from excessive flood stages in the Sacramento River channel downstream of the American River. The weir limits flood stages (water surface elevations) in the Sacramento River to project design levels through the Sacramento/West Sacramento area. Downstream of the Sacramento Weir, the design flood capacity of the American River is 5,000 cfs higher than that of the Sacramento River. Flows from the American River channel during a major flood event often exceed the capacity of the Sacramento River downstream of the confluence. When this occurs, floodwaters flow upstream from the mouth of the American River to the Sacramento Weir.

Figure 1-8: The Sacramento Weir.

The project design capacity of the weir is 112,000 cfs. It is currently 1,920 feet long and consists of 48 gates to divert floodwaters to the west through the 2 mile-long Sacramento Bypass to the Yolo Bypass. Each gate has 38 vertical wooden plank "needles" (4 inches thick by 1 foot wide by 6 feet long). Though the weir crest elevation is 27.25 feet NAVD88, the weir gates are not opened until the river reaches 30.0 feet NAVD88 at the I Street gage with a forecast to continue rising. This gage is about 1,000 feet upstream from the I Street Bridge and about 3,500 feet downstream from the mouth of the American River. The number of gates to be opened is determined by the National Weather Service /Department of Water Resources (DWR) river forecasting team to meet either of two criteria: (1) to prevent the stage at the I Street gage from exceeding 29 feet, or (2) to hold the stage at the downstream end of the weir to 30.0 feet (DWR, 2010). The weir gates are then closed as rapidly as practicable once the stage at the weir drops below 27.5 feet. This provides "flushing" flows to re-suspend sediment deposited in the Sacramento River between the Sacramento Weir and the American River during the low flow periods when the weir is open during the peak of the flood event (DWR, 2010).

Upstream Dams

Folsom Dam and much of the north levee of the American River were authorized by Congress under the American River Basin Development Act (Pub. L. No. 81–356, 63 Stat. 852 (1949)). Folsom Dam was designed with a flood control space that could 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 that caused the objective release for Folsom Dam to occur. Reassessment of the hydrology for Folsom Dam including information from the 1955 flood event showed that downstream areas, including the City of Sacramento, had considerably less flood protection than previously understood, despite the construction of Folsom Dam and of the extensive flood control systems emplaced by the SRFCP. Discussion began about the need for additional flood storage upstream of Folsom Dam, which led to a proposal for a flood control dam near the town of Auburn on the North Fork of the American River.

Construction of Auburn Dam was authorized by Congress under the Auburn-Folsom South Authorization Act, Pub. L. No. 89-161, 79 Stat. 615 (1965). However, construction on the dam was halted in 1976 when earthquake activity near Oroville Dam north of Auburn suggested a system of faults in the western Sierra Nevada Mountains. A U.S. Geological Survey (USGS) investigation identified a fault close to the Auburn Dam site, which led to a reassessment of the dam's design. No decision on the redesign was made and the completed cofferdam and diversion tunnel remained unaltered until 1986, when a new flood of record washed out the cofferdam and very nearly caused catastrophic flooding in Sacramento.

Without Auburn Dam, Folsom Dam remains the only flood water retention structure on the American River. 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, and each time considerable levee repair was required after the event. For the

1964 flood event, flood-fighting efforts were required to prevent levees from failing. In 1986, rapid filling of Folsom Lake led to releases of 134,000 cfs to manage the risk of dam failure. This flow stressed the American River levees and came dangerously close to causing levee failures in the City of Sacramento. Conditions at Folsom Dam came close to requiring operation of the emergency flood gates at flows in excess of 152,000 cfs, which would likely have flooded Sacramento. The storm subsided slightly before this action was required.

1.4.2 The Common Features Project

Following the 1986 flood, Congress directed the Corps to investigate additional means for reducing flood risk to the City of Sacramento. The Corps completed a feasibility study in 1991, recommending a concrete gravity flood detention dam at the Auburn Dam site and levee improvements downstream of Folsom Dam[5]. Congress, in the Defense Appropriations Act of 1993 (Pub. L. No. 102-396, § 9159, 106 Stat. 1876, 1944-46 [1992]), then directed the Corps to conduct supplemental analysis of the flood control options considered in the 1991 study.

The resulting *Supplemental Information Report, American River Watershed Project, California* (March 1996) outlined three plans to achieve flood risk reduction, including the Folsom Modification Plan, the Stepped Release Plan and the Detention Dam Plan, which was identified as the NED Plan. The Chief of Engineers did not fully concur with the recommendations and deferred a recommendation on the detention dam feature. In recognition of the significant flood hazard potential facing the greater Sacramento area, the Chief of Engineers recommended implementation of several incrementally justified elements common to the final candidate plans, including stabilization of 24 miles of levees along the lower American River, strengthening and raising about 12 miles of levees on the east side of the Sacramento River and implementation of the telemeter inflow gage system and emergency flood warning system. 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 in WRDA 1996 (Pub. L. No. 103-303, §101[a][1]). Meanwhile, improvements to levees protecting the Natomas Basin and the ARN basin across from the Natomas Basin had been authorized in the Defense Appropriations Act of 1993 (Pub. L. No. 102-396 § 9159, 106 Stat. 1876, 1944-1946 (1992)). The Sacramento Area Flood Control Agency (SAFCA) constructed these latter improvements between 1995 and 1998 for which they received both credit and reimbursement.

In WRDA 1999, Congress authorized physical modifications to Folsom Dam as well as additional studies for flood control. Section 101 of WRDA 1999, authorized the Folsom Dam Modification Project to modify the existing outlets to allow for higher releases earlier in flood events. At the same time, Congress also directed the Corps in Section 566 of WRDA 1999 to review additional modifications to the flood storage of Folsom Dam to maximize the use of Folsom Dam for flood damage reduction. The Folsom Dam Raise Project was subsequently authorized by Congress in the EWDAA of 2004.

[5] USACE, 1991.

Section 366 of WRDA 1999 authorized modifications to the Common Features project authorized in WRDA 1996. These modifications included construction of slurry walls to reduce seepage, levee raises along four stretches of the American River, and construction of levee strengthening and raising of 5.5 miles of the Natomas Cross Canal levee in the Natomas Basin. Additional construction components authorized by WRDA 1996 and WRDA 1999 are described in Chapter 5.

All American River features authorized in WRDA 1996 and 1999 have been constructed by the Corps of Engineers or are in construction for completion by the summer of 2015. Design and construction have been undertaken under a Project Cooperation Agreement with the Central Valley Flood Protection Board (CVFPB) that was executed July 13, 1998, and has been amended five times. Cost sharing for these features is 75% Federal and 25% non-Federal.

Features in the Natomas Basin that were authorized in WRDA 1996 and 1999 were deferred pending further study. Following the flood of 1986, significant seepage was experienced on the Sacramento River from the Verona river gauge (upstream end of Natomas) at River Mile (RM) 79 to the town of 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 levee improvements as part of the EWDAA of 1987 for the Sacramento River Flood Control System Evaluation, Sacramento Urban Area, Phase I (Sac Urban Project). The Sac Urban Project constructed shallow seepage cutoff walls from Powerline Road in Natomas down to the town of Freeport (approximately 20 miles) and a stability berm from Verona to Powerline Road (approximately 32 miles). At the time, seepage through the levees was considered to be the only significant seepage problem affecting the City of Sacramento.

After construction of the Sac Urban Project, 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 expected because the levee improvements had not yet been constructed. However, the occurrence of significant seepage on the Sacramento River in the reach improved as part of the Sac Urban Project confirmed that deep underseepage was a significant concern in this area. This led to a geotechnical evaluation of levees in the vicinity of the City of Sacramento which showed that deep underseepage was of concern; a conclusion later confirmed by the Levee Seepage Task Force in 2003[6].

Following the recognition of deep underseepage as a major concern, seepage reduction measures on the American River needed to be redesigned to reduce both through- and deep underseepage. The redesign led to considerable cost increases over what was originally authorized by Congress: increasing project costs to $91.9 million from the originally-authorized $56 million under WRDA 1999, and to $205 million under the EWDAA of 2004.

[6] USACE, 2003

Because of the considerable cost increase of reducing the seepage problem on the American River, almost all funds appropriated by Congress for the project in 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 the Common Features project. Congress was notified in 2004 that, as a result of the underseepage concerns, additional authorized cost increases would be required for study, design, and construction of levee improvements in the Natomas Basin.

While the reevaluation study was beginning for the Common Features project, the Folsom Dam Post Authorization Change report (PAC) was being completed[7]. The results of this study showed that additional levee improvements were needed on the American River and on the Sacramento River below the American River in order to realize the planned benefits of the Folsom Dam projects. These levee problems were expected to consist primarily of erosion concerns on the American River and seepage, stability, erosion, and overtopping problems on the Sacramento River below the confluence with the American River. Because the full extent of these levee problems was not known, it was understood that additional reevaluation studies needed to include the two remaining basins comprising the City of Sacramento: American River North and American River South.

In December 2010, the Natomas Basin Post Authorization Change Report (PACR) and Interim General Reevaluation Report (GRR) was completed. That document focused on the problems associated with the existing levees in the Natomas Basin and recommended improving levee performance by addressing seepage and stability problems, but it did not address measures to raise the height of the levees. The recommendations included in the Natomas Interim GRR were authorized in WRRDA 2014. Measures to raise the height of the Natomas Basin levees are addressed in this report.
Table 1-1 summarizes the Authorized Project Features.

[7] USACE, 2007

Table 1-1: Authorized Project Features.

WRDA 1996 Authorization
Install approximately 24 miles of slurry walls along the lower American River
Install approximately 12 miles of levee modifications along east bank of Sacramento River downstream from NCC
Install three telemeter stream gauges upstream from Folsom Reservoir
Modify the flood warning system on the American River
WRDA 1999 Authorization
Raise left bank of non-Federal levee upstream of Mayhew Drain for distance of 4,500 feet by average of 2.5 feet
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
Modify 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.
Modify 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
Install gates to the existing Mayhew Drain culvert and pumps to prevent backup of floodwater on the Folsom Boulevard side of the gates
Install 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
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
EWDAA 2004
Increased authorized project cost to $205 million
2006 Chief's Discretionary Authority
Install 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 on the Sacramento River in the Pocket Area
Install six relief wells, collector drains and appurtenant features, and a landside berm on the levee toe on the Sacramento River in the Pioneer Reservoir area
WRRDA 2014
Widen 2.0 miles of levee in place and install seepage cutoff wall through levee and foundation on the Lower American River
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
Widen the existing levee in place and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet on the Pleasant Grove Creek Canal
Widen 12.8 miles of existing levee and installation of 10.7 miles of soil bentonite cutoff wall on NEMDC
Widen 5.5 miles of existing levee in-place and install deep seepage cutoff walls on south bank of NCC

*For the purposes of this report, it is assumed that the authorized features included in the Natomas PAC Report are in place.

1.4.3 Authorized Project Features Summary

Project features, as they have evolved through subsequent authorizations, are presented in Table 1-1 and an economic summary of the authorized plan is presented in Table 1-2. The project features associated with the 2010 Natomas Post Authorization Change Report (Natomas PACR) are assumed to be in place as part of the future without-project condition. Therefore, they are included in these tables.

Table 1-2: Economic Summary of the Authorized Plan ($1,000s)[1*]

ESTIMATE OF FIRST COSTS ($000)[1]*			
ITEM	**FEDERAL**	**NON-FEDERAL**	**TOTAL**
Total First Cost	986,257	481,723	1,467,980
Interest During Construction			131,000
Total Investment Cost			1,598,980
Interest and Amortization			53,275
OMRR&R			5,180
Total Annual Costs			58,455
AVERAGE ANNUAL BENEFITS			
Total Annual Benefits			502,500
NET ANNUAL BENEFITS			444,045
BENEFIT TO COST RATIO			8.6

Notes:

[1] Based on October 2014 price levels, 3.375% interest rate, and 50-year period of analysis.

[*] For the purposes of this report, it is assumed that the features of the authorized plan contained in the Natomas Post Authorization Change Report (NPACR) are in place.

1.4.4 American River Common Features GRR

Based on the recognition of underseepage concerns, this GRR assesses the 92 miles of levees that provide flood risk management to the Sacramento area but that have not been designated for improvements under previous Common Features authorizations. These include the east side tributary levees along Dry Creek, Robla Creek, and Arcade Creeks, the east bank of the Natomas East Main Drainage Canal (NEMDC), and the east bank of the Sacramento River levees downstream from the confluence of the American and Sacramento Rivers down to just below the town of Freeport. In addition, based on the modifications that are occurring at Folsom Dam and the effects of targeted releases down the American River, erosion concerns along the American River are evaluated. Also, levee raises for Natomas Basin have been assessed since they were not a part of the Natomas PACR. This GRR does not include any changes to the recommendations contained in the 2010 Natomas PACR.

1.5 WATERSHED PLANNING

1.5.1 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 flood management system in place in the Sacramento Valley since the early 1900s known as the Sacramento River Flood Control Project. Currently, there are more than a dozen authorized projects being studied or implemented by the Corps within the Sacramento River watershed and tributaries (Figure 1-9). 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. 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.

American River Watershed Program

Three authorized projects make up the American River Watershed Program. One of these is the Common Features project, the subject of this report. The other two are the Folsom Modification Project and the 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 is intended to be constructed following the Folsom Modification Project. The Folsom Dam Raise Project primarily includes enlarging the flood control storage space in Folsom Reservoir, features to meet the United States Bureau of Reclamation's (USBR) 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 and recommendations in this GRR for features 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 an 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.

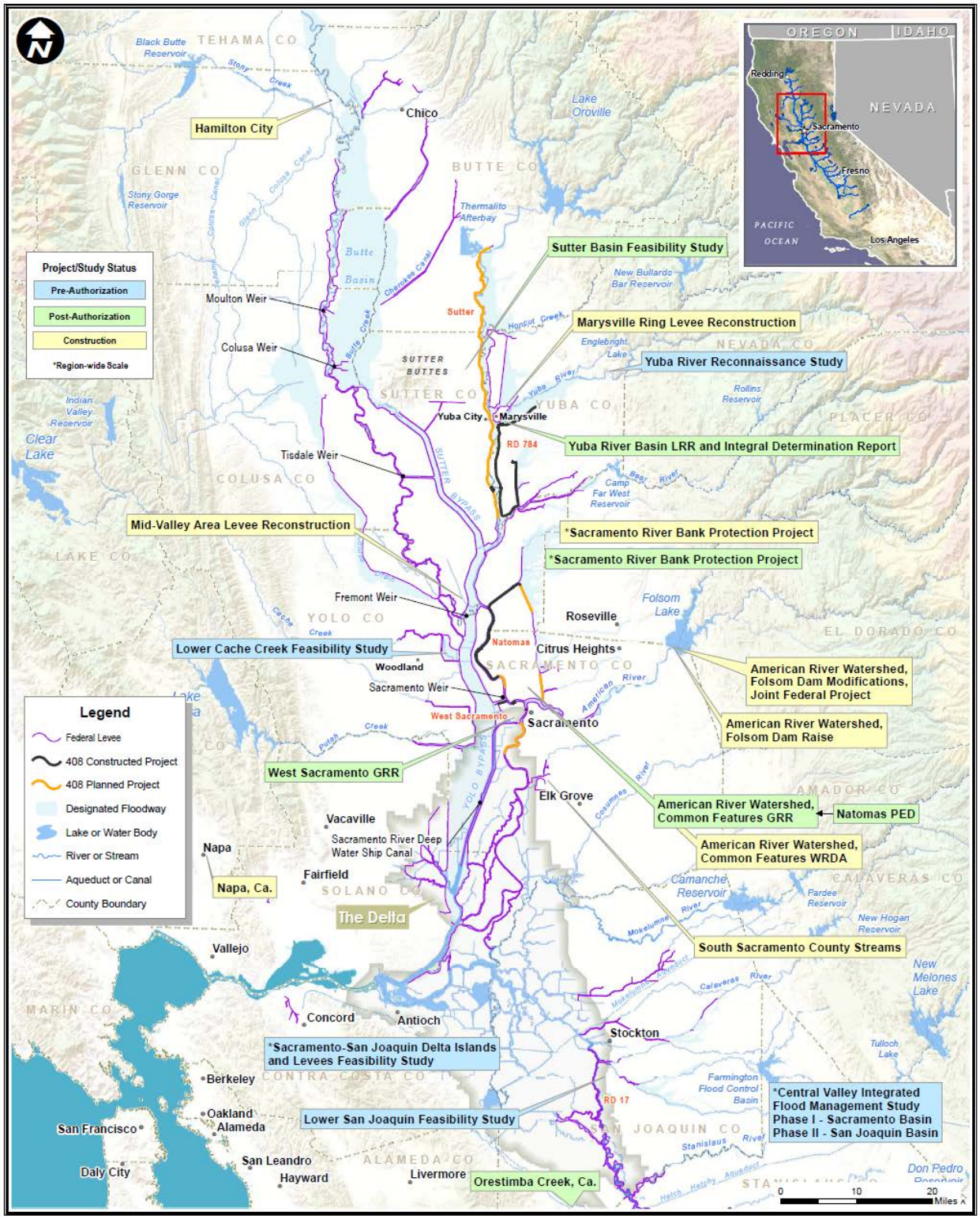

Figure 1-9: Studies and Projects within the Sacramento River Watershed.

Natomas Levee Improvement Program (NLIP)

Under the Natomas Levee Improvement Program (NLIP), SAFCA, in cooperation with the California Department of Water Resources and the Central Valley Flood Protection Board, has constructed urgently needed improvements to address seepage problems in the Natomas Basin levees. Specifically, these include levee improvements for the south levee on the Natomas Cross Canal and the east levee of the Sacramento River from the Natomas Cross Canal to near Powerline Road. These improvements were authorized as part of the WRDA 96/99 and WRRDA 2014 authorizations for the Common Features project. NLIP achieves the targeted flood risk reduction objectives in a manner that is consistent with current Federal engineering and environmental standards. The Corps has provided extensive technical support for this effort. These levee improvements were permitted under Section 408 (33 U.S.C. § 408) and were approved for potential credit under provisions of Section 104 of WRDA 1986 by the Office of the Assistant Secretary of the Army for Civil Works ASA(CW). The features constructed by SAFCA and the State under NLIP were incorporated into the previously discussed Natomas PACR.

Delta CALFED Program

The 1,300 square miles of the Sacramento-San Joaquin River Delta are the hub of California's water delivery system that redistributes runoff from over 40 percent of California's landmass to farms and to more than two-thirds of the state's population. By the 1990s, increasing salinity intrusion and other water quality issues in the Delta led to increasing conflicts among the needs of local and remote water supply interests and the sustainability of the ecosystem. CALFED, a 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 in the Delta. CALFED determined that the Delta levee system is critical to all CALFED objectives and named the Corps as the Federal lead of the program.

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. Authorization for the CALFED Levee Stability Program is contained in Section 103(f)(3) of the Water Supply, Reliability, and Environmental Improvement Act (Pub. L. No. 108-361, § 103(f)(3), 118 Stat. 1681, 1695-96 [2004]). This authorization was subsequently amended by Section 3015 of the WRDA of 2007 (Pub. L. No. 110-114, § 3015, 121 Stat. 1041, 1109-10 [2007]) and Section 210 of the FY 2010 Energy and Water Appropriations Act (Pub. L. No. 111-85, § 210, 123 Stat. 2845, 2860 [2009]).

Sacramento River Flood Control Project

Congress authorized the Sacramento River Flood Control Project in 1917, which adopted the system of locally built levees as Federal levees, and authorized the construction of additional levees, bypasses, overflow weirs, and pumping facilities. 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, West Sacramento, Yuba City, and Marysville, as well as to numerous other small communities. Although the Sacramento River Flood Control Project levees were often constructed of poor materials such as dredged river soils that would not meet today's engineering standards, the levees are still relied upon to provide flood protection during major storms to over 2 million people in approximately 50 communities with an estimated $39 billion in urban and agricultural development.

Sacramento River Bank Protection Project

Erosive forces on the Sacramento River have weakened the 100 year-old levees of the Sacramento River Flood Control Project. In response to requests from the State of California, Congress authorized the Sacramento River Bank Protection Project in two phases to maintain the integrity of these levees and other flood control facilities. 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. WRDA 2007 authorized an additional 80,000 lineal feet of bank protection before the completion of Phase II.

Central Valley Flood Protection Plan and Central Valley Integrated Flood Management Study

The Central Valley Flood Protection Act of 2008 (CVFPA), passed by the California legislature as Senate Bill (SB) 5, directs local flood risk management efforts. The CVFPA, along with other companion legislation, required the Central Valley Flood Protection Board to adopt the Central Valley Flood Protection Plan (CVFPP) by July 2012.

The CVFPP is developing system wide plans to address flood risk management (FRM) issues in the Central Valley of California, which includes the Sacramento and San Joaquin River Basins. The Corps is conducting a parallel planning process, the Central Valley Integrated Flood Management Study (CVIFMS). CVIFMS is a next phase of the Sacramento and San Joaquin River Basins, California Comprehensive Study. The CVIFMS complements the CVFPP process with a multi-objective watershed study focused on integrated water resource management for flood risk management, ecosystem restoration, and other water resource purposes. The CVFPP and CVIFMS both strive to identify long-range projects to reduce the flood risk within the Sacramento and San Joaquin River basins, while restoring and protecting the riparian and floodplain ecosystems. They will provide a framework for a

management plan that can be effectively implemented and supported by local, state, and Federal agencies.

The Final CVFPP was released in June 2012; the CVFPP will be updated every five years. The CVFPP identifies the State's vision for modernizing the State Plan of Flood Control (SPFC) facilities to address current challenges and future trends. The goals of the CVFPP are as follows:

CVFPP Primary Goal

- Improve Flood Risk Management – Reduce the chance of flooding, and damages once flooding occurs, and improve public safety, preparedness, and emergency response through the following:
    - *Identifying, recommending and implementing structural projects and actions that benefit lands currently receiving benefits from facilities of the SPFC.*
    - *Formulate standards, criteria and guidelines to facilitate implementation of structural and non-structural actions for protecting urban areas and other lands of the Sacramento and San Joaquin river basins and the Delta.*

CVFPP Supporting Goals

- Improve Operations and Maintenance – reduce system-wide maintenance and repair requirements by modifying the flood management systems in ways that are compatible with natural processes and adjust, coordinate and streamline regulatory and institutional standards, funding, and practices for operations and maintenance, including significant repair.
- Promote Ecosystem Functions – Integrate the recovery and restoration of key physical processes, self sustaining ecological functions, native habitats, and species into flood management system improvements.
- Improve Institutional Support – Develop stable institutional structures, coordination protocols, and financial frameworks that enable effective and adaptive integrated flood management (designs, operations and maintenance, permitting, preparedness, response, recovery and land use and development planning).
- Promote Multi-Benefit Projects – Describe flood management projects and actions that also contribute to broader integrated water management objectives identified through other programs.

The physical features are organized into regional and system elements, including: urban, small community and rural agricultural improvements projects to achieve local and regional benefits, and system improvements that provide cross-regional benefits and improve the function and performance of the SPFC. System elements include weir and bypass system expansion, flood system structures, and operational changes of reservoirs, weirs and bypasses.

The CVFPP proposes improvements to urban (population 10,000 or more) levees to achieve protection from a 0.5% (1/200) ACE flood at a minimum. The CVFPP states that since many of the existing levees in urban areas are often located immediately adjacent to houses and businesses, few opportunities exist for setting back levees or making improvements that enlarge levee footprints. Therefore, reconstruction of existing urban levees is generally the method for increasing flood risk management. The State is already supporting many urban levee improvement projects, including ARCF and West Sacramento, through the Early Implementation Program, now known as the High Risk Area Flood Risk Reduction Program. These programs provide a means for the State, with local sponsor support, to address critical levee concerns in urban areas.

As presented in the CVFPP, the key benefits of implementing the recommendations identified in the CVFPP, compared with current conditions, are the following:

- 67% reduction in expected annual damages.
- Construction to increase economic output by $900 million and generate over 6,500 jobs annually.
- Avoided business losses to increase long term economic output by over $100 million.
- 49% reduction in life risk.
- 10,000 acres of new habitat and 25,000 acres of habitat-compatible crops.
- Sustainable rural-agricultural lifestyle.
- Resiliency and adaptation to future changes.

After release of the Final CVFPP in June 2012, the State initiated two basin-wide feasibility studies (in the Sacramento Basin and in the San Joaquin Basins). These State feasibility studies will examine the measures and alternatives considered in the 2012 CVFPP to determine their feasibility. A legislatively mandated update to the CVFPP is due in 2017. This update is focused on potential modifications to the bypass and weir components of the existing State Plan of Flood Control (SPFC) as well as environmental conservation measures in conjunction with any proposed modifications. Improvements to the conveyance system, such as widening the Sacramento Weir and Bypass, would provide greater system flexibility and resiliency in accommodating future hydrologic changes in the project area, including those due to climate change.

Because the majority of the Central Valley flood risk management facilities and most of the SPFC facilities are part of the State-Federal flood management system, any modifications or additions to this system requires Federal participation and approval through USACE. Major improvements or modifications to the SPFC will require a feasibility study to be used by Federal decision makers and Congress to authorize new projects or project modifications, and appropriate funds.

CVIFMS is a watershed study focused on the Sacramento River watershed and will evaluate water resources problems including flood risk management, ecosystem restoration, and water supply. Resulting recommendations from the watershed study would be published in a watershed plan but would not result in any construction. Based on the findings and recommendations of CVIFMS, it is anticipated that several regional feasibility studies would be initiated. When completed, the feasibility studies would determine Federal interest in implementing elements of the CVFPP and identify non-Federal responsibilities for improvement to the system.

Lower Sacramento/Delta North Regional Plan

One outgrowth of the CVFPP was the creation of six regional flood management planning areas in the Central Valley. They were established to promote a grassroots approach for the preparation of a regional multi-objective plan by encouraging flood management agencies in each region to include cities, counties, emergency responders and other important stakeholders in their collaborative efforts to resolve longstanding flood risk management issues.

The Lower Sacramento/ Delta North Regional Flood Management Plan (RFMP) study area encompasses portions of Yolo, Solano, Sacramento and Sutter Counties. It will establish the flood management vision and a prioritized list of flood risk reduction actions including expansion of both the Fremont and Sacramento Weirs and widening of the Yolo and Sacramento Bypasses. These modifications, in concert with improvements to Folsom Dam, will lower flood stages in the Sacramento River downstream of the Fremont Weir, in the tributary channels around the Natomas Basin, in the American River, Feather River, and Sutter Bypass channels upstream of the Fremont Weir, and in the Yolo Bypass itself. The regional partners believe that these actions would also provide new regularly inundated floodplain that could be managed to improve fish rearing and passage as part of an overall framework that includes agricultural sustainability and other objectives.

FloodSAFE California

FloodSAFE California is a strategic initiative of the State of California to improve flood protection and public safety. The FloodSAFE program is 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. The California Department of Water Resources (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, the California Department of Fish and Wildlife (CDFW (formerly known as the California Department of Fish and Game)), the Corps, the Federal

Emergency Management Agency (FEMA), the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), tribal entities, and many local sponsors and other stakeholders. One of the products of the FloodSAFE program is the Statewide Flood Risk Report.

SAFCA Development Impact Fee

In 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 under 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, the County of Sacramento, and the County of Sutter. SAFCA expects that the fee will raise $148 million. Fee collection began January 1, 2009. 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 waterside and landside levee strengthening, acquisition of agricultural easements, and improved system operation.

Public Law 84-99 Eligibility Retention and Flood System Improvement Framework

In the aftermath of Hurricane Katrina, the Corps began to place heightened emphasis on the removal of woody vegetation from flood control works under 33 C.F.R. § 208.10(b)(1) and its replacement by sod (see also Engineer Technical Letter (ETL) 1110-2-583, Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures). In central California, the situation is atypical because 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 preserved in an effort to provide erosion protection for the levees. Additionally, the vegetation on the levees provides important habitat.

1.5.2 Summary

The implementation of the projects at Folsom Dam, the evolving levee safety criteria, and other studies in the area all must be considered in establishing the future without-project condition. Additionally, the ongoing efforts toward development of a comprehensive plan of flood risk management in the Central Valley make it all the more important that the Common Features Project work in conjunction with the development of the comprehensive CVFPP and CVIFMS. It is assumed that the American River Common Features Project would be an early implementation project of the overall State plan.

1.6 PLANNING PROCESS AND REPORT ORGANIZATION

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:

- Chapter 2, 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 establishes planning objectives and constraints for the reevaluation of the project.
- Chapter 3, Alternatives, is the heart of the report. It covers the third step in the planning process (formulation of alternatives) as well as 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).
- Chapter 4, The Selected Plan, describes the selected plan resulting from the evaluation of alternatives.
- Chapter 5, Changes to the Common Features Project, integrates the reevaluated Common Features Project with the other previously recommended, authorized, and constructed portions of the project to describe the proposed changes to the authorized Common Features Project.
- Chapter 6, Public Involvement, Review, and Consultation, covers the public and agency participation in the study to date.
- Chapter 7, Recommendations, provides the recommendation for project reauthorization.

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.

2.1 NATIONAL OBJECTIVE

In WRDA 2007, Congress passed statutory language (codified at 42 U.S.C. § 1962-3) that describes national water resources planning policy: "water resources projects should reflect national priorities, encourage economic development, and protect the environment by:

> (1) seeking to maximize sustainable economic development;
>
> (2) seeking to avoid the unwise use of floodplains and flood-prone areas and minimizing adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used; and
>
> (3) protecting and restoring the functions of natural systems and mitigating any unavoidable damage to natural systems."

In consideration of the many competing demands for limited Federal resources, Federal investments in water resources should strive to maximize public benefits, with appropriate consideration of costs. Public benefits encompass environmental, economic, and social goals, include monetary and non-monetary effects and allow for the consideration of both quantified and non-quantified measures. Congress directs the Corps of Engineers to study various water resource related issues in compliance with the specific planning and technical requirements defined by regulations and law. Compliance with those regulations and law provide the tools to prioritize economic development, the wise use of floodplains and the protection of the environment.

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. The National Economic Development (NED) Plan is the plan that

reasonably maximizes benefits relative to cost. 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

Public input was received through coordination with the sponsors, other agencies, and through public workshops. A discussion of public involvement is included in Chapter 6, Public Involvement, Review and Consultation. The public concerns that are related to the establishment of planning objectives and planning constraints are:

- Vegetation Removal: The Corps' Engineer Technical Letter regarding vegetation on levees, ETL 1110-2-583, is a nationwide standard established because vegetation on levees can pose a risk to a levee's integrity. ETL 1110-2-583 causes much public concern due to the standard approach identified in that document for the removal of vegetation on levees and the loss of riparian habitat. Much of the riparian habitat present in the Sacramento Valley was lost due to construction of the Sacramento River Flood Control Project and associated land reclamation. The remaining riparian areas along the rivers are important habitat for a number of Federal and State listed and endangered species, including several fish species and the Swainson's Hawk. Vegetation that is on and near levees along the project is part of this habitat. There is concern that additional vegetation removal will reduce the remaining habitat present in the Sacramento Valley. The GRR has identified several methods that would allow the vegetation on and near the levees to remain or be addressed over time if they don't pose an immediate risk to the integrity of the levee.
- Flood Insurance and Rates: FEMA certification of some of the levees within the City of Sacramento has expired. SAFCA is working on recertification to maintain the FEMA preferred rates. In order to meet this goal, SAFCA is focused on the necessary levee improvements to make them eligible for FEMA certification. In addition, the cost of flood insurance may be changing. FEMA is evaluating the cost of disaster recovery and the associated flood insurance rates needed to cover the cost of the program. The cost of flood insurance for leveed systems may be drastically changing, significantly driving up the cost for flood insurance for non certified levee systems. There is concern that flood insurance may be required in the City of Sacramento and additionally, there is concern about what the flood insurance rates may be in the future.
- Real Estate and Encroachments: Since completion of the Sacramento River Flood Control Project (SRFCP), in certain reaches, development has occurred up to and, in some cases, directly on top of the levee. There are segments of levees within the study area where this has extensively occurred. There is concern that when the Corps begins to construct levee improvements, much of the real estate development and encroachments that have occurred up to and on top of the levees will have to be permanently removed to be in compliance with the Corps criteria. Sacramento Bypass Widening: The purpose of widening the Sacramento Weir and Bypass is to draw more flow away from the urban area near the Sacramento River and convey it to the Yolo Bypass. There is concern that doing this will impact the rural property

owners in and adjacent to the Yolo and Sacramento Bypasses. In addition, Yolo County is concerned about losing agricultural property and the effect that will have on property tax collections.

- Erosion Protection Armoring: Erosion protection usually involves placing rock revetment to counter the forces of flow and velocity to protect against a possible levee failure. There is concern about placing rock revetment in river environments because of the potential effects on native habitat, loss of recreational amenities, and the perceived loss of the aesthetic value of the natural environment.
- Timing of Levee Safety Criteria and the SWIF Process: There are various problems with levees that require improvements to reduce the flood risk to the City of Sacramento. These improvements include seepage cutoff barriers, bank protection, slope flattening, levee raising, vegetation and encroachment removal, and providing landside access. Associated with constructing some of these improvements is the need to acquire real estate. There is concern that the time that it takes to acquire the necessary real estate will slow down construction of features that have the greatest impact on reducing flood risk such as seepage cutoff barriers. Because of this, the sponsors and USACE are supportive of constructing features that require land acquisition over time under a System Wide Improvement Framework (SWIF) so that it doesn't delay construction of other features. This will allow the project to address the levee problems in a worst-first manner.
- California's Senate Bill 5 and 200-Year Level of Protection: Senate Bill 5 requires urban areas to achieve a 200-year level of protection which is defined as the 200 year mean water surface elevation plus 3' of freeboard. There is concern that the Federal plan might not include improvements up to this 200-year State standard.

2.3 PROBLEMS

The Sacramento metropolitan area is one of the most at risk areas for flooding in the United States. There is a high probability that flows in either the American or Sacramento Rivers will stress the network of levees protecting the study area to the point that levees could fail. The consequences of such a levee failure would be catastrophic because the inundated area is highly urbanized and the flooding could be up to 20 feet deep. This section describes the problems addressed by the GRR to reduce flood risk in the Sacramento metropolitan area. The following sections include a description of the flood risk in terms of the probability of flooding and the resulting consequences.

2.3.1 Problem: There is a high probability of flooding in the Sacramento Metropolitan Area

The Sacramento metropolitan area has a high probability of flooding because of its location within the floodplain at the confluence of two major rivers. Both of these rivers have large watersheds with very high potential runoff that has overwhelmed the existing flood management system in the past. The existing levee system was designed and built many years ago, before modern construction methods

were employed. These levees were constructed close to the river to increase velocities in order to flush out hydraulic mining debris. This debris is essentially gone now but the high velocities associated with flood flows are eroding the levees that comprise the flood risk management for the study area. All of the factors that contribute to the high probability of flooding are discussed in more detail in the following sections.

Past Flood Events

Newspaper accounts and anecdotal evidence mention at least nine major floods prior to 1900, which prompted the construction of spoil bank levees across the flood plain. The modern flood control system originated with the SRFCP levees authorized in 1917, the Central Valley Project (including Shasta Dam), the completion of Folsom Dam in 1956, and the completion of Oroville Dam in 1967. In the time since Folsom Dam began operations, large floods on the American River have occurred in 1955, 1964, 1969, 1970, 1982, 1986, 1997, and 2006. The 1986 flood is the flood of record.

February 1986 Flood

In February 1986, a series of storms led to severe flooding in central and northern California. In many areas, precipitation from this 10-day storm delivered more than half of the normal annual precipitation for the area. The Sacramento River flood control system was overloaded and reservoirs in the system were filled beyond their design capacity. Record flow releases from the reservoirs produced river flows that exceeded the design capacity of downstream levees: water came within inches of overtopping levees protecting Sacramento. The timely cessation of the storm event prevented overtopping of the American River levees. At the runoff peak, approximately 134,000 cfs was released from Folsom Dam with an estimated 650,000 cfs flowing past the Sacramento metropolitan area in either the Sacramento River or Yolo Bypass and out to the Sacramento Delta.

Emergency levee work and flood fighting prevented catastrophic flooding (Figure 2-1). However, the extended high water caused boils, slips, sloughing, seepage, flood flow erosion, and wave erosion that required emergency work to minimize or prevent further damage during the flood. Several levees upstream from Sacramento failed during this flood. At the conclusion of the storm, the Governor declared emergencies in 39 counties, with damages totaling more than $500 million. Sacramento County had damages estimated at $49 million (1986 dollars).

Figure 2-1: Slope Failures on the Landslide of the Levee and Seepage Exiting at the Levee Toe on the Garden Highway in Natomas during the 1986 Flood.

January 1997 Flood

In mid- to late-December 1996, heavy snow fell in the Sierra Nevada Mountains. This was followed by heavy precipitation on the western slope of the mountains. The rain began to fall on December 26, and from December 31 to January 3, an atmospheric river (locally known as a "Pineapple Express") brought approximately 30 inches of rain on the western slopes of the Sierra Nevada, in the process dumping more than half a year's worth of rain on Northern California in 10 days. In addition to the local rainfall, 50°F temperatures and rain in the Sierra Nevada melted the snowpack below 6,000 feet. The combination of record snowfall and record rain resulted in high stream flows around Sacramento. The Sacramento River peaked within half a foot of the 1986 record level. Folsom Lake experienced a peak inflow of 255,000 cfs and was able to control it to the objective release of 115,000 cfs. Upstream from Sacramento, outside of the study area, levees on the Feather River at Olivehurst and on the Sutter Bypass breached.

General Description of the Flood Flows

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 in the vicinity of the Verona river gauge. 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.

Evaluation and determination of the extent of flooding due to levee overtopping and/or levee failure were performed with numerical floodplain models using FLO-2D. A full range of flood frequencies were analyzed and the associated floodplains were determined. Table 2-1 shows the area inundated in the event of a levee breach. Figure 2-2 shows the 200-year floodplains for the study area. The 200 year frequency was selected as a representative floodplain to depict the extent and depth of a very large flood event.

Table 2-1: Flood Plain Area.

Economic Impact Area	Total Acres	Total Square Miles
American River North	24,340	38.0
American River South	146,370	228.6
Natomas	53,570	83.7
TOTAL	224,280	350.3

Flood Management System Capacity

Evaluations of storms and floods of record indicate that critical flood-producing conditions in the project area will exist only during the winter season when there is a wet snowpack and a prolonged series of general storms occurring over the entire basin. Usually, storm precipitation amounts are distributed in the same general pattern as normal annual precipitation amounts. Major departures from this pattern do occur, however. Generally, a storm series will last from 2 to 5 days; however, some series have been longer (the 1986 storm lasted 10 days). During such periods, groundwater levels rise, infiltration capacities decline, and the natural and artificial storage within the basin is progressively filled.

Flood flows in the American River basin are rather frequent and of two general types: winter rain-on-snow floods and spring snowmelt floods. Historically, only flood flows resulting from intense winter rainfall over the foothills and mountains have caused serious flooding. Outside the winter season, storms are less severe, cover smaller portions of the basin at a time, and are so widely separated in time that existing basin flood control facilities are usually easily capable of controlling the runoff.

Prior to the construction of levees, the Sacramento River annually would overflow its banks flooding the primarily riparian and wetland habitats of the valley. After levee construction began under the SRFCP, flows were confined to the river in most areas. Before the bypass system was constructed, levee failures occurred frequently, flooding the previously “reclaimed” areas. After completion of the SRFCP system, which included the bypasses, levee failures still occurred, but only on the more severe flood events.

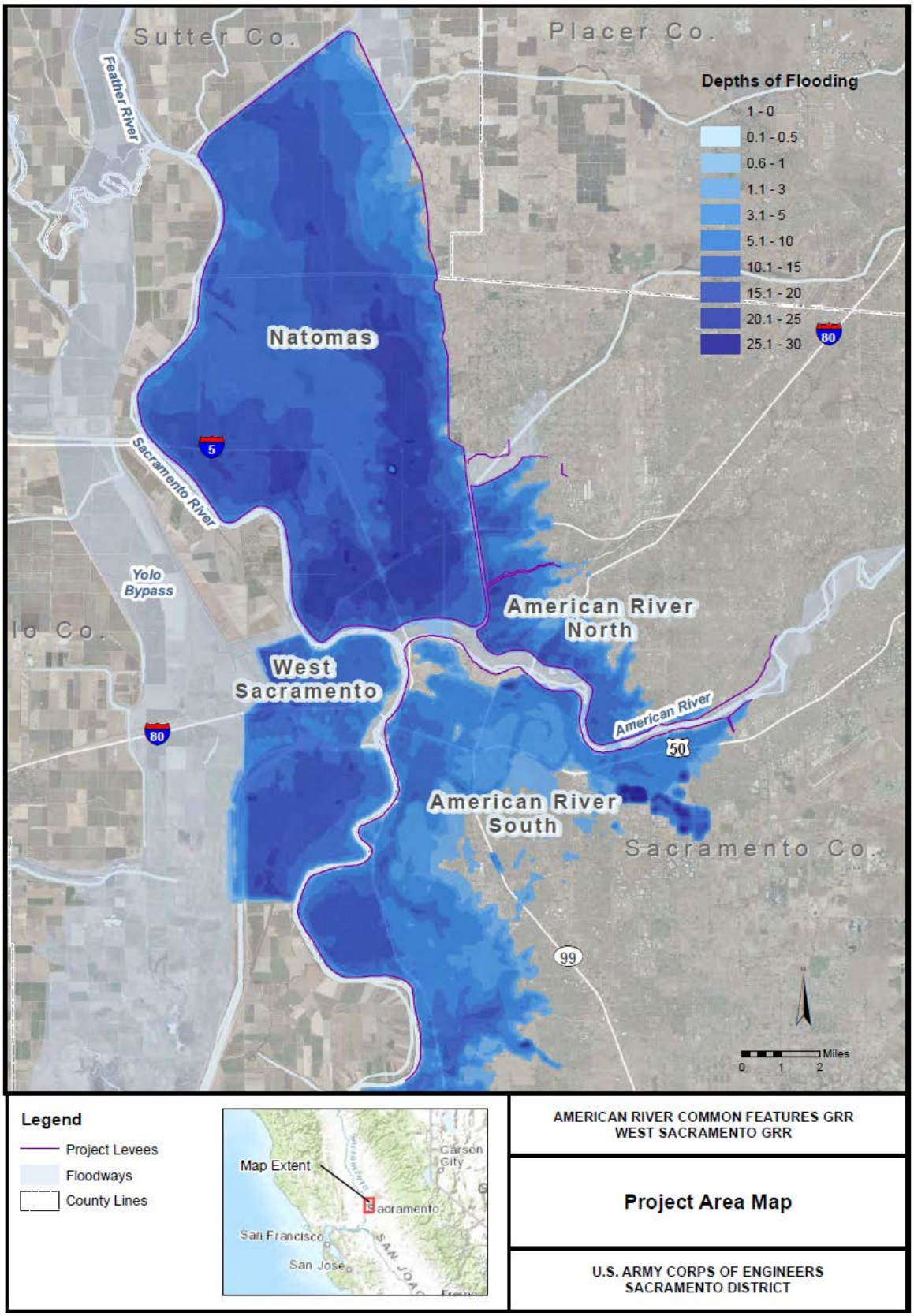

Figure 2-2: 1/200-Year ACE Flood Plains in the Sacramento Area.

The SRFCP was designed to pass the known flood of record, which at the time of Congressional authorization was the 1909 flood. During construction of the system, a new flood of record occurred in 1927, which was incorporated into the overall system design. After completion of the Federal system in the 1950s, a new flood of record occurred in 1986, followed by the slightly smaller flood of January 1997. The floods of 1986 and 1997 delivered much more water to the leveed reaches than they were designed to carry, resulting in levee failures. On the American River, the four biggest floods occurred after completion of Folsom Dam and the SRFCP. In general, throughout the Sacramento Valley, climatology following the completion of the Federal system has been much wetter with more precipitation than the period that the original design of the system was based upon, and more flow is being delivered to the levee system than it was intended to safely carry. This has resulted in large levee failures, with ensuing significant loss of property and some loss of life. Table 2-2 shows the design capacities for various locations in the river system and computed flows for a 100- and 200-year event for these same locations.

Table 2-2: Design Flows and Flood Flows in the Project Area.

Location	SRFCP Design Capacity(ft^3/sec)	100-year flood frequency flow (ft^3/sec)	200-year flood frequency flow (ft^3/sec)
Sacramento River (upstream of Sacramento Bypass)	107,000	120,000	130,000
Sacramento River (downstream of American River Confluence)	110,000	122,000	134,000
Sacramento Bypass	112,000	115,000	149,000
American River (Folsom Dam release)	115,000	115,000	160,000

*Assumes Folsom Dam improvements (JFP and dam raise) in place and operable.

Since the SRFCP was completed in the 1950s, only localized improvements have been completed. Most of the recent work consists of maintenance such as bank protection, and seepage and stability fixes to correct localized problems within reaches. Over this same period, many areas have seen substantial urban development. This urbanization has dramatically increased the consequences of levee failure in these areas. Since levee improvements have not kept pace with the rate of urban development, overall flood risk has drastically increased since completion of the SRFCP system in the 1950s.

Folsom Dam Operational Improvements

The existing configuration of Folsom Dam is such that the lower level outlets are at elevation 280 feet; the spillway sill is at elevation 418 feet, and the bottom of the 400,000 acre feet permanent flood control pool is at elevation 427 feet. Because of this configuration, only 30,000 cfs can be released until the stage in the reservoir reaches the spillway. The objective release for Folsom Dam is 115,000 cfs.

However, this amount of flow cannot be released until the stage is sufficiently high enough above the spillway to force it through the spillway. With this configuration and with the levees downstream of Folsom Dam only being able to reliably convey 115,000 cfs, the level of flood protection is relatively low as compared to other similar size cities throughout the country.

With the Folsom Dam Joint Federal Project (JFP), an auxiliary spillway is being constructed with a spillway sill at elevation 368 feet. With this new spillway, a release of 115,000 cfs can be made at a much lower reservoir stage than with the existing spillway only, also allowing for this release to be made for a longer duration. Additionally, with this new spillway and allowing for releases to increase to 160,000 cfs, the 200-year event design storm can be safely conveyed past the dam. However, the levees downstream of the dam have a high probability of failure with flows at 160,000 cfs.

Conditions Affecting the Reliability of Levee Performance

In addition to the problems associated with the capacity of the American and Sacramento River system, investigations conducted by USACE and the State of California have identified issues with the levees built to reduce the flood risk in Sacramento. The foundation conditions and the non-engineered construction of some of these levees have resulted in issues associated with through-seepage, underseepage, and stability. The seepage and stability problems associated with the levees in many locations are so severe that these problems must be corrected before any other types of flood risk management measures can be considered. Reductions of flood levels on the order of several feet are not sufficient to offset the problems associated with seepage. Additionally, the levees were built very close to the riverbanks, with the result being that they are directly subjected to the erosive forces of the river. Because of the urban setting of these levees, many have issues with vegetation, encroachments, and a lack of access for maintenance and flood fighting. In addition, in some locations, the elevation of the top of the levee is not high enough to contain some large flow events. Figure 2-6 shows the locations of specific levee issues. These specific levee issues are discussed below.

Seepage and Underseepage

The poor construction of most of the levees in the Sacramento area leads them to have problems with water seeping through the levees. The levees were constructed of material dredged from the river. 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 to 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 2-1 shows the effects of seepage under and through the levee.

Figure 2-3: Sandbag Ring Surrounds a Sand Boil on the Natomas Levee during the 2006 Flood.

In addition to seepage through the levees, the integrity of these levees is also potentially compromised by underseepage. Underseepage occurs when water seeps through permeable sand and gravel lenses underlying a levee. In the project area, numerous lenses lie under and cross beneath the existing levee system because the flood plain on which the levees are built is crisscrossed by former river channels, meanders, oxbows, and current and former point bars. Under high water stages, areas protected by levees can still flood because of underseepage through these highly permeable sand and gravel layers.

These layers are also easily eroded, 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. If this pressure is suddenly released due to blanket failure or other cause, rapid piping will undermine the levee embankment, leading to failure. Such piping was observed in the Natomas levees after the 1986, 1997, and 2006 floods. The piping took the form of sand boils, which result when the seepage beneath the levee is fast enough to bring sand particles with it. This kind of internal erosion can undermine a levee and lead to instability and failure. Figure 2-3 shows a sand boil being treated with a sandbag ring during the 2006 flood. This flood was a 10-year frequency flood.

Levee Stability

During the 1986 floods, stability problems were observed during high water stages on both the landside and waterside slopes. The materials used to construct the levees were not selected for their suitability, rather they were chosen because of their availability as dredge material from the riverbed. The construction methods were also inadequate: the levee material was not compacted but was constructed with clamshells or dredged, with assorted objects such as dead trees indiscriminately buried in the levee

embankments. Seepage through the levee embankment and underseepage through its foundation raises 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.

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

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 levees provided a degree of protection from flooding. Second, the strategy removed material from the river bed, causing the channel 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 channel capacity.

The levees continue to confine the flow into a relatively narrow channel, contributing to erosion and degradation of the river channel. However, most of the sediment deposited in the river channels has been depleted and the Sacramento River and the American River are sediment-starved. Additionally, on the American River, Folsom Dam blocks sedimentation from upstream sources. As a result, the energy of the flow contributes to erosion of riverbanks and levees along both rivers. Channel erosion and degradation could have detrimental effects on the levees by undercutting the foundation materials,

particularly if the riverbank materials are easily erodible. The erosion of the riverbank adjacent to levee embankments may also increase 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 river bank erosion in the area can be both gradual and episodic. Some erosion occurs almost every year, with major losses occurring with large flood events. A sedimentation analysis was not completed for this study. However, a sediment study of the Sacramento River from Colusa to Freeport is near completion under the Sacramento River Bank Protection Project[1]. The main objective of this sediment study was to investigate sediment transport processes and geomorphic trends along the lower Sacramento River and its major tributaries and distributaries. A HEC-6T sediment transport model was developed for the study reaches of the Sacramento, Feather, and American Rivers to estimate degradational or aggradational trends over the next 50 and 100 years.

For the entire study reach of the Sacramento River (RM 79-46), the average bed elevation decreases by 0.02 ft for the 50-year simulation period and decreases by 0.10 ft for the 100-year simulation period. Despite a few significant (on the order of feet) localized vertical adjustments in the channel geometry (mostly associated with infilling of deep pools and scour of elevated riffles), the study reach of the Sacramento River appears to have a slight degradational trend. The potential for lateral movement of the river is of greater concern due to the possibility for river bank and levee erosion in this narrow channel. Some rock erosion protection has been placed along the Sacramento River to protect the levees from erosion. Often this rock was placed using the reactive or passive approach such as part of ongoing maintenance activities or as part of the Sacramento River Bank Protection Project. While some recent designs and construction of rock erosion protection are expected to provide adequate localized erosion protection, other locations may not deliver the same performance during a flood event. Some previous rock erosion protection does not meet current design standards, is past its intended design life, and is in need of repair and/or replacement.

The "Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events[1]" determined that hardpan has been reached in part of the channel and is slowing degradation; however, the river is now eroding laterally. Some additional erosion of the channel bed is possible, however, this is considered to be a future risk beyond the 50 year period of analysis for this study. Erosion of the riverbank is occurring even at low flow conditions of 7,000 cfs. In some sections of the river velocities can reach 11 feet/second for flows of 115,000 cfs, and as high as 12 feet/second at flows of 160,000 cfs. This study concluded that flows of 145,000 cfs could cause damage and potentially cause a levee failure.

[1] USACE, 2012

Levee Overtopping

Although the levees in the Sacramento area have not been overtopped in recent flood events, several floods have come within inches of overtopping. However, it is possible that a large enough flood event could occur that would overtop the levees on either the Sacramento or American River. Because the Sacramento area levees were not built to modern engineering standards, levee overtopping would potentially lead to failure of the levee and cause devastating flooding.

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

Figure 2-5: Sacramento River near the Little Pocket and Pocket Neighborhoods.

Vegetation and encroachments on and adjacent to levees is problematic because:

- Levee visibility is reduced, making it challenging for maintenance and inspection crews to identify problems in levee integrity such as the presence of burrowing animals, cracks, slumping, and seepage.
- Levee accessibility is reduced as vegetation and encroachments can block access to the levee crest or landside of the levee for flood fighting and maintenance access purposes.
- Through-levee seepage can be initiated by the roots of riparian vegetation, which can also impair the general integrity of the levee.
- Wind throw of trees can produce large holes, gaps or weak spots in levees, displacing relatively large amounts of earth. This can affect the strength of the levee, or if on the waterside, increase the risk of scour.
- Slope stability is impaired when the roots of trees or other riparian vegetation accelerate erosion problems along levee toes, a particularly critical part of the levee in terms of slope stability.

Levee Problems at Specific Locations

Levee problems occur at many locations within the project area. With the exception of the Natomas Basin, it is convenient to describe the specific problems of the Sacramento area by organizing the discussion around the various bodies of water involved. Flooding problems and levee performance issues are found in relation to the following rivers and streams:

- Arcade Creek
- Dry and Robla Creeks
- Natomas East Main Drainage Canal
- Magpie Creek
- Sacramento River south of the American River
- American River

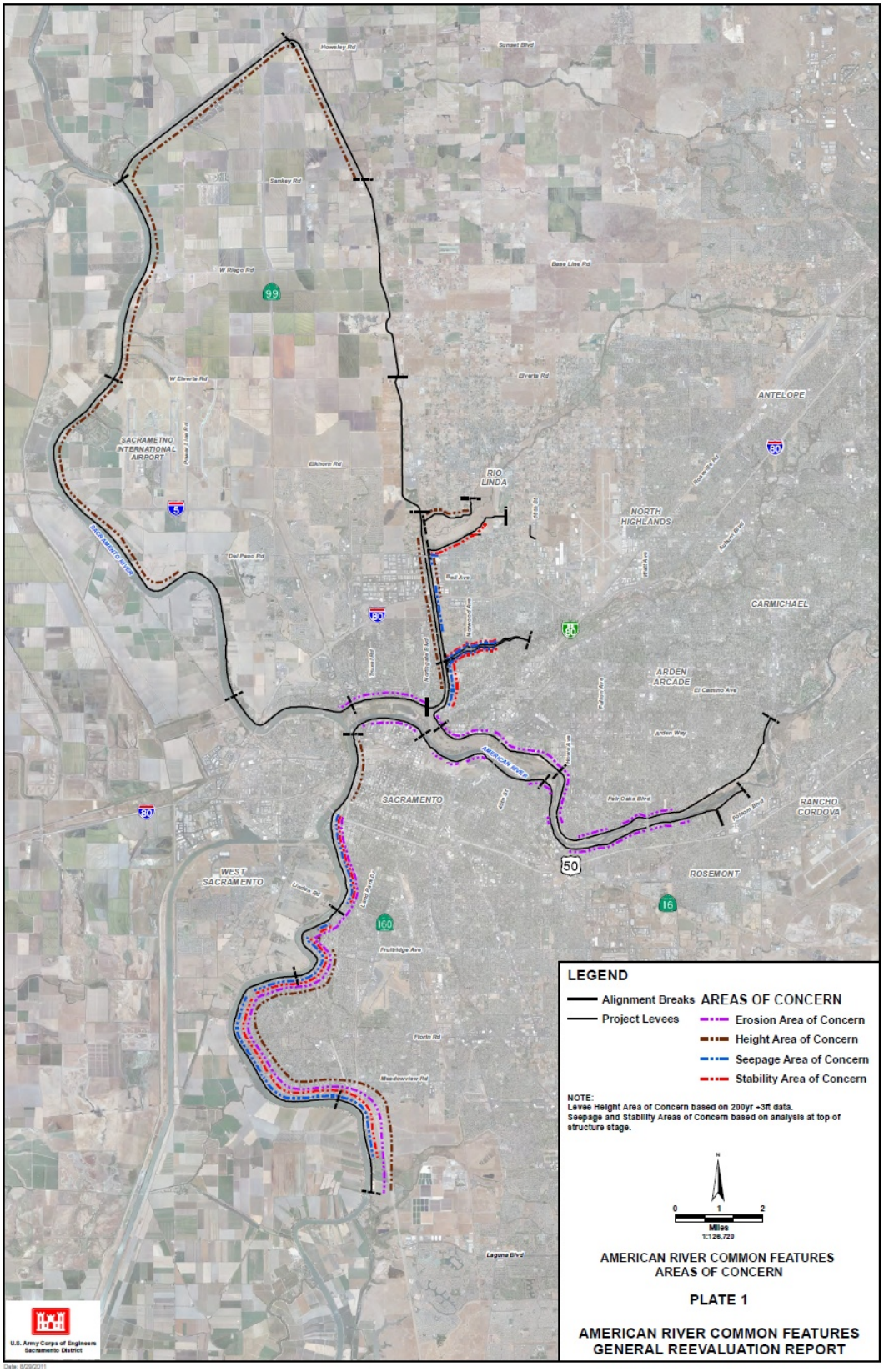

Figure 2-6: Problems at Specific Locations in the Study Area.

Natomas Basin

The Natomas Basin is shown in Figure 2-6. Once the improvements recommended in the Natomas PACR are implemented, levee overtopping will be the remaining major issue with the Natomas levees. The levee improvements recommended in the Natomas PACR leave residual average annual damages of $19 million. The annual exceedance probability is 0.015, or a 1-in-67 chance of overtopping in any given year. The State of California has adopted a standard level of protection for urban levees, that being 200-year flood level plus three feet. Although some levees were raised under NLIP, most Natomas Basin levees do not provide this level of protection. Since the PACR did not include a recommendation for levee raises, this GRR will evaluate whether or not there is a Federal interest in constructing levee raises If so, this GRR will evaluate how much credit to the local sponsor is warranted (pursuant to previous preliminary approvals under Section 104, WRDA 1986) for the levee raises they have already constructed. In addition to height, there are issues with encroachments and vegetation on the levees.

Arcade Creek

Arcade Creek (Figure 2-6) is located in the American River North (ARN) sub-basin. The key issues with the Arcade Creek levees are seepage and stability as a result of placement of the levees on deposits of pervious materials and construction with overly steep side slopes. The seepage and stability problem is exacerbated by a deep ditch on the landside levee toe of the levee. In addition, as previously described in this section under the description for "Flood Management System Capacity," the levees were only constructed tall enough to convey flows experienced prior to completion of the overall flood control system in the mid 1950s and have since been stressed with larger floods which have threatened overtopping in certain reaches. Vegetation and encroachments on or near the levee are issues for this reach as well.

Dry and Robla Creeks

The Dry and Robla Creek levees (Figure 2-6) are also in the American River North (ARN) sub-basin. As with Arcade Creek, conveyance limitations regarding height are likewise a problem.

Natomas East Main Drainage Canal

The east levee of the Natomas East Main Drainage Canal (Figure 2-6), located in the American River North (ARN) sub-basin, is constructed on top of an old stream bed. These gravelly stream deposits have led to seepage and stability issues with the levee. In addition, as with Arcade Creek, conveyance limitations regarding height are likewise a problem.

Magpie Creek

Magpie Creek is in the American River North (ARN) sub-basin (Figure 2-6). Magpie Creek is diverted into the Magpie Creek Diversion Channel (MCDC) to direct the flow of the creek northward, away from homes and businesses to Robla Creek. The flooding problems in this area consist primarily of flows that outflank or overtop the levee next to the MCDC and flow toward the historic channel of Magpie Creek. Floodwaters can overtop the existing left bank levee of the MCDC at approximately the 14-year event. Outflanking of the levee at Raley Boulevard currently occurs at a two-year event.

Sacramento River South

The Sacramento River east levee south of the American River is in the American River South (ARS) sub-basin (Figure 2-6). The levees in this area protect some of the most heavily populated areas of Sacramento. Deep underseepage is common in the area, and for some levees, steep side slopes have led to stability problems. In addition, woody vegetation, encroachments, and a lack of access for maintenance and flood fighting are significant problems in this area. Erosion is a concern because the levees are located very close to the river and in some areas. In addition, as with Arcade Creek, conveyance limitations regarding height are likewise a problem. Vegetation and encroachments on or near the levee are issues for this reach as well.

American River

The north levee along the American River is located in the ARN sub-basin while the south levee is located in the ARS sub-basin (Figure 2-6). These levees have been improved under the 1996 and 1999 authorization of the Common Features project. However, erosion remains a major issue along the American River. The Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events[2], evaluated the potential for erosion of grass-covered levees and overbanks in response to different stream discharges resulting from releases of various magnitudes from Folsom Dam. This study concluded that the river system is degrading under present operating conditions because the lower American River is starved of sediments by Folsom Dam and Nimbus Dam (a fish hatchery and diversion dam project just downstream of Folsom Dam). Hardpan has been reached in the channel bottom as far downstream as Guy West Bridge (river mile 7.0), and this hardpan is slowing further degradation. With the river starved for sediment and unable to further scour its channel; the river is now eroding laterally to satisfy its need for sediment. Erosion of the riverbank is occurring even at low flow conditions of 7,000 cfs, which was the peak flow from the 2003 runoff season. Ongoing erosion has scarred the channel banks leaving them susceptible to further erosion, especially during high flow events. Lateral erosion is further reducing the amount of berm separating the main channel from the levee. The loss of

[2] Ayers Associates, 2004. Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events, Report presented to the U.S. Army Corps of Engineers (July 2004).

vegetation on the berm and bank is leaving bare soil, which is more susceptible to erosion at a lower velocity than if the berm or bank was covered with vegetation.

Figure 2-7 shows velocity contours in the area where erosion is greatest, between River Miles 6 and 7.5. As can be seen in Figure 2-7, velocities reach 11 ft/sec for flows of 115,000 cfs, and get as high as 14 ft/sec for 160,000 cfs. The study concluded that a flow of 145,000 cfs could cause damage at most of 12 identified priority sites, and could cause a levee failure to occur for at least one of the sites. Vegetation and encroachments on or near the levee are issues for this reach as well.

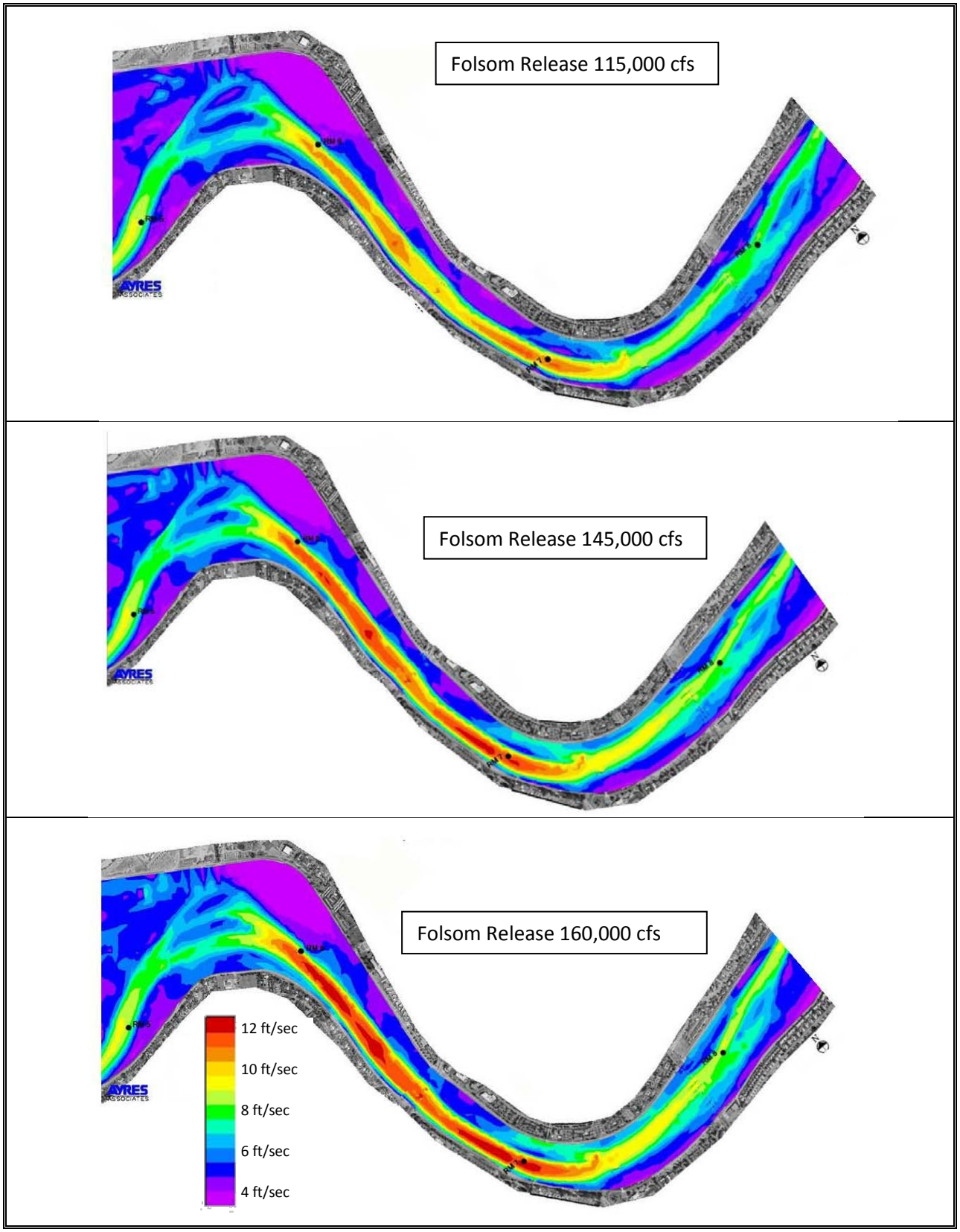

Figure 2-7: American River Velocity Contours.

2.3.2 Problem: the Potential Consequences of Flooding in the Study Area are Catastrophic

If flooding were to occur within the study area, the potential consequences would be catastrophic. The flooding would rapidly inundate a highly urbanized area with minimal warning or evacuation time. As the Capital of California, the Sacramento metropolitan area is the center of State government and many essential statewide services are located here. The study area is also at the crossroads of 4 major highway/interstate systems that would be impassable should a flood occur. The effects of flooding within the study area would be felt not only at the local level, but at the regional, State and National level as well.

Population at Risk

As depicted in Figure 2-2, a significant portion of the City of Sacramento and other portions of the study area are located within the 200-year flood plain (selected as representative flood event, coincident with flows from Folsom Dam). Life safety and population at risk information was taken from the USACE Levee Screening Tool (LST) for use in this study. The Levee Screening Tool supports the levee screening process by facilitating a preliminary assessment of the general condition and associated risks of levees in support of the USACE Levee Safety Program[3].

The overall data for life safety and life loss estimates can be found in Table 2-3. This information comes from a series of Levee Screening Tool Presentations by the Sacramento District on the three basins or systems (USACE, 2011, 2012a, and 2012b).

Table 2-3: Life Safety and Life Loss Information (from USACE's Levee Screening Tool).

	American River South	American River North	American River North, Small Streams	Natomas	Total
Population at Risk (Day)	350,000	58,500	15,500	77,000	501,000
Population at Risk (Night)	440,000	51,500	24,000	66,000	580,000
Loss of Life (Day)	500	170	80	670	1,400
Loss of Life (Night)	980	160	130	550	1,800

Health and Safety

Flooding in urban areas can cause serious health and safety problems for the affected population. In the three basins making up the study area, there are 500,000 residents at risk. Additionally, census data indicates that another 100,000 people work in the Sacramento area but do not live there. Significant numbers of people traverse the area via Interstate 5, Interstate 80, U.S. Highway 99 and U.S. Highway 50 every day. Data obtained from the California Department of Transportation shows that 185,000 vehicles

[3] Risk Characterization for Levees, USACE Levee Safety Program, April 2011.

pass through the Sacramento area in the north-south direction in an average 24-hour period. The number of vehicle occupants is estimated to be 270,000.

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.

In California's Central Valley, the risk of a large flood is seasonal. The majority of rainfall occurs in the October through March rainy season, making the area most vulnerable to winter floods. The temperature range in the rainy months is shown in Table 2-4.

Table 2-4: Average Temperature Range in the Rainy Season.

Month	Low (°F)	High (°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 that is cooler than 75°F (24°C) will remove body heat more rapidly than it can be replaced, resulting in hypothermia. 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 in 40°F water and perhaps 2-3 hours in 50°F water. Physical activity such as swimming or other struggling in the water increases heat loss, reducing survival time to minutes. Without thermal protection, swimming is not possible and 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, opossums, 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, hypothermia, structural instability, exhaustion, hazards associated with heavy equipment operation, drowning, biohazards, fire, musculoskeletal hazards, burns from fires caused by energized line contact or equipment failure, carbon monoxide, falls from heights, hazardous materials, and dehydration.
After floodwaters have receded, debris cleanup would be a substantial undertaking. After the flooding in New Orleans resulting from Hurricane Katrina, debris removal included general household trash and personal belongings, construction and demolition debris, vegetative debris, household hazardous waste, white goods, and electronic waste. Curbside debris was in excess of 51 million cubic yards. There were nearly 900,000 units of white goods and over 600,000 units of electronic goods. More than 350,000 cars were abandoned.

Evacuation Routes

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 has a FEMA Community Rating System (CRS) Class 3 rating on a 1-10 scale. This rating is based on Public Information, Mapping and Regulation, Flood Damage Reduction, and Flood Preparedness. The Class 3 rating is one of the top ratings in the State of California. Hypothetical flood depth, rescue, and evacuation area maps have been developed by the City and County of Sacramento for various hypothetical levee failure locations in the Sacramento area 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 different levee failure locations on the levees protecting Sacramento. Depending on the levee failure location, the elapsed time to get to flood depths over one foot can range from 6 minutes to 200 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.

The primary urban centers in the region are located in the Natomas and American River South Basins. These communities are all located on or near the following major evacuation routes: Interstate 5, which is the main Interstate Highway on the West Coast of the United States, running north-south from Canada to Mexico. Within the study area, Interstate 5 runs across the Sacramento River, past the airport, across the American River at the confluence of the American and Sacramento Rivers, through Downtown Sacramento, and through Southwestern Sacramento. In a flooding event, depending on the levee breach location, portions of Interstate 5 could become impassable in 3 to 4 hours and access to the airport would be blocked in 2 to 3 days. Interstate 80 is a transcontinental east-west highway which runs from San Francisco, California to the East Coast. Within the study area, Interstate 80 crosses over the Yolo Bypass and veers north, crossing the Sacramento River, and running through Natomas and American River North. Portions of Interstate 80, through the Natomas area, would become impassable in 8 to 12 hours depending on the levee breach location. California State Route 99 runs north-south through Natomas, North Sacramento, joins with Interstate 5 and crosses the American River, through Downtown Sacramento, and then through South Sacramento and continues south. Portions of California Route 99 would become impassible in the American River Basin South in 3 to 4 hours and impassible in 1 to 2 days in the Natomas Basin. U.S. Highway 50 runs east from West Sacramento, across the Sacramento River, and through Downtown Sacramento and continues to the Nevada state line. Portions of U.S. Highway 50 would become impassible in 4 to 8 hours in a flood event. These highways and interstates would likely be the primary evacuation routes in the event of a flood; however, these routes are subject to change since they are event-specific and official routes are established by the County Sheriff's office during an emergency.

Evacuation preparation can be made days in advance for predictable rain events. For example, a 0.2% ACE (1/500 year event) rain storm would be identified by meteorologist and residents could be given notice days in advance. As a significant rain event nears, warnings and evacuation efforts would be increased and reiterated. This would allow time for evacuation of immobile residents and other people with special evacuation needs (hospitals, rest homes, jails, elderly individuals, schools) via the established routes.

Flood Damages

Damageable property in the study area 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.

Structure counts for the main categories are listed in Table 2-5 below, and represent only those structures falling within the 0.2% Annual Chance Exceedance (500-year) floodplain.

Table 2-5: Number of Structures by Category and Basin Structures in 0.2% Annual Chance Exceedance (500-yr) Floodplain.

CATEGORY	STRUCTURE COUNT			
	ARS BASIN	ARN BASIN	NATOMAS BASIN	TOTAL
COMMERCIAL	3,210	784	292	**4,286**
INDUSTRIAL	1,031	226	149	**1,406**
PUBLIC	819	151	82	**1,052**
RESIDENTIAL	104,535	15,974	22,247	**142,756**
TOTAL	**109,605**	**17,135**	**22,770**	**149,510**

Table 2-6 shows the value of damageable property by basin for structures and contents.

Table 2-6: Value of Damageable Property by Category and Basin (in $1,000s): Structures and Contents, 0.2% Annual Chance Exceedance (500-yr) Floodplain October 2014 Price Level.

DAMAGE CATEGORY	VALUE OF DAMAGEABLE PROPERTY (in $1,000s) STRUCTURES AND CONTENTS			
	ARS BASIN	ARN BASIN	NATOMAS BASIN	Total
Commercial	7,899,237	3,205,027	945,982	12,050,246
Industrial	2,789,871	765,131	672,440	4,227,441
Public	6,463,751	815,190	771,535	8,050,476
Residential	26,771,526	4,756,498	6,393,909	37,921,933
TOTAL	**43,924,385**	**9,541,845**	**8,783,865**	**62,250,096**

Annual chance exceedance (ACE) event damages are sometimes referred to as single-event damages. Single-event damages assume that a breach from a specific probability event occurs; it does not take into account the likelihood of this event actually happening. Single-event damages are useful in that they show the magnitude of consequences, within a particular consequence area, *should* a specific flood event occur in that area. Table 2-7 below shows the damages that may occur for a range of events within the three main basins. These damage values include automobiles, structures, and contents, and represent damages based on flooding from one index point per basin.

Figure 2-8: The Sacramento River Facing Downstream Toward the I Street Bridge.

Table 2-7: Annual Chance Exceedance (ACE) Event Damages, October 2014 Price Level (in $1,000s)

BASIN	ACE EVENT DAMAGES						
	50%	10%	4%	2%	1%	0.5%	0.2%
ARS	6,639,651	8,692,658	9,036,475	9,540,476	11,941,662	12,876,621	21,004,919
ARN	0	0	2,777,614	2,860,881	4,560,254	4,855,423	5,910,919
NATOMAS	4,404,922	5,579,812	5,784,706	6,109,155	6,271,056	6,403,807	6,896,591
TOTAL	**11,044,574**	**14,272,471**	**17,598,795**	**18,510,511**	**22,772,972**	**24,135,852**	**33,812,428**

Expected annual damage (EAD) is the metric used to describe the consequences of flooding on an annual basis considering a full range of flood events – from high frequency/small events to low frequency/large events over a long time horizon (years). It is the main economic statistic used to describe the flooding problem in the study area; it is also used as the baseline to measure potential benefits from proposed alternatives. Table 2-8 displays the EAD results by basin.

Table 2-8: Without-Project Expected Annual Damages by Basin, October 2014 Price Level (in $1,000s)

BASIN	WITHOUT-PROJECT EXPECTED ANNUAL DAMAGES (EAD)						
	AUTOS	COMMERCIAL	FARM	INDUSTRIAL	PUBLIC	RESIDENTIAL	TOTAL
ARS	15,080	42,514	395	11,197	35,644	227,555	**332,383**
ARN	3,221	27,383	0	9,301	6,960	30,438	**77,303**
NATOMAS	863	3,294	36	2,328	2,774	19,300	**28,595**
TOTAL	**19,164**	**73,191**	**431**	**22,826**	**45,378**	**277,293**	**438,281**

Emergency Costs

During and after a flood event, the public costs for emergency services, evacuation, securing infrastructure, and clean-up can be substantial. For example, considering the costs associated with evacuation, there are significant costs (and therefore, economic losses) related to temporary movement of a population away from a flood-impacted area. Evacuation and its associated costs can take place before, during, or after a flood event.

In order to simulate the economic impact of these emergency costs, a series of economic models was developed. Thirteen distinct models were developed for thirteen categories of emergency costs. The basis for the data to be used in the models was expert elicitation. The thirteen categories of emergency costs are as follows:

- Evacuation
- Telecommunications
- Medical
- Wastewater utility
- Legislative
- Judicial
- Education
- Water supply utility
- Incarceration
- Debris
- Natural gas supply
- Police and Fire
- Electrical utility

The complete estimates of emergency costs for these thirteen categories are detailed in the Economics Appendix (Appendix E). The information is summarized in Table 2-9 below.

Table 2-9: Without-Project Expected Annual Damages (EAD) – Emergency Costs, ARS, ARN, and Natomas Basins, October 2014 Price Level Values in $1,000s.

BASIN	STRUCTURE, CONTENTS, & AUTO EAD[1] (IN $1,000S)	EMERGENCY COST LOSSES AS % OF TOTAL[2]	EMERGENCY COSTS EAD (IN $1,000S)
ARS	332,383	1.7%	5,651
ARN	77,303	1.7%	1,314
NATOMAS	28,595	1.7%	486
TOTAL	**438,281**	**1.7%**	**7,451**

[1]Values taken from Table 2-8.
[2]Percentage extrapolated from ARS Index Point B analysis

Critical Infrastructure

A significant amount of critical infrastructure is located within the study area. 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)

Impacts to critical infrastructure from a flood event would have significant local, regional, and statewide impacts because Sacramento is the capitol of the State of California. The California State Capitol and many State office buildings are located in downtown Sacramento, which could be flooded by 5 to 10

feet several feet of water due to a flood event. If critical elements of the State government are disabled due to a flood event, the Central Valley region and the State of California could be severely impacted. State functions such as emergency response and other essential State services could be impacted. Impacts to State of California departments and agencies could become critical for the entire state if the duration of flooding extends beyond a few days. State agencies provide payroll, retirement benefits, medical benefits, vehicle registration, criminal justice, and other activities that affect people throughout California.

Business and government centers would be isolated from customers and employees. Significant numbers of people commute into downtown Sacramento to work at various Federal, State and local agencies and private businesses. The Sacramento District USACE offices are located in downtown Sacramento along with many other Federal and State facilities including the Secretary of State, Department of Transportation, Water Resources Board, Attorney General's Office, Department of Consumer Affairs, and the Legislative Office Building. Local government facilities include Police and Sheriffs' Offices, City Library, and City and County of Sacramento Administrative offices.

Flood recovery programs are run by State and local government agencies. Because these agencies could be located in areas impacted by flooding there could be significant impacts on the distribution of disaster assistance. Although funding may be available, limited material and labor availability could potentially slow implementation of needed repairs and recovery.

Another piece of critical infrastructure located in the Natomas Basin is the Sacramento International Airport, a major transportation hub for Sacramento and all of northern California. The airport can handle up to 29 flights per hour; in a typical month 800,000 passengers arrive or depart the airport. If a flood were to occur, passenger travel would be disrupted and those stranded at the airport would have to be evacuated to high ground. Mail and freight transit through the airport would also be interrupted. Flooding of transportation routes, utilities and public services will likely occur throughout the region and impacts could be felt in areas far beyond the actual flooding.

Transportation facilities that could potentially be affected by flooding in the study areas include:

- Light rail lines in east and south Sacramento and downtown
- Regional transit bus routes and facilities throughout the city of Sacramento
- Interstate 5
- Interstate 80
- US 99
- US 50

Critical infrastructure in the three basins has been characterized in two categories: At Risk Population Facilities and Essential Services Facilities. Overall data for these facilities can be found in Table 2-10. The identified impacted facilities are located within the 200-year floodplain.

Table 2-10: Critical Infrastructure Facilities at Risk within each Basin.

	Critical Infrastructure Facilities at Risk (n)			
	American River South	**American River North**	**Natomas**	**Total**
At Risk Population Facilities	162	44	22	228
Essential Services Facilities	142	26	11	179

2.4 PLANNING OPPORTUNITIES

There is an opportunity to increase public awareness of the flood risk and ongoing residual risk.

2.5 PLANNING OBJECTIVES

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, which are applicable over a 50-year planning horizon, are specified as follows:

- Reduce the probability of flooding in the study area as measured by a reduction in the Annual Exceedance Probability (AEP).
- Reduce the consequences of flooding in the study area as measured by the reduction in Expected Annual Damages (EAD), the population at risk, life safety concerns and availability of evacuation routes.
- Reduce the impacts to critical infrastructure in the study area measured by the reduction in damages and availability of emergency facilities during flood events
- Encourage wise use of the flood plain measured by the strength of the Floodplain Management plan, and ability to direct flood flows away from urban areas and instead to floodways.
- Educate the public about ongoing residual risk measured by increased public awareness as a result of annual notifications of residual flood risk.

2.6 PLANNING CONSTRAINTS

Unlike planning objectives that represent desired positive changes, planning constraints limit plan formulation. The planning constraint identified in this study is as follows:

- Plans must not violate the Federal Aviation Administration (FAA) restrictions regarding providing additional bird habitat in the area of the Sacramento International Airport.

2.7 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. Although these are not incorporated directly into the plan formulation or analysis, these concerns and goals can help compare plans that have similar outputs. These concerns are:

- Plans should be compatible with local land use plans to the extent practicable. Improvements should be compatible with the Natomas Basin Habitat Conservation Plan (NBHCP) that was developed as a requirement of the Endangered Species Act (ESA), 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.
- If feasible, plans should achieve the minimal 200-year urban level of protection standard as defined by the State of California, to the extent that it is in the Federal interest. The State has established this standard for the Central Valley of California and it applies to cities with populations greater than 10,000. 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. Portions of the Sacramento area levees do not meet this standard.
- Plans should strive for no or minimal loss of riparian vegetation. 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.
- Plans must be maintainable and should minimize costs for operation, maintenance, repair, rehabilitation, and replacement.
- Plans should be able to be implemented quickly, to reduce increased flood risk associated with the Folsom Dam improvements, which are scheduled to be completed between 2017 and 2019. Sacramento has an unacceptably high risk of flooding that poses a serious threat to life, health, and safety.

2.8 FUTURE WITHOUT-PROJECT CONDITION

The future 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 is 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 future without-project condition for this study:

2.8.1 Common Features WRDA 1996 and WRDA 1999

The elements of the Common Features project as authorized by WRDA 1996 and WRDA 1999 are assumed to be in place. These features (Figure 2-9) addressed the seepage and stability concerns along the American River but do not address the erosion risk.

2.8.2 Natomas 2010 Post Authorization Change Report (PACR)

The levee modifications recommended in the 2010 Natomas PAC Report and authorized by WRRDA 2014 (Pub. L. No 113-121) are assumed to be in place, which improve the levees but do not include levee raises to address higher volume, low frequency flows. Even with the levee improvements recommended in the Natomas PACR and those constructed by the NLIP, the Natomas Basin would still face significant flood risk. With an annual exceedance probability of 1 in 67, there are residual average annual damages of $19 million. In the absence of an additional Federal project to improve the level of flood risk management, 100,000 residents would still be subjected to considerable threat from flooding.

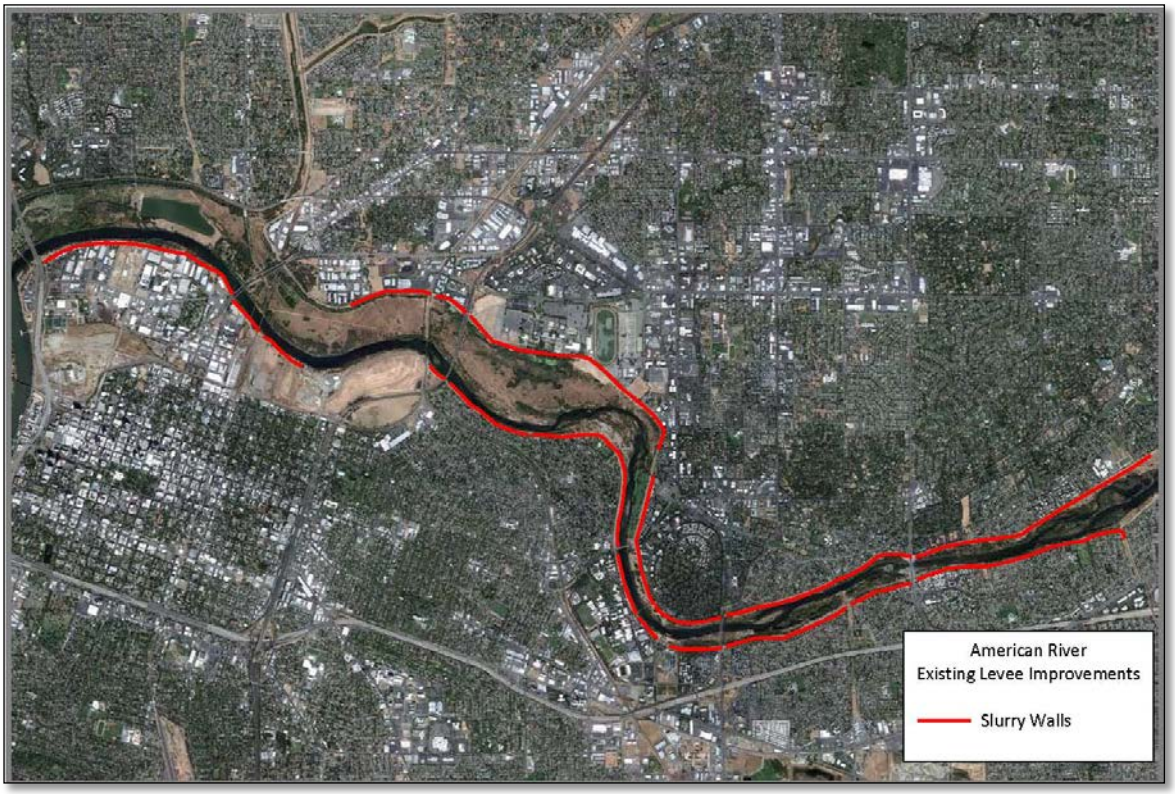

Figure 2-9: Existing Levee Improvements on the American River authorized by WRDA 96 and 99.

2.8.3 Folsom Joint Federal Project (JFP)

In 2017, the Folsom Joint Federal Project (JFP) auxiliary spillway at Folsom Dam (Figure 2-10) will be completed and a new water control manual will be adopted (Folsom Dam Modifications). The JFP will allow dam operators to release larger quantities of water at lower reservoir stages and more efficiently utilize flood space in the reservoir. Operation of the JFP is to some degree dependent on the American River levees downstream of the dam being able to safely pass the objective release of 160,000cfs. At the time of the Folsom PAC report in 2007, assumptions were made based on the available information at the time, that the downstream improvements authorized by WRDA 1996 and 1999 would be in place and allow for the safe passage of the objective releases identified in the Folsom PAC report. However, as was noted in the Folsom PAC, an erosion study of the downstream channel was needed to provide more information on this subject. Results of this erosion study are included in the Engineering Appendix, which identifies the need for additional erosion protection. Therefore, erosion protection to these levees would enable more optimal operation of the JFP. In the absence of a Federal project to enable the levees to safely pass this objective release, downstream levees could fail leading to flooding in the Sacramento Metropolitan area.

Figure 2-10: Construction in Progress at Folsom Dam as part of the Folsom JFP.

2.8.4 Folsom Dam Raise

The 3.5-foot raise of the Folsom Dam will be completed between 2018 and 2020.

2.8.5 West Sacramento GRR

The West Sacramento GRR is evaluating recommendations for various improvements to the levees along the west side of the Sacramento River, directly across the river from the Common Features Study area. However, for evaluation purposes, these improvements are not included in the future without project condition assumptions. Plan formulation strategy with regards to the interrelation with West Sacramento is described in Chapter 4.

2.8.6 National Flood Insurance Program

At the present time, the American River North and American River South Basins are not mapped in the FEMA Regulatory (100-year) floodplain. Based on analysis conducted as part of this investigation as well

as other investigations by the State of California, the levee system for the greater Sacramento area has a high probability of failure in multiple locations. FEMA may remap these basins into the regulatory floodplain which would affect flood insurance rates and requirements. The Natomas Basin is currently mapped in the FEMA Regulatory floodplain and properties with federally insured mortgages are required to have flood insurance. In the absence of a Federal project to address flood risk in the greater Sacramento area, most of the city would remain exposed to a substantial long-term risk of flooding.

2.8.7 Future Development in Floodplain

The floodplains for the American River North and American River South Basins are largely built out. As such, the future conditions for these two basins are not considered significantly different from base year conditions for these two basins.

North Natomas is the largest new growth area of the City of Sacramento comprised of approximately 7,200 acres located in both the city and county. From the late 1990s to mid-2000's the Natomas Basin experienced extensive residential development, office park, and retail construction. At the time, this development was outside the 100-year floodplain. However, in 2008 the area was remapped and placed within the 100-year floodplain, which has since precluded most new construction. A North Natomas Community Plan has been developed to guide future development in the Natomas Basin after the floodplain designation is removed. This plan includes a mixture of residential, commercial and civic uses interdependent on quality transit service and a radial network of connections linking activity centers with streets, transit routes, and linear parkways with pedestrian/bike trails.

Using USACE Risk and Uncertainty methodology (EC 1110-2-6067), with the 2010 Natomas PAC and SAFCA Natomas Levee Improvement Program (NLIP) improvements in place, the Natomas basin would not meet the criteria of having 90% assurance of containing the 100-year event and therefore the levees surrounding the Natomas Basin would not be certified and the development restrictions would not be lifted. Using traditional FEMA methodology (Title 44 CFR Section 65.10), reflecting the same improvements, the Natomas basin may be eligible for certification. There are several locations within the levee system that have slightly less than 3 feet of freeboard for the 100-year event. There are provisions in the FEMA certification methodology that allow for less than 3 feet of freeboard in these conditions. Therefore, local interests may be able to demonstrate the case to certify the Natomas basin with completion of NPAC and NLIP work.

As a result of the recognition of the extent of levee problems in the Natomas Basin, SAFCA, in cooperation with the California Department of Water Resources and the Central Valley Flood Protection Board, has constructed urgently needed improvements to address seepage problems in the Natomas Basin levees as part of the Natomas Levee Improvement Program (NLIP). Specifically, these include levee improvements for the south levee on the Natomas Cross Canal and the east levee of the Sacramento River from the Natomas Cross Canal to near Powerline Road. These improvements were authorized as part of the WRDA 96/99 and WRRDA 2014 authorizations for the Common Features project. NLIP achieves the targeted flood risk reduction objectives in a manner that is consistent with current Federal

engineering and environmental standards. The Corps has provided extensive technical support for this effort. These levee improvements were permitted under Section 408 (33 USC 408) permits and are eligible for credit under provisions of Section 104 (WRRDA 1986). The features constructed by SAFCA and the State under NLIP were incorporated into the Natomas PACR. These levee improvements constructed as part of the NLIP program, along with the authorized improvements in the Natomas PACR have allowed the City of Sacramento, Sacramento County and Sutter County to jointly apply for a Physical Map Revision (PMR) to replace the Zone AE (BFE of 36 feet NAVD 88 datum) with the A99 Zone designation. The SAFCA Natomas Basin Flood Protection System A99 Eligibility Summary Report (dated June 20, 2012 and revised March 26, 2014) is the basis for the application to revise the zone. FEMA has determined that adequate progress has been made on the flood protection system project to warrant a change in zone designation to Zone A99 as defined by Paragraphs 61.12(b) of the National Flood Insurance Program (NFIP) regulations. Areas designated as Zone A99 still fall within the 1-percent annual chance flood floodplain however enough progress has been made on construction of a federally authorized flood protection system to consider it complete for insurance rating purposes. The revised Flood Insurance Rate Map (FIRM) panels are anticipated in 2015.

2.8.8 Vegetation

As part of the CVFPP, the State of California has developed a Levee Vegetation Management Strategy, which focuses on a long term vegetation life cycle management plan allowing existing trees and other vegetation to live out their normal life cycles but results in the gradual elimination of trees from the levee and adjacent areas, with the exception of the lower waterside slope of the levee. This study assumes that the Levee Vegetation Management Strategy presented in the CVFPP will be a part of the future without-project condition, forming the basis for the formulation of modifications to the Federal project that may be required to address the new requirements of the USACE Levee Safety Policy. The sponsor has submitted a “Letter of Intent” (LOI), the first step in the development of a “Systemwide Improvement Framework” (SWIF) which would provide a formal agreement between the Corps of Engineers and the Levee Maintaining Agencies for addressing Levee Safety Policy issues specific for the study area. For the purposes of formulating a project, the Levee Safety policy will be taken into consideration, and its requirements factored into any alternatives.

The Levee Vegetation Management Strategy established in the CVFPP is summarized below:

- The State proposes adherence to USACE guidance for new levee construction, such as a setback levees, bypasses, or ring levees located away from the river channel.
- Vegetation present on the system, except for the lower waterside slope, will be trimmed to provide for visibility and access, as originally defined in the Framework.
- Vegetation present on the system will be evaluated, based on accepted engineering practice, and as part of the routine O&M responsibilities, trees and other woody vegetation will be monitored to identify changed conditions that could pose an unacceptable threat.

- DWR will implement and will advise local maintainers in their implementation of an adaptive vegetation management strategy that will include a long term vegetation life cycle management plan. This will allow existing trees and other vegetation to live out their normal life cycles but will result in the gradual elimination of trees from the vegetation management area zone through removal. Throughout their lives and after their deaths the trees will be periodically evaluated and if found to pose an unacceptable threat to levee integrity will be removed in coordination with the resource agencies. This strategy will gradually, over a period of several decades, result in levees that are clear of woody vegetation, consistent with the Corps ETL, except for vegetation on the lower waterside slope.

2.8.9 Potentially Developable Floodplains (Wise Use of Floodplains)

Current measures in place to restrict or mitigate development in areas subject to flooding in Sacramento and Sutter Counties are listed below.

- The Sacramento County General Plan and Floodplain Management Ordinance contain restrictive development policies for floodplains.
- Local policies, combined with recent state legislation and Federal regulations, are expected to limit land development.
- Conservation easements and Williamson Act contracts are in place, and the potential exists to expand use of these conservation tools.
- The State of California provides annual flood risk notifications to landowners.

3 - ALTERNATIVES

This chapter describes the formulation of alternative plans to address the planning objectives identified in Section 2.6 (in brief):

- Reduce the probability of flooding in the study area
- Reduce the consequences of flooding in the study area
- Reduce the impacts to critical infrastructure in the study area
- Encourage wise use of the flood plain
- Educate the public about ongoing residual risk

In this chapter, management measures (individual actions that can be taken) to address these planning objectives are described and screened for completeness, efficiency, effectiveness, and acceptability. Alternative plans are then formulated based on combinations of retained measures.

3.1 PLAN FORMULATION RATIONALE

A wide variety of management measures were developed to address the planning objectives. These measures were evaluated and screened based on completeness, efficiency, effectiveness, and acceptability. Formulation strategies were then developed to combine these measures into alternative plans that address various combinations of the planning objectives while avoiding the identified planning constraint. Based upon these strategies, which are discussed in Section 3.12, 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 tentatively selected plan is identified.

3.2 MANAGEMENT MEASURES

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 was considered and they are discussed in the following paragraphs. The measures are listed in Table 3-3 along with the objective each addresses.

3.3 MEASURES TO REDUCE FLOOD STAGES

3.3.1 Upstream Storage on the American River

This measure includes construction of a dam on the North Fork of the American River near the town of Auburn. This measure is assumed to be similar in scope to the authorized Auburn Dam project which was designed to be about 650 feet high and impound a reservoir of 2.3 million acre feet. When operated with Folsom Dam downstream, it would provide greater than a 200-year level of flood protection to the Sacramento Metropolitan area. The project would yield about 270,000 acre feet for water supply and 600 gigawatt hours (GWh) of power annually. This measure would have adverse impacts on environmental resources through the loss of about 500 to over 2,000 acres of oak woodland, chaparral and coniferous forests.

3.3.2 Transitory Storage on the Sacramento River

Transitory storage on the Sacramento River provides reduction in stage primarily in the Natomas Basin. Three alternative locations were investigated as potential sites for transitory storage (or off-stream storage). These locations are shown in Figure 3-1 below.

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, 42.8 feet (NAVD88) 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 the basin, in the left bank levee of the Sacramento River at about RM 85, about one mile upstream of the Fremont Weir. The total cost for implementing transitory storage in the Robbins Basin would be about $1 Billion. 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, cost to build a ring levee around Robbins, and costs to acquire real estate easements for water storage and to purchase and/or relocate existing properties in the basins. For various less probable flood events (more extreme than a 50-year event), the stage in the Sacramento River at RM 70 (about halfway between the Natomas Cross Canal and American River confluences) would be reduced by up to 2.3 feet.

Nicolaus Basin (RD1001)

Floodwaters would be diverted into Nicolaus Basin via a gated weir approximately 500 feet long at RM 8.5 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 levees, 44.4 feet (NAVD88) for a storage space of 25,000 acre-feet. Exit gates and/or weir would also be needed to drain the water out of 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 $500 Million. For various less probable flood events (more extreme than a 50-year event), the stage in the Sacramento River at RM 70 would be reduced by 1.8 feet.

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 on the Sacramento River. For this alternative to perform successfully, it is necessary to assure that the basin would be empty at the start of weir flow. Therefore, 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, 32.4 feet (NAVD88), 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 about $400 million. For various less probable flood events (more extreme than a 50-year event), the stage in the Sacramento River at RM 70 would be reduced by up to 0.9 feet.

Table 3-1: Comparison of Costs for Transitory Storage on the Sacramento River ($ millions).

Alternative	Construction Cost
Robbins Basin	$1,066
Nicolaus Basin	$545
Elkhorn Basin	$401

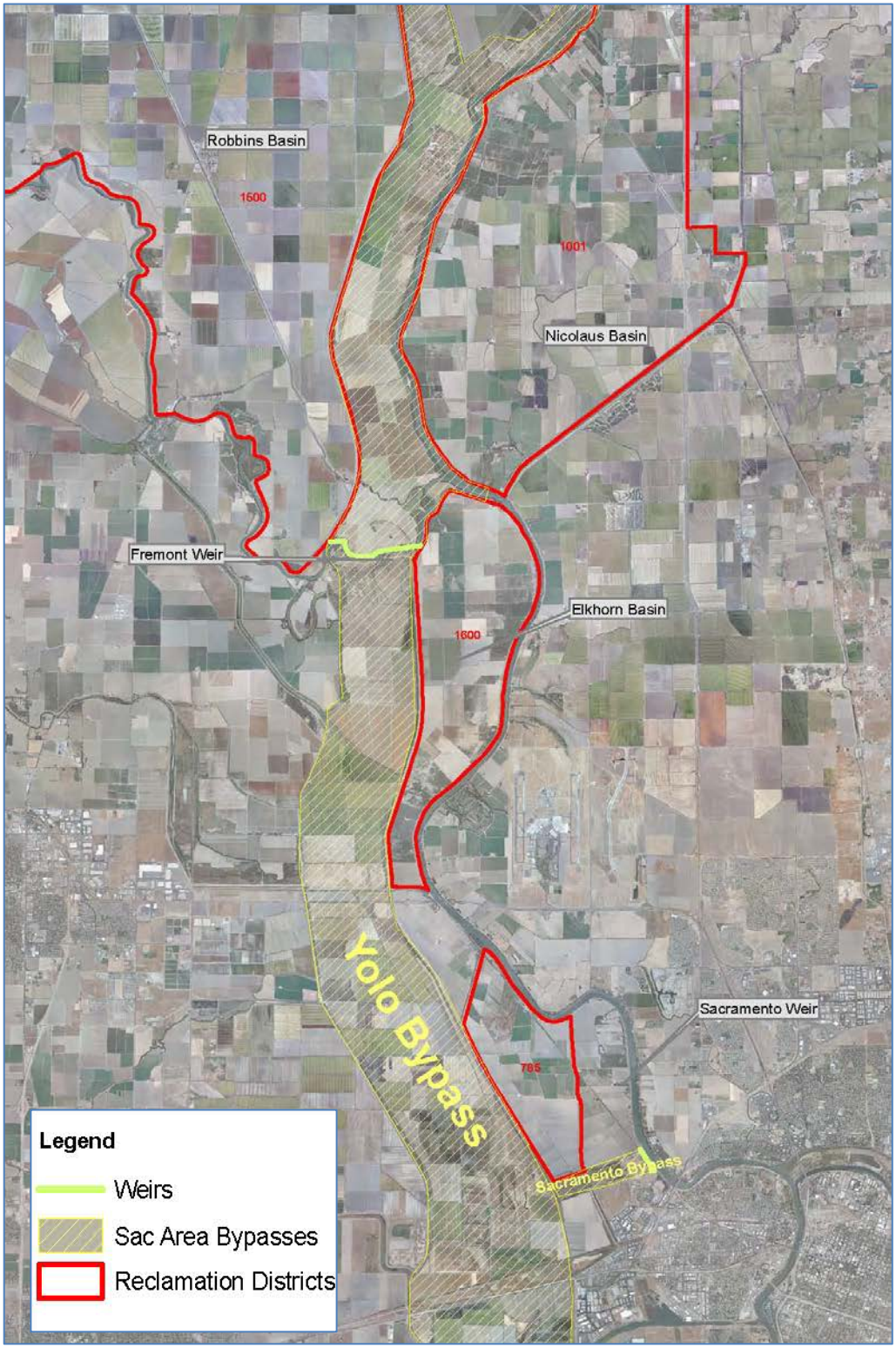

Figure 3-1: Transitory Storage Areas.

3.3.3 Reoperation of Upstream Reservoirs

Reoperation of SRFCP reservoirs upstream of the study area in the Sacramento River basin was considered. Reoperation of Folsom Dam was not considered under this GRR because the Folsom Water Control Manual Update, a segment of the overall American River Watershed Investigation, is currently studying reoperation of Folsom Dam. This study takes into account the potential changes to the watershed from all associated American River Watershed projects, including the Folsom JFP, the Folsom Dam Raise, and the ARCF GRR alternatives.

Major reservoirs upstream of the study area include Shasta Lake, Lake Oroville, Folsom Lake, and New Bullards Bar Reservoir. These reservoirs control approximately 11,000 square miles of the 27,000 square mile Sacramento River basin. This is about 40% of the drainage area. The flood storage is a small component of these dams' storage, since they are also water supply reservoirs. These dams were completed prior to the largest floods in Sacramento; therefore, their designs are based on hydrology that does not take these large floods into account. Reoperation of these upstream reservoirs would not substantially reduce the flood risk to the Sacramento area.

3.3.4 Sacramento Weir and Bypass Improvements

The Sacramento Weir and Bypass would be expanded by 1,500' to allow additional floodwaters to flow out into the Bypass and reduce the water surface elevation of the Sacramento River as it flows past the Sacramento Metropolitan area. The existing northern levee of the Sacramento Bypass would be degraded and a new levee constructed approximately 1,500 feet to the north. A new weir would be extended north of the existing Sacramento Weir without impacting the existing structure. The new north levee of the Sacramento Bypass will be constructed per the standard levee section for new construction and would include a 300 foot wide drained landside seepage berm to address the underseepage related issues in this area.

3.3.5 I Street Diversion Structure

This measure would include the construction of a diversion structure just upstream of the existing I Street Bridge on the Sacramento River. This diversion structure would restrict flows going down the Sacramento River past the cities of Sacramento and West Sacramento, and would cause a portion of the flows from the Sacramento and American Rivers to be backed upstream through the Sacramento Bypass out to the Yolo Bypass. The Sacramento Bypass and Weir would be widened to accommodate the increased flows to the bypass system. The effect of this diversion structure would be to reduce the water surface elevation of the Sacramento River downstream of the structure to the point at which seepage, stability, height, and erosion improvements would not be needed.

3.3.6 Yolo Bypass Improvements

This measure is described in the report, Lower Sacramento River Regional Project Conceptual Design and Cost which was developed for the Sacramento/San Joaquin River Comprehensive Study. It would consist of lengthening the Fremont Weir, and widening the Yolo and Sacramento Bypasses 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 measure would consist of the following features:

- 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.

3.3.7 Offstream Storage on Deer Creek

This measure would involve the transfer of water from one basin to another to meet flood risk management goals. Deer Creek is a tributary of the Cosumnes River that comes within 10 miles of Folsom Reservoir. Water can be conveyed to Deer Creek via gravity flow. This measure would provide additional storage by diverting floodwaters from the American River watershed to the adjacent Cosumnes/Mokelumne Rivers system. Flood flows would be temporarily stored in a detention basin on Deer Creek and released into the Delta via the Cosumnes and Mokelumne Rivers after flood peaks had passed on those rivers. The measure would consist of several features:

- A six-bay radial gate overflow section outlet works adjacent to the west side of Folsom Reservoir's Mormon Island Dam.
- A connecting channel extending from the Folsom Reservoir Outlet Works to the detention basin approximately 8 miles to the south.
- A 600,000 acre-foot detention basin to store diverted flood flows from the American River, created by a 141-foot high random fill embankment dam.
- Channel modifications and revetment protection along Deer Creek, Cosumnes River, and the Delta to accommodate extended flood releases.

This measure could have substantial vegetation and associated wildlife impacts. This would require a long-term commitment to mitigation, maintenance, and monitoring of mitigation efforts. Detention basin releases would significantly extend flooding along the Cosumnes River and in the Franklin Pond area. Additional flood easements would be acquired along the Cosumnes River to mitigate for these extended flood releases. The detention basin is located in the vicinity of several hazardous waste sites. Flood storage in the basin could affect groundwater flows under these sites or receive contaminated flows from the site. A plan to monitor shallow groundwater would need to be implemented, and groundwater entering or leaving the area would be checked for contamination.

3.4 MEASURES TO REDUCE LEVEE SEEPAGE AND UNDERSEEPAGE

Levee underseepage and levee through-seepage problems have been identified at many locations in the Sacramento River levee system. When the seepage velocity is great enough, piping of soil particles can occur because the frictional drag exerted on the particles is strong enough to mobilize the particles in the water flow. Seeping water thus removes soil, starting from the exit point of the seepage, and piping advances further into the levee up gradient. This piping of the soil, can lead to failure of the structure and to sinkhole formation. Vertically upwards seepage is a source of danger on the downstream side of sheet piling and beneath the toe of a dam or levee.

Underseepage problems can be corrected through the use of slurry cutoff walls, sheet pile 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 if constructed deep enough. Therefore, the following discussion focuses exclusively on underseepage remediation.

3.4.1 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. 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.

3.4.2 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 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 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. Relief wells have high operation and maintenance costs, which, if not conducted on a routine basis, will cause this feature to lose performance over time.

3.4.3 Seepage Cutoff Walls

Cutoff walls reduce through and 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. Cutoff walls are generally installed to depths that will tie in with existing impervious or lower permeability soil layers in the foundation beneath the levee.

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 mix, cement-bentonite mix, or a soil-bentonite mix using conventional trench methods, deep soil mixing or trench remixing deep. The soil-cement-bentonite 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 soil-cement-bentonite wall can provide some 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.

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 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-half of the levee height to prevent hydraulic fracturing and to provide a working platform for the construction equipment. 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 foundation. 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.

3.4.4 Sheet Pile Walls

Sheet pile walls consist of a row of interlocking vertical pile segments driven to form an essentially straight wall. Sheet piles can consist of hot- or cold-rolled steel, aluminum, or vinyl. Hot-rolled steel sheet piles have tighter interlocks than do cold-rolled sheet piles and, therefore, do a better job of controlling seepage. Additionally, interlocks can be treated to help seal the interlocks.

3.4.5 Removal of Ditches Adjacent to Levees

There is a ditch located adjacent to the landside toe along a portion of the Arcade Creek right bank levee. This ditch poses problems for the levee in that seepage from flood waters has a shorter path to the landside of the levee. This shorter path results in exit gradients that can cause material to be removed from the foundation of the levee by piping. A measure that could manage the seepage and the resulting soil loss is to replace the ditch with a culvert.

3.5 MEASURES TO ADDRESS LEVEE STABILITY

Many of the measures designed to address seepage problems will also address stability problems, if seepage pressures are seen to be the cause of those stability problems. These measures would include seepage cutoff walls or sheet pile walls. Measures that specifically address stability issues include widening and flattening levee slopes, construction of stability berms, and full levee degrade and reconstruction.

3.5.1 Widen and Flatten Levee Slopes

Some levees within the study area have landside slopes that are considered too steep 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 waterside or 2H:1V landside slope geometry.

3.5.2 Stability Berms

A stability berm adds weight to the landside toe of the slope. This method is used when land is available on the landside of the levee. Stability berms can be several hundred feet wide and several feet thick.

3.5.3 Full Levee Degrade and Reconstruction

In areas where the available construction footprint is limited due to existing infrastructure and development, a full levee degrade may be used to reduce stability issues. The levee would then be reconstructed using geotextile material placed in alternating layers with soil in three foot intervals.

3.5.4 Reconstruct with Geotextile Materials

In areas where the steepness of the levee slope has created a slope stability problem, the levee could be partially degraded and reconstructed with a geotextile material to reinforce the levee slope.

3.6 MEASURES TO ADDRESS LEVEE OVERTOPPING

Throughout most of the study area, the levees were not designed to convey a particular flood event and instead were sized to convey the flows that had previously been experienced (1907, 1909, and 1927); some subsequent flood events were larger than those for which the flood control system was sized (1955, 1964, 1986, and 1997). Measures to address levee height fall in two general categories: levee raises and floodwalls. These methods of levee raising can also be combined with various seepage and stability measures, depending on what problems exist in specific locations.

3.6.1 Raise Levees in Place

Levee raises can be accomplished by adding more embankment material to the top of the levee (providing that the width of the levee is adequate) or by widening the existing levee to gain the required height and width.

3.6.2 Raise Levees with Adjacent Levees

This measure involves construction of a new levee adjacent to and adjoining the existing levee.

3.6.3 Add Floodwalls to Existing Levees

Floodwalls can be added to the top of an existing levee.

3.6.4 Construct Natomas Cross Levee

This measure involves construction of a cross levee running east to west across the Natomas Basin to protect existing developed areas in the City of Sacramento. This measure would make it unnecessary to implement levee raises in the Northern Natomas portion of the basin.

3.6.5 Remove Levees and Construct Floodwalls

This measure consists of removal of the levee, construction of a cutoff wall, and placement of a floodwall along the same alignment. The advantage of this measure is that no additional real estate would be needed. The disadvantages are the relatively high cost of floodwall construction and the significant environmental impacts associated with the removal of the levee.

3.6.6 Construct Partial Floodwalls

This measure would add a floodwall to the top of the existing levee but the floodwall would be constructed more toward the riverside slope of the levee. This would move the levee prism riverward, which would allow the removal of landside levee embankment to provide landside access to the levee toe.

3.6.7 Construct New Levees

In areas where no levees exist, new levees could be constructed to reduce flood risk.

3.7 MEASURES TO ADDRESS EROSION

Waterside armoring of the levees to prevent erosion and subsequent damage to the levee can be accomplished using riprap and vegetation.

3.7.1 Waterside Armoring of Levee Slopes

One measure consists of placing riprap on the bank in a manner similar to that used for the Sacramento River Bank Protection Project. This measure is generally cost effective and depending on vegetation conditions, can be the least environmentally damaging option.

3.7.2 Launchable Rock Trench

Another measure includes a launchable trench filled with rock, designed to deploy once erosion has removed the bank material beneath it.

3.7.3 Bioengineered Armoring of Slopes

Another measure being considered is bioengineering, which uses plant material along with rock to stabilize the eroded slope and prevent further loss of material.

3.7.4 Grade Control Structures in the River

In addition to bank erosion concerns, there are concerns with channel degradation along the American River. Degradation of the channel could lead to bank destabilization and ultimately to levee failure. Currently, locations of hardpan are preventing further down-cutting. However, if erosion degrades through the hardpan, the potential exists for rapid erosion of the softer layers underneath the more erosion-resistant layer. To combat this, rock would be placed in the channel at appropriate locations to enhance erosion resistance.

3.8 NON-STRUCTURAL MEASURES

Risk reduction and risk education are objectives that can be partially addressed through the implementation of non-structural measures. These measures are included in the basic approaches to non-structural flood risk management discussed below. These measures would be largely implemented by the non-Federal sponsor or other local agencies with land use jurisdictions.

3.8.1 Zoning

Avoidance of using the floodplain for activities other than those compatible with periodic flooding is a risk reduction measure. Floodplain development requirements can be instituted, such as land-use controls that minimize new unsafe development in high-risk areas. Non-Federal sponsors for USACE FRM projects are required to publicize floodplain information and provide this information to zoning and other regulatory agencies.

3.8.2 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.

3.8.3 Outreach

A wide array of measures that address the objectives of risk education and community cohesion can be employed. These can include conducting training for hospitals and schools, media dissemination of information before, during, and after construction, development of a school curriculum on flooding, community workshops on flooding, and the establishment of websites that educate the public of flood risk, and flood warning and evacuation plans.

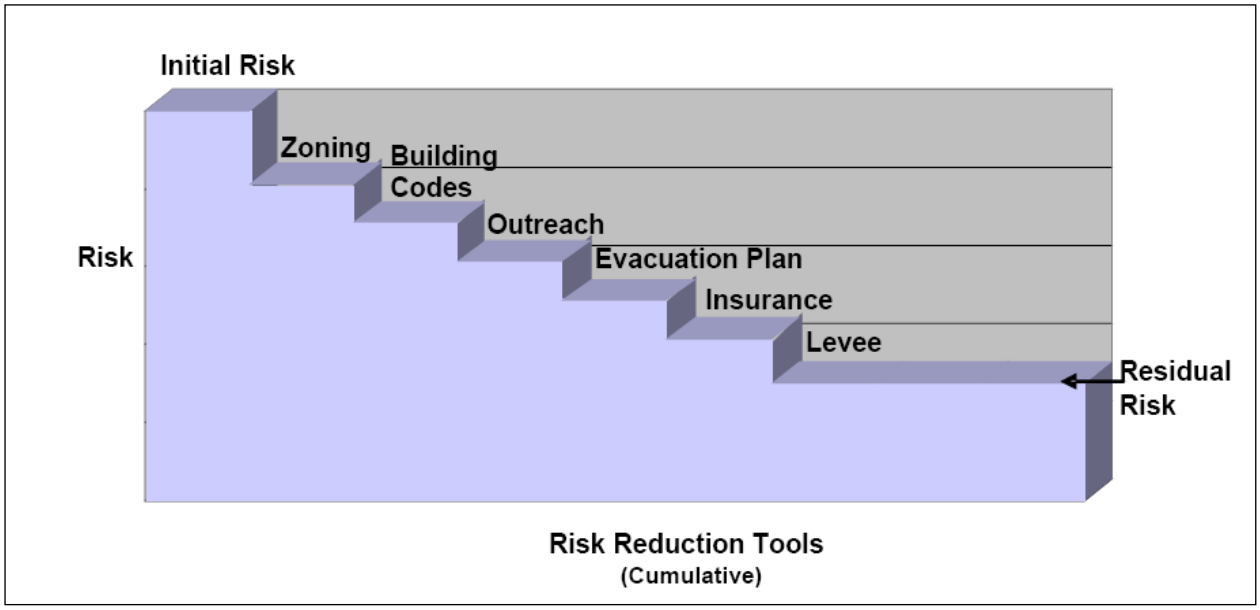

Figure 3-2: Implementation of Flood Risk Management Measures.

3.8.4 Evacuation Plan

Robust and effective evacuation plans and warning systems are essential in order to get 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.

3.8.5 Insurance

Insurance is a way to mitigate losses to those who are subject to flooding by providing indemnification through forms of public and private insurance.

3.8.6 Removing Structures from the Floodplain

Another non-structural measure is to remove the structures from the floodplain. There are three ways to do this. The first is permanent relocation of all residents and businesses affected by flooding. The second is raising affected structures above flood elevations. The third is flood proofing of structures. These measures are generally most effective when the number of structures affected by flooding is small. The urbanization in Sacramento is very concentrated. Most of the urban area is within the 1/200-year ACE floodplain. There are over 85,000 structures in the 1/100 year ACE floodplain, 122,000 structures in the 1/200-year ACE floodplain and over 147,000 in the 1/500-year ACE floodplain.

Permanent relocation, raising in place, and floodproofing of existing structures are non-structural measures that would face significant obstacles to implementation given the concentrated urbanization of the Sacramento Metropolitan area: to relocate everyone out of the floodplain would involve the nearly-impossible task of moving 500,000 residents. Raising or floodproofing every structure in the Sacramento metropolitan area would completely change the character of the city, and would face opposition from residents. A significant number of historic structures would have to be altered.
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 3-2 shows the order in which solutions for flood risk management would ideally be implemented.

Table 3-2 summarizes the non-structural measures. 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. Based on this, a determination was made as to whether these measures would be considered a part of the No Action plan or could be non-structural measures included as a part of a plan for reauthorization.

Table 3-2: Non-Structural Measures.

Measure	Authorized Project	State Programs	Without Project	Non-Structural Alternative
Permanent Relocation				X
Raising Structures in Place				X
Flood Proofing Existing Structures				X
Zoning				
Floodplain Management	*	X	X	
Provide Floodplain Information to Regulatory Agencies	*	X	X	
Building Codes				
Local Building Codes		X	X	
Outreach				
Annual Publication of Residual Risks	*	X	X	
Evacuation Plan				
Telemeter Stream Flow Gages	X			X
Modifications to Flood Warning System	X			X
Insurance				
Federal Flood Insurance Program	*		X	

* Required items of local cooperation

3.9 SCREENING OF MEASURES

An initial evaluation of the measures was performed to assess their response to the measures screening criteria. These criteria include Effectiveness and Efficiency and are described below. In the formulation of preliminary plans, measures are selected from this list that best meet the planning objectives plus when combined best meet the Federal planning criteria of Completeness, Effectiveness, Efficiency, and Acceptability.

Table 3-3: Measures and Objectives.

	Objective Addressed				
	Reduce the Probability of Flooding within the Study Area	**Reduce Consequences of Flooding within the Study Area**	**Reduce Risk to Critical Infrastructure within the study area**	**Encourage Wise Use of the Floodplain**	**Educate the public about ongoing risk**
Measures to Reduce Flood Stages					
Upstream Storage on the American River	X		X		
Transitory Storage on the Sacramento River	X		X		
Reoperation of Upstream Reservoirs	X		X		
Sacramento Weir and Bypass Improvements	X		X		
I Street Diversion Structure on Sacramento River	X		X		
Yolo Bypass Improvements	X		X		
Offstream Storage on Deer Creek	X		X		
Measures to Reduce Levee Seepage and Underseepage					
Seepage Berms	X		X		
Relief Wells	X		X		
Slurry Walls	X		X		
Sheet Pile Walls	X		X		
Removal of Ditches Adjacent to Levees	X		X		
Measures to Address Levee Stability					
Widen/Flatten Levee Slopes	X		X		
Stability Berms	X		X		
Full Levee Degrade and Reconstruction	X		X		

	Objective Addressed				
	Reduce the Probability of Flooding within the Study Area	**Reduce Consequences of Flooding within the Study Area**	**Reduce Risk to Critical Infrastructure within the study area**	**Encourage Wise Use of the Floodplain**	**Educate the public about ongoing risk**
Reconstruction with Geotextile Material	X		X		
Measures to Address Levee Overtopping					
Raise Levees in Place	X		X		
Raise levees with Adjacent Levees	X		X		
Add Floodwalls to Existing Levees	X		X		
Construct Cross-Natomas Levee	X		X	X	
Remove Levees and Construct Floodwalls	X		X		
Construct Partial Floodwalls	X		X		
Construct New Levees	X		X		
Measures to Address Erosion					
Waterside Armoring of Levee Slopes (Sac Bank-type Repair)	X		X		
Launchable Rock Trench	X		X		
BioEngineering Armoring of Slopes	X		X		
Grade Control Structures in River	X		X		
Non-Structural Measures					
Permanent Relocation		X	X	X	
Raising Structures in Place		X	X	X	
Flood Proofing of Existing Structures		X	X	X	
Floodplain Management		X		X	X
Providing Floodplain Information to Regulatory Agencies				X	
Local Building Codes		X	X	X	
Annual Publication of Residual Risks				X	X
Telemeter Stream Flow Gages		X			

	Objective Addressed				
	Reduce the Probability of Flooding within the Study Area	**Reduce Consequences of Flooding within the Study Area**	**Reduce Risk to Critical Infrastructure within the study area**	**Encourage Wise Use of the Floodplain**	**Educate the public about ongoing risk**
Modifications to Flood Warning System		X			
Federal Flood Insurance Program		X		X	

A preliminary screening of the measures identified was done before combining them into alternatives. Screening level cost estimates were developed for the measures described. These estimates included construction costs, environmental costs, and real estate costs. The estimates were developed by applying each measure over the entire length of the area under consideration. The goal was to screen out measures that would not be cost-effective. A measure may be ruled out for general use in this preliminary screening, but if circumstances in a particular area warrant special treatment, that measure may be employed if it satisfies the need.

An estimate of environmental mitigation costs was also made. The purpose of developing these costs was to indicate a relative level of environmental impact for each measure. It is important to realize that appropriate environmental mitigation may not be possible for a particular measure. Some impacts could have the result of a jeopardy opinion from the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

Table 3-4 displays the screening criteria and metrics used to evaluate and screen the measures. Table 3-5 displays the summary of the management measures retained for further analysis or dropped from further consideration.

Table 3-4: Measures Screening Criteria and Metrics.

	Measure Screening Criteria	Metric
1	Effectiveness	Does the measure respond to one or more of the planning objectives?
2	Efficiency	Ability of measure to address the problem for the least cost for a given output.

Table 3-5: Summary of Management Measures Retained or Dropped.

Measures	Retained	Dropped	Rationale
Measures to Reduce Flood Stages			
Upstream Storage on the American River	x		Effective method of reducing the flood risk to the downstream communities.
Transitory storage on the Sacramento River		x	Implementation of this measure is not efficient, because it does not reduce stages enough to preclude levee improvements anywhere within the study area.
Reoperation of Sacramento River Watershed reservoirs upstream of study area		x	Implementation of this measure is not efficient, because it does not reduce stages enough to preclude levee improvements anywhere within the study area.
Reoperation of American River Watershed reservoirs upstream of study area		x	Folsom Dam Modification Water Control Manual update is considering modifications to the flood control space. Additional reoperation of reservoirs upstream of Folsom Dam would most likely yield minimal downstream flood risk reduction benefits because these reservoirs only slightly regulate a small portion of the overall watershed tributary to Folsom Dam. Therefore, this measure is not effective.
Sacramento Weir and Bypass Improvements	x		Provides regional benefits in the form of reduced water surface elevations in the Sacramento River in the study area and to communities downstream of the study area. High reliability of moving flood flows away from urban area to rural bypass area
Improvements to the Yolo Bypass		x	Implementation of this measure is not efficient, because it does not reduce stages enough to preclude levee improvements in the study area.
Offstream Storage on Deer Creek		x	This measure is not efficient, because substantial development has taken place in the area where this alternative would be located. High costs would be incurred in relocating these communities.
Construct Diversion Structure on Sacramento River near I Street Bridge	x		Reduces water surface elevation in the Sacramento River downstream to the extent that seepage, stability and erosion issues are addressed and levee improvements not needed.
Measures to Address Seepage and Underseepage			
Seepage Berms	x		Existing residential and commercial development immediately adjacent to the levee toe makes this measure more costly than other seepage reduction measures in most areas. May be retained for use in areas with land available on the landside of the levee.
Relief Wells	x		Effective method of addressing residual seepage without jeopardizing levee integrity.
Slurry Walls	x		Effective method of reducing levee seepage and underseepage.
Sheet Pile Walls		x	Not an effective construction technique for deep cutoff of seepage. Screened based on cost and constructability.
Removal of Ditches Adjacent to levees	x		Effective at lengthening seepage path to meet seepage criteria.
Measures to Address Levee Stability			
Stability Berms		x	This measure is not efficient, because existing residential and commercial development immediately adjacent to the levee toe make this measure much more costly than other stability

Measures	Retained	Dropped	Rationale
			improvement measures.
Sheet Pile Walls		x	Not an effective construction technique to address stability. Screened based on efficiency.
Widen/Flatten Levee Slopes	x		Effective method of improving levee stability.
Full Levee Degrade	x		Effective method of improving levee stability.
Reconstruction with Geotextile Material	x		Effective method of improving levee stability.
Measures to Address Levee Overtopping			
Raise Levees in Place	x		Effective method of increasing levee performance.
Raise levees with Adjacent Levees		x	This measure is not effective, because residential and commercial development exists immediately adjacent to existing levee toe. Real estate requirements make this measure much more costly than other measures that achieve similar results.
Add Floodwalls to Existing Levees	x		Effective method of increasing levee performance.
Construct Cross-Natomas Levee		x	This measure is not efficient, because it is much more costly than improving existing levees. Very high real estate costs.
Remove Levees and Construct Floodwalls		x	This measure is not efficient, because other measures that achieved the same result were more cost effective. High environmental effects. May be used in localized areas.
Construct Partial Floodwalls		x	This measure is not efficient, because other measures that achieved the same result were more cost effective. May be used in localized areas.
Construct New Levees		x	This measure is not efficient, because improving existing levees is more cost effective due to construction and real estate costs.
Measures to Address Erosion			
Waterside Armoring of Levee Slopes (Sac Bank-type repair)	x		Effective method of reducing erosion potential on the levee.
Launchable Rock Trench	x		Effective method of reducing erosion potential on the levee.
Biotechnical Armoring of Slopes	x		Used in areas with a wide natural bank. Would not be used on levee slopes. Effective method to reduce erosion.
Grade Control Structures in River		x	Analysis confirmed that erosion of the river bed is not a significant concern during the period of analysis.
Non-Structural Measures			
Permanent Relocation		x	This measure is not efficient, because it is too costly to relocate the City of Sacramento out of the floodplain.
Raising in Place		x	This measure is not efficient, because it is more costly than improving levees and would alter the character of the community.
Flood Proofing of Existing Structures		x	This measure is not efficient, because it is more costly than improving levees and would alter the character of the community.
Floodplain Management	x		Item of local cooperation provided by the non-Federal sponsor.
Providing Floodplain Information to	x		Supports effective land use policies. Item of local cooperation provided by the non-Federal sponsor.

Measures	Retained	Dropped	Rationale
Regulatory Agencies			
Annual Publication of Residual Risks	x		Item of local cooperation provided by the non-Federal sponsor.
Telemeter Stream Flow Gages	x		Provides advance notice of flood risk and potentially increases warning time
Modifications to Flood Warning System	x		Provides advance notice of flood risk and potentially increases warning time
Federal Flood Insurance Program	x		Promotes community resilience.

3.10 PLAN FORMULATION STRATEGIES

Plan formulation is the process of putting together plans that meet the planning objectives and avoid the planning constraints. Often, the plan formulation process emphasizes structural details, costs, project outputs, safety, reliability, and other matters that are quantifiable. However, formulation must be balanced by also considering environmental, social, institutional, and other qualitative information. To overlook such information runs the risk of developing plans that cannot be implemented. In an effort to balance the technical evaluations with those that are less so, the formulation process begins with the development of strategies. A plan formulation strategy is a systematic way of combining measures into plans based on selected criteria. The inspiration for a strategy may be institutional, as in laws, policies, regional plans, or other institutional realities. It may be technical, as in formulation of the least cost plan. Or it may be inspired by issues important to stakeholders or local objectives and constraints. A strategy becomes the recipe for formulating a plan. And during iterations of the planning process, strategies can become more precise. The development of strategies usually begins with screened management measures. The combinability, dependency and mutual exclusivity of the measures are evaluated, and then a strategy is applied to combine measures into candidate plans.

The plan formulation strategy applied for this study consisted of a few steps. Overall, alternatives were developed to comprehensively reduce flood risk. However, this was done by starting with an understanding of addressing the greatest risk drivers. As described in the problems section, the greatest flood risk driver to the Sacramento Area is the risk of a geotechnical levee failure along the Sacramento River from a relatively high frequency event. The next risk driver is a levee failure from erosion from a relatively high frequency flow along the American and Sacramento Rivers. The third order risk driver is from lower frequency, high volume flows exceeding the flood carrying capacity of the Sacramento, American and Natomas levee systems. Lastly, there is some risk from encroachments and from vegetation, although there are isolated instances of significant risk from encroachments and vegetation. Encroachments may obstruct flood monitoring or flood fighting activities in areas of distress occurring on a levee during high flow; depending on the circumstances of a specific encroachment, some encroachments might pose a significant risk. Vegetation has the effect of shortening seepage paths, leading to piping of material. Vegetation might also fall during a flood event greatly reducing the geometry of the levee and therefore the stability, possibly to the point of levee failure.

There are some reaches of levees where the seepage and stability issues are worse than other reaches. However, improving those reaches just moves the point(s) of greatest concern to the next location. It would not be efficient to improve only a few reaches at a time when the extent of the problem applies to the Sacramento River levee from the confluence with the American River to the south. Traditionally, erosion has been addressed from a reactionary standpoint once erosion is active or imminent. This has been done via the Sacramento River Bank Protection Project. (The Sacramento River Bank Protection Project is an authority to preserve the integrity of the Sacramento River Flood Control Project, which includes the Sacramento and American River levees.) However, evaluating the history and nature of erosion as part of this GRR indicates strong evidence that active and imminent erosion is present and constitutes a relatively high risk. There is also a high degree of likelihood that extensive erosion will occur without preventative measures put in place to prevent erosion of the existing and proposed flood risk reduction features.

Additional plan formulation strategies include the following:

- Combine measures that improve levee performance
  - *Improve conveyance*
  - *Improve levees in place by various methods*
- Combine measures that reduce flood stages
  - *Improve upstream storage*
  - *Reduce flow which reaches study area*
- Combine measures which improve levee performance and reduce flood stages
  - *Identify measures which together provide optimal storage and conveyance opportunities*

3.11 INITIAL ARRAY OF ALTERNATIVES

Using the formulation strategies outlined, retained measures were assembled into initial alternatives. These initial alternatives were then screened using the Federal planning criteria along with risk management tools, and coordination with the non-Federal sponsor, stakeholders and the vertical team. The Corps is required to consider “No Action” as one of the alternatives for selection in order to comply with Corps planning policies and the requirements of the National Environmental Policy Act (NEPA). The No Action Plan here assumes that neither the Federal Government nor local interests would implement the recommendations in this GRR. Consequently, the No Action Alternative would not improve the current condition of the levees in the project area and the likelihood of failure of those levees would not change. The potential loss of life, loss of property, and loss of critical infrastructure would not be reduced under this scenario. Because the No Action Plan is required to be included among the candidate plans in the final array of alternatives, the resulting effects of a levee failure are described in the

Summary System of Accounts Comparison of the Final Array of Alternative Plans, later in this chapter. The No Action plan and the future without-project condition are assumed to be the same for this study.

3.12 SCREENING OF INITIAL ARRAY OF ALTERNATIVES

Federal planning criteria were used for the first level screening of the initial array of alternatives. Planning criteria are used to formulate, screen, evaluate and compare alternative plans. Four specific criteria are required in USACE water resource studies: completeness, effectiveness, efficiency and acceptability. These criteria are useful in narrowing down the array of possible alternatives plans.

3.12.1 Completeness

The definition of "completeness" from ER 1101-2-100, the Planning Guidance Notebook, is "the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities."

3.12.2 Effectiveness

Within identified constraints of the study, each alternative in the focused array addresses the planning objectives regarding flood risk management and life safety to varying degrees. No further evaluation and screening was necessary for this criterion.

3.12.3 Efficiency

This criterion is defined in terms of cost efficiency and compares economic benefits to economic costs from a national perspective. As part of the analysis for cost efficiency, the NED Plan is identified as the alternative that reasonably maximizes annual net benefits. The focused array of alternatives will be screened for cost efficiency using economic criteria.

3.12.4 Acceptability

Alternatives are acceptable when they are compatible with existing laws, regulations, and public policies.

Table 3-6 displays the extent to which the initial alternatives meet the planning criteria and the results from this screening. No alternatives were screened out using these criteria.

Table 3-6: Screening of the Initial Array of Alternatives.

Preliminary Alternative	Completeness	Efficiency	Effectiveness	Acceptability	Carried Forward?
Improve Levees within Existing Geometry (Minimum Plan)	Yes	Yes	Yes	Yes	Yes
Improve Levees	Yes	Yes	Yes	Yes	Yes
Improve Levees & Widen Sacramento Weir and Bypass	Yes	Yes, benefits exceed costs	Yes	Yes	Yes
Improve Levees and Construct I-Street Diversion Structure	Yes	No	Yes	Yes	Yes
Upstream Storage on American River	Yes- if combined with downstream levee improvements	No	Yes – if combined with downstream levee improvements	No, Congressional support and public support lacking	Yes
Maximum Plan	Yes	No	Yes	Yes	Yes
Non-Structural	Yes	Yes	Yes	Yes	Yes

From this screening, the initial alternatives were refined to form a focused array of alternatives that were carried forward for further evaluation. A description of each of the focused array of alternatives follows.

3.13 DESCRIPTION OF THE FOCUSED ARRAY OF ALTERNATIVES

A focused array of alternatives was identified from the screening process described in the previous section. Verification of the geotechnical levee issues and hydraulic modeling scenarios focused these alternatives on the need to improve the levee performance or drastically reduce the water surface elevation.

3.13.1 Focused Alternative 0.5: Improve Levees within Existing Geometry

This alternative would incorporate levee improvements for seepage, stability and erosion but not include any levee raises. This plan addresses the worst risk factors of seepage, stability and erosion. Table 3-7 identifies the measures recommended for this alternative for each waterway.

Table 3-7: Focused Alternative 0.5: Improve Levees within Existing Geometry – Proposed Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, geotextile and slope flattening	Bank Protection, Launchable Rock Trench	---
NEMDC	Cutoff Wall	Cutoff Wall	---	---
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	---
Dry/Robla Creeks	---	---	---	---
Magpie Creek	---	---	---	---
Natomas	---	---	---	---

3.13.2 Focused Alternative 1: Improve Levees

Focused Alternative 1 involves the construction of in-place levee improvement measures to address seepage, slope stability, erosion, and overtopping concerns identified for the American and Sacramento River levees, NEMDC, Arcade, Dry/Robla, and Magpie Creeks. In addition, Alternative 1 would include levee raises for the Natomas Basin. Analyses of the Natomas Basin levee raises are included in this GRR; however, this measure was analyzed for NEPA and CEQA in the Natomas Levee Improvement Program, Phase 4b, Landside Improvement Project EIS/EIR in 2010. As a result, the EIS/EIR accompanying this GRR incorporates the analysis of the levee raise by reference to the earlier EIS/EIR.

Due to environmental, real estate, and hydraulic impact concerns within the American River North and South basins, Alternative 1 proposes to improve levees within their existing footprint to the extent possible. The purpose of this alternative would be to improve the flood management system to safely convey flows to a level that maximizes net benefits. Table 3-8 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 3-8: Focused Alternative 1 – Improve Levees – Proposed Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, geotextile and slope flattening	Bank Protection, Launchable Rock Trench	Levee Raise
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

3.13.3 Focused Alternative 2: Improve Levees and Widen the Sacramento Weir and Bypass

Focused Alternative 2 would include the levee improvements discussed in Focused Alternative 1, except for almost all of the levee raises along the Sacramento River. Instead of the levee raises, the Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. The levees along the American River, NEMDC, Arcade, Dry/Robla, and Magpie Creeks would be improved to address identified seepage, stability, erosion, and height concerns through the methods described under Alternative 1. The levees along the Sacramento River would be improved to address identified seepage, stability, erosion, and overtopping concerns through the measures described under Alternative 1. Due to environmental, real estate, and hydraulic capacity constraints within the American River North and South basins, the majority of the levees would be improved within the existing levee footprint to the extent possible.

This alternative would include widening the Sacramento Bypass by approximately 1,500 feet to increase the amount of flow it conveys into the Yolo Bypass. This alternative includes construction of a new weir adjacent to the existing Sacramento Weir, demolition of the existing north Sacramento Bypass levee, and construction of a new levee approximately 1,500 feet to the north. Expanding the Sacramento Weir and Bypass would greatly reduce the amount of levee raises needed along the Sacramento River. Table 3-9 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 3-9: Focused Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass – Proposed Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	Cutoff Wall	Cutoff Wall, geotextile and slope flattening	Bank Protection, Launchable Rock Trench	Sacramento Bypass and Weir Widening
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

3.13.4 Focused Alternative 3: Improve Levees and Construct the I-Street Diversion Structure

Focused Alternative 3 would include the construction of a diversion structure just upstream of the existing I Street Bridge on the Sacramento River. This diversion structure would restrict flows going down the Sacramento River past the cities of Sacramento and West Sacramento, and would cause a large portion of the flows from the Sacramento and American Rivers to be forced upstream through the Sacramento Bypass out to the Yolo Bypass. The Sacramento Bypass and Weir would be widened to accommodate the increased flows to the bypass system. The effect of this diversion structure would be to reduce the water surface elevation of the Sacramento River downstream of the structure to the point at which seepage, stability, height, and erosion improvements would not be needed. Table 3-10 summarizes the levee problems discussed above and the proposed measure for each waterway.

The I Street Diversion Structure would consist of a two hundred (200) foot wide, non-gated u-frame structure and four (4) sixty-two (62) foot wide Tainter gates. Tie-in-T-Walls are provided on either side of the major structures to tie in to the existing levees along the Sacramento River. The structures consist of conventionally reinforced concrete, supported on pipe pile foundations. Upper sand layers within the Sacramento River will be densified with ground improvement technology to prevent liquefaction during a seismic event. The structures would be constructed in three phases utilizing internally braced temporary retaining structures (TRS) for cast-in-place construction.

Table 3-10: Focused Alternative 3 – Improve Levees and Construct the I Street Diversion Structure – Proposed Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	---
Sacramento River	I Street Diversion Structure	I Street Diversion Structure	I Street Diversion Structure	Sacramento Bypass and Weir Widening and I St. Diversion Structure
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

3.13.5 Focused Alternative 4: Upstream Storage on the American River

This alternative involves construction of a flood control dam near the town of Auburn on the north fork American River for the purpose of attenuating flows continuing downstream into Folsom Reservoir and the lower American River. The basis for this alternative is the 1996 American River Watershed Investigation Supplemental Information Report updated to current price levels and understanding of downstream levee work. The location of the dam is driven by the shape of the canyon; costs for seismic considerations are not a driver. Additionally, levee improvements to address seepage, stability, erosion, and overtopping concerns are included where they exist in various stretches of levee protecting the City of Sacramento.

Table 3-11 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 3-11: Focused Alternative 4 – Upstream Storage on the American River – Proposed Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	Upstream Storage (reduce flanking)
Sacramento River	Cutoff Wall	Cutoff Wall, geotextile and slope flattening	Bank Protection, Launchable Rock Trench	Sacramento Bypass and Weir Widening
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

3.13.6 Focused Alternative 5: Maximum Plan

The Maximum Plan to reduce flood risk for the City of Sacramento and the surrounding area would include most of the measures previously discussed. Due to the fact that the City of Sacramento is the Capital of the State of California, has several hundred thousand residents residing and working in the floodplain, critical infrastructure of State and National value, and is one of the most at risk urban areas in the country for flooding, the focus of this Maximum Plan would be to identify all means possible to reduce the risk of flooding and not constrain the plan by net benefits or performance. Therefore, the Maximum Plan would include levee improvements along the Sacramento and American Rivers as well as the NEMDC, Arcade, Dry/Robla and Magpie Creek tributaries and the Natomas levee raises. This alternative would also include construction of a dam upstream on the American River near the town of Auburn which would further reduce the risk of flooding from a 200 year to about a 400 year event. Additional levee raises along the Sacramento River would also be included to increase the performance of these levees to a level comparable to that of the American River flood management system with an upstream dam in place. Table 3-12 summarizes the levee problems discussed above and the proposed measure for each waterway.

Table 3-12: Focused Alternative 5 (Maximum Plan) – Proposed Improvement Measures by Waterway.

Waterway	Seepage Measures	Stability Measures	Erosion Protection Measures	Overtopping Measures
American River	---	---	Bank Protection, Launchable Rock Trench	Upstream Storage (reduce flanking)
Sacramento River	I Street Diversion Structure and Cutoff Wall	I Street Diversion Structure and Cutoff Wall	I Street Diversion Structure and Bank Protection, Launchable Rock Trench	I Street Diversion Structure and Sacramento Bypass and Weir Widening
NEMDC	Cutoff Wall	Cutoff Wall	---	Floodwall/Levee Raise
Arcade Creek	Cutoff Wall	Cutoff Wall and geotextile	---	Floodwall/Levee Raise
Dry/Robla Creeks	---	---	---	Floodwall
Magpie Creek	---	---	---	Floodwall/New Levee/Detention Basin
Natomas				Levee Raise

3.13.7 Preliminary Alternative 6: Non-Structural Alternative

The non-structural alternative would consist of measures such as floodplain management, providing floodplain information to regulatory agencies, annual publication of residual risks, telemeter stream flow gages, modifications to flood warning system, and participation in the Federal Flood Insurance Program.

Several non-structural flood risk management elements could be added to any of the structural alternative plans in the final array to further reduce flood risk. Whereas structural project features, such as levees and channel improvements, can reduce the probability of flooding, non-structural features can reduce the consequences of flooding. The combination of both structural and non-structural elements should ideally be used to reduce the flood risk to an area.

Table 3-13 below lists the measures included in each of the Focused Array of alternatives.

Table 3-13: Measures Included in the Focused Array of Alternatives.

Retained Measures	Focused Array of Alternatives						
	0.5 Minimum Plan	1 Improve Levees	2 Sac Bypass	3 I Street Diversion	4 Auburn Dam	5 Maximum Plan	6 Non Structural
Upstream Storage on the American					x	x	
Sacramento Weir and Bypass			x	x		x	
I St. Diversion Structure				x		x	
Relief Wells	x	x	x	x	x	x	
Slurry Walls	x	x	x	x	x	x	
Remove Ditches Adjacent to Levees	x	x	x	x	x	x	
Widen & Flatten Levee Slopes	x	x	x	x	x	x	
Raise Levees in Place		x	x		x	x	
Add Floodwalls to Existing Levees		x	x	x	x	x	
Waterside Armoring of Levee Slopes	x	x	x	x	x	x	
Launchable Rock Trench	x	x	x	x	x	x	
Floodplain Management	x	x	x	x	x	x	x
Provide Floodplain Information	x	x	x	x	x	x	x
Publication of Residual Risk	x	x	x	x	x	x	x
Telemeter Stream flow gages	x	x	x	x	x	x	x
Modifications to Flood Warning System	x	x	x	x	x	x	x
Federal Flood Insurance Program	x	x	x	x	x	x	x

3.13.8 Evaluation and Comparison of the Focused Array of Alternatives

After alternative plans have been screened using the planning criteria, they are evaluated and compared against more specific evaluation criteria. Evaluation criteria can include costs, outputs, or effects and reflect the planning objectives or constraints. Some or all of the evaluation criteria may be used at various stages in the plan formulation process to compare alternative plans. Effective evaluation criteria must be measurable and reveal differences or trade-offs between alternative plans.

An evaluation of the Focused Array of Alternatives was conducted using criteria established by Executive Order 11988. Based on the findings, all alternatives were compliant for the American River North and American River South basins. However, additional levee improvements for the Natomas Basin were determined to not be compliant with E.O. 11988. Additional discussion regarding the Natomas Basin is included in the evaluation and comparison of the Final Array of Alternatives below.

Comparison of the Focused Array of Alternatives focuses on the economic benefits and costs of each alternative. The economic benefits are derived from the computation of without project annual damages and the associated reduction in those damages as a result of implementation of the various alternatives. The costs displayed here are screening level costs developed early in the study phase and these have not been updated since they were initially established.

Without-project expected annual damages were computed at eight representative index points throughout the study area. These index points, which are located on the main flood sources, were chosen in order to be able to reasonably characterize the flood risk associated with each of the three main basins by accounting for the multiple sources of flooding in each basin.

Similarly, with-project damages reduced (benefits) associated with various project alternatives were also computed at each representative index point for each basin. If the flood risk in a basin (or any other consequence area) could be attributed to one and only one flood source, then the total benefits computed at an index point along a particular flood source would represent the benefits of building a project on that flood source. This is not the case, however, for the ARCF study area as flood risk in each basin/consequence area can be attributed to multiple flood sources. Under this scenario, benefits were computed first at each index point (source), and then estimated for the whole basin using the appropriate calculation method as determined by assessments of the hydrologic/hydraulic correlation between the flood sources within a basin. (For more detail, see the Economic Appendix to the ARCF GRR).

Table 3-14 compares the preliminary first costs, annual costs, annual benefits, and net benefits for the focused array of alternatives.

Table 3-14: Comparison of Costs (in $1,000s) and Benefits of the Focused Array of Alternatives[1,2].

	Alt 0.5 (minimum)	Alt 1 (Improve Levees)	Alt 2 (Widen Sac Weir and Bypass)	Alt 3 (I Street Diversion Structure)	Alt 4 (Upstream Storage)	Alt 5 (Maximum Plan)	Alt 6 (Non-Structural)
First Costs	1,262,915	1,426,055	1,567,746	2,122,000	3,226,055	4,567,746	N/A
Average Annual Costs[3]	71,203	80,412	92,562	119,638	181,885	257,530	N/A
Average Annual Benefits	384,047	433,581	430,798	428,000	451,600	451,600	N/A
Net benefits	312,844	353,169	338,236	308,362	269,715	194,070	N/A
B/C	5.4	5.4	4.7	3.6	2.5	1.8	N/A

Notes:
[1] Based on October 2013 price levels, 3.5% discount rate, and a 50-year period of analysis.
[2]Preliminary costs were based on a combination of estimates developed for the GRR, previous USACE studies and costs developed by private consultants.
[3]Average Annual Costs include preliminary Interest During Construction (IDC) calculations.

Net benefits were derived for each of the alternatives in the focused array and the net benefits curve is shown in Figure 3-3 below.

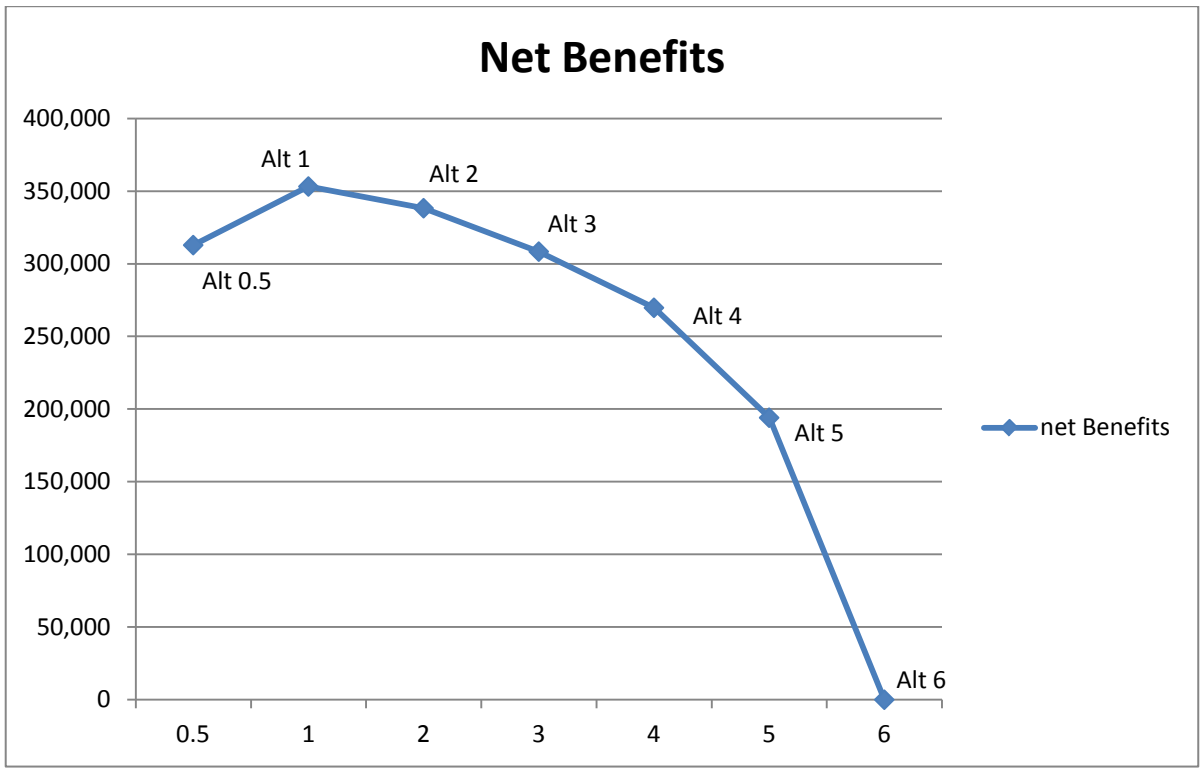

Figure 3-3: Net Benefits of Focused Array of Alternatives.

A summary of the evaluations of the Focused Array of Alternatives are presented in Table 3-15 below.

Table 3-15: Summary Evaluation of Focused Array of Alternative Plans.

Focused Alternative	Evaluation Summary	Carried Forward?
0.5. Improve Levees within Existing Geometry (Minimum Plan)	This alternative does not maximize net benefits and is on the rising portion of the net benefits curve. It was therefore dropped from further consideration.	No
1. Improve Levees	Improving the existing levees to address seepage, stability, erosion and height issues is the first increment to reducing flood risk for the Sacramento area. Because this alternative increases system performance and appears to have the highest net benefits, it was carried forward for further consideration.	Yes
2. Improve Levees & Widen Sacramento Weir and Bypass	This alternative reduces the flood risk to the urbanized area and has high net benefits and is therefore carried forward for further evaluation	Yes
3. Improve Levees and Construct I-Street Diversion Structure	This alternative is not efficient. Does not meet worst-first implementation strategy. The implementation sequencing would leave the densely populated areas of Sacramento at risk of flooding until the end of the construction timeframe. The Yolo and Sacramento Bypass levee work would be constructed first in order to accept the higher flows associated with this alternative. Once this was completed, then work on the diversion structure itself would begin. Since no levee work is recommended on the Sacramento river levees as part of this alternative, this high risk area would remain exposed throughout implementation of the project.	No
4. Upstream Storage on American River	Construction of an upstream storage facility does not address the high frequency flood risk associated with the poor performance of levees in the study area. It also does not reduce the risk for the highest risk area along the Sacramento River since this is dominated by Sacramento River flows. All downstream levee improvements contained in Alternatives 1 and 2 would need to be included to effectively reduce the high frequency flood risk for the study area. Other alternatives offer more efficient methods to reduce the flood risk.	No
5. Maximum Plan	Other plans offer more efficient ways to reduce risk.	No
6. Non-Structural	These measures reduce the consequences of flooding, but do not reduce the probability of flooding and therefore do not significantly reduce the overall risk of flooding.	No

Based on the evaluation, two alternatives were retained for the final array of alternatives.

3.13.9 Identification of Tentative NED Plan

The comparison of the costs and benefits of the Focused Array of Alternatives identifies Alternative 1 as the tentative NED plan; the plan which reasonably maximizes net benefits, pending more detailed evaluation. Due to the fact that the costs and benefits for both Alternative 1 and Alternative 2 were very close, both alternatives were carried forward to the final array of alternatives for further evaluation and comparison. Alternative 1 is the tentative NED Plan.

3.14 FINAL ARRAY OF ALTERNATIVES

Based on the results of the evaluation of the focused array of alternatives, Alternatives 1 and 2 were carried forward to the final array of alternatives for further evaluation and comparison. This section contains more detailed descriptions of each of these alternatives.

3.14.1 Final Alternative 1: Improve Levees

Alternative 1 would include the construction of levee improvement measures to address seepage, stability, erosion, and height measures identified for the Sacramento River, Natomas East Main Drainage Canal (NEMDC), Arcade, Dry/Robla, and Magpie Creeks. Alternative 1 would also include erosion measures for specific locations along the American River. This alternative combines construction of levee improvement measures while maintaining the present levee alignment in its existing location (fix in place). Due to the urban nature and proximity of existing development within the American River North and South basins, Alternative 1 proposes to improve the levees within their existing footprint, with minimal additional real estate requirements. The purpose of this alternative would be to improve the flood risk management system to safely convey flows to a level that maximizes net benefits.

No additional recommendations for levee improvements in the Natomas Basin are included in the final alternatives. Seepage, stability, and erosion problems in the Natomas Basin were addressed in the Natomas Post Authorization Change Report (PACR). Levee raises were evaluated as part of this GRR but were not carried forward for recommendation as a result of evaluation of the final array of alternatives. It was determined that proposed actions by the State of California and local authorities could render the levee raises unnecessary.

The following sections contain more detailed information on the specific features and reaches included in this alternative.

Sacramento River Levees

Levees along the Sacramento River would be improved to address seepage, stability, erosion and height issues. Some real estate acquisition will be required for levee construction, inspection, maintenance, monitoring, and flood-fighting access.

A slurry wall would be constructed through the levee crown to address seepage concerns. Degradation of the levee crown is necessary to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids. Depending on the depth of the slurry wall needed to address the seepage issue the slurry wall would be installed by one of two methods. The conventional slot trench method, utilizing a long boom excavator can install a slurry wall to a depth of approximately 80 feet. For slurry walls of greater depth the Deep Soil Mixing (DSM) method would be utilized. The DSM method involves a crane supported set of two to four mixing augers used to drill through the levee crown and subsurface to a maximum depth of approximately 140 feet. For both methods, once the slurry has hardened it is capped and the levee embankment reconstructed with impervious or semi-impervious soil.

The proposed levee section consists of 20-foot wide levee crown with 2:1 to 3:1 side slopes. Where the existing levee does not meet the levee design requirements, slope flattening, crown widening, and or levee raise is required. This improvement measure addresses problems with slope stability, geometry, and levee crest access and maintenance.

To begin levee embankment grading, the area is cleared, grubbed, stripped, and where necessary portions of the existing embankment are removed to allow for bench cuts and keyways to tie in additional embankment fill. Excavated and borrow material (from nearby borrow sites) must be stockpiled at staging areas. Haul trucks and front end loaders bring borrow materials to the site and graders spread material evenly according to levee design plans. Sheepsfoot rollers compact the material. In the lower reach of the Sacramento River, near the town of Freeport, the steepness of the levee slope has created a slope stability problem. To address this problem, the levee would be partially degraded and reconstructed with a geotextile material to reinforce the levee slope. Landside access will likely be required to construct this feature from the levee toe upwards.

Erosion concerns would be addressed by either rock protection on the bank or the launchable rock trench method described in the American River section above. There are about 10 miles of erosion protection required.

American River Levees

The erosion protection measures for the American River levees consist of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. One measure consists of placing rock protection on the bank to prevent erosion; this, in general, is the approach of the Sacramento River Bank Protection Project. This measure entails filling the eroded portion of the bank and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. Another measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it. The trench would be excavated at the toe of the existing levee. The bottom of the trench will be constructed close to the summer mean water surface elevation in order to reduce the rock launching distance and amount of rock required. After rock

placement the trench would be covered with a minimum of 3 feet of soil. The levee slope would be reshaped and armored with riprap and covered with 2 feet of soil. All disturbed areas would be reseeded with native grasses and small shrubs, where appropriate. Another feature that would be used in lower velocity reaches is a bioengineering method, which uses plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of material. Figure 3-4 identifies the sites where either bank protection or launchable rock would be required. There are about 4 miles of erosion protection required for the right bank and about 7 miles required for the left bank.

Tributaries

- **Dry and Robla Creeks.** A floodwall would be constructed on top of the existing left bank levee.
- **Natomas East Main Drain Canal (NEMDC).** Along the east levee of the NEMDC, there are seepage and stability problems at the locations where historic creeks had intersected the current levee alignment. A conventional slurry wall would be constructed at these locations to address the seepage and stability problems. NEMDC also has height issues which will be addressed with an on-bank floodwall.
- **Arcade Creek.** The problems on Arcade Creek are seepage and, to a lesser degree, stability as well as some levee height issues when the event exceeds the design. A cutoff wall would be constructed for seepage management. There is a ditch adjacent to the north levee at the landside toe which provides a shortened path for deep seepage, and could affect the stability of the levee. The ditch would be replaced with a pipe or culvert and then backfilled. This would lengthen the seepage path and improve the stability of the levee. The levee stability would also be reinforced through the use of geotextile materials. An on-bank floodwall would address height issues on both sides of Arcade Creek along with a raise and bolster method where there is already existing on-bank floodwall.
- **Magpie Creek.** The existing left bank levee of the Magpie Creek Diversion Canal would be raised and the overall levee length would be extended by about 1,000 feet to prevent flanking. A new culvert will be constructed under an embankment which will connect with Robla Creek. The alternative also includes the purchase and preservation of about 80 acres of the floodplain in perpetuity for attenuation of flood flows.

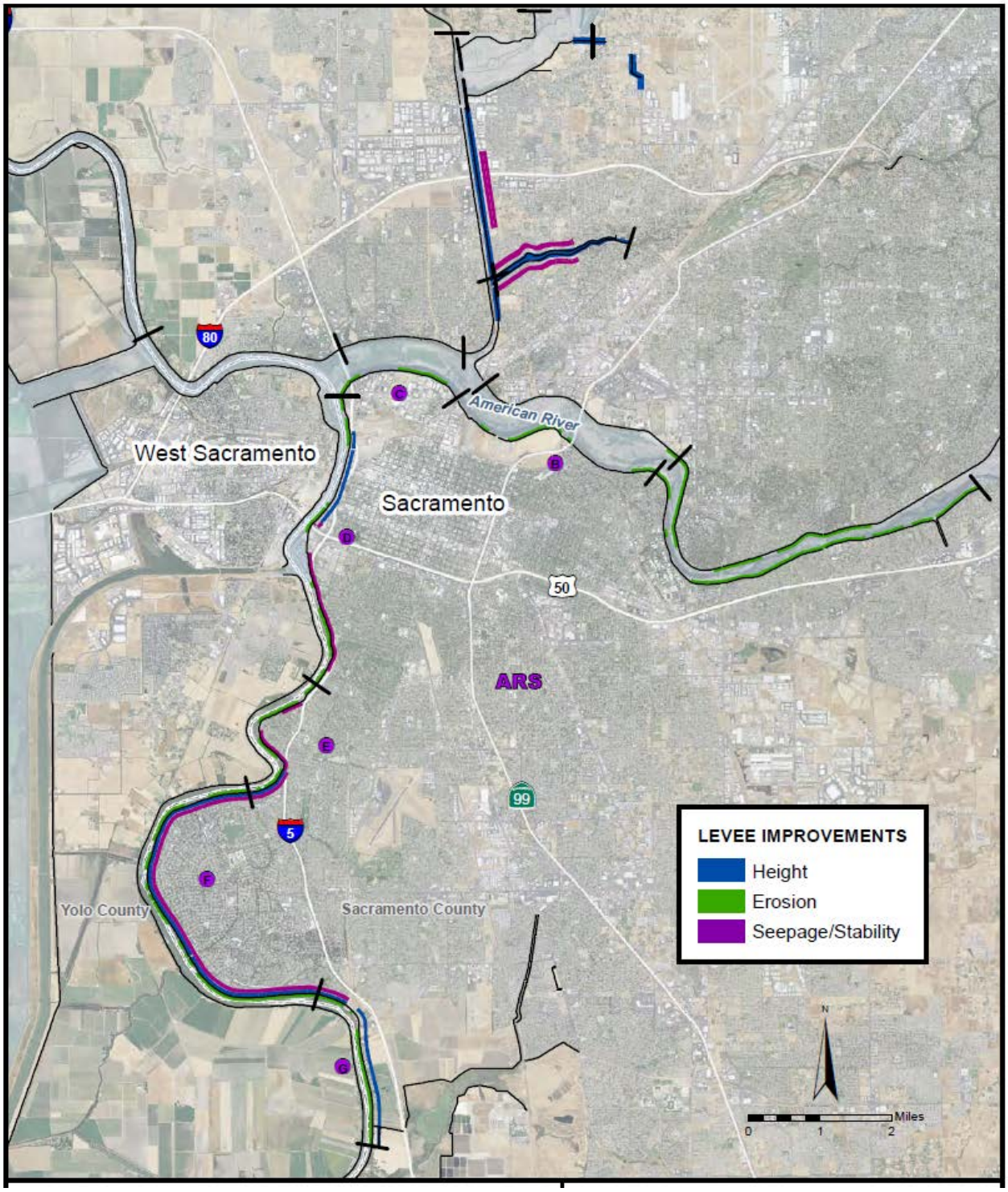

Figure 3-4: Final Alternative 1 – Improve Levees.

Vegetation and Access

The USACE *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures* (ETL 1110-2-571, updated as ETL 1110-2-583 on April 30, 2014), requires that a vegetation free zone be established. The vegetation free zone is a three-dimensional corridor surrounding all levees, floodwalls, embankment dams, and critical appurtenant structures in all flood risk management systems. The vegetation free zone applies to all vegetation except perennial, non-irrigated grass. Grass species are permitted, but only perennial grasses whose primary function is to reliably protect against erosion. The Sacramento District (SPK), USACE, *Geotechnical Levee Practice, SOP 003*, requires a minimum 20-foot wide landside easement for maintenance, inspection, and flood fight access.

As per ETL 1110-2-583, the primary purpose of a vegetation free zone is to provide a reliable corridor of access to, or along, levees, floodwalls, embankment dams, and appurtenant structures. This corridor must be free of obstructions to assure adequate access by personnel and equipment for surveillance, inspection, maintenance, monitoring, and flood-fighting. In the case of flood fighting, this access corridor must also provide the unobstructed space needed for the construction of temporary flood fighting features. Access is typically by four-wheel-drive vehicle, but for some purposes, such as maintenance and flood-fighting, access is required for larger equipment, such as tractors, bulldozers, dump trucks and helicopters. Accessibility is essential to the reliability of flood risk management systems. The minimum width of the corridor shall be the width of the levee, floodwall, or embankment dam, including all critical appurtenant structures, plus up to 15 feet on each side, measured from the outer edge of the outermost critical structure. The minimum height of the corridor shall be 8 feet from any point on the ground.

The Common Features GRR addresses vegetation requirements by recommending removal of vegetation on the waterside upper half of the levee slope, the levee crest, and the upper half of the landside levee slope as part of construction related activities required to install the seepage cutoff wall. The remainder of the lower portion of the landside levee slope would be covered by a Systemwide Improvement Framework (SWIF) or other sort of formal agreement with the sponsor to address remaining levee safety issues. Levee safety policy compliance for areas outside of the construction footprint would be a sponsor action and not part of this project. These actions are considered part of the future without project condition and would affect future operation and maintenance (O&M) requirements of the sponsor and its local cooperating agencies. For levee reaches where levee slopes would be flattened or the levee would be raised, vegetation would be removed on the entire landside levee slope as part of construction activities and construction access would be provided at the landside levee toe. A vegetation variance, as per the *Policy Guidance Letter (PGL) – Process for Requesting a Variance from Vegetation Standards for Levees and Floodwalls,* will be sought for the lower half of the waterside levee slope and up to 15 feet waterward of the waterside levee toe. Figures 3-5, 3-6, and 3-7 below describe the construction footprint, the areas covered by a vegetation variance, and the areas covered by a SWIF or other formal agreement with the sponsors.

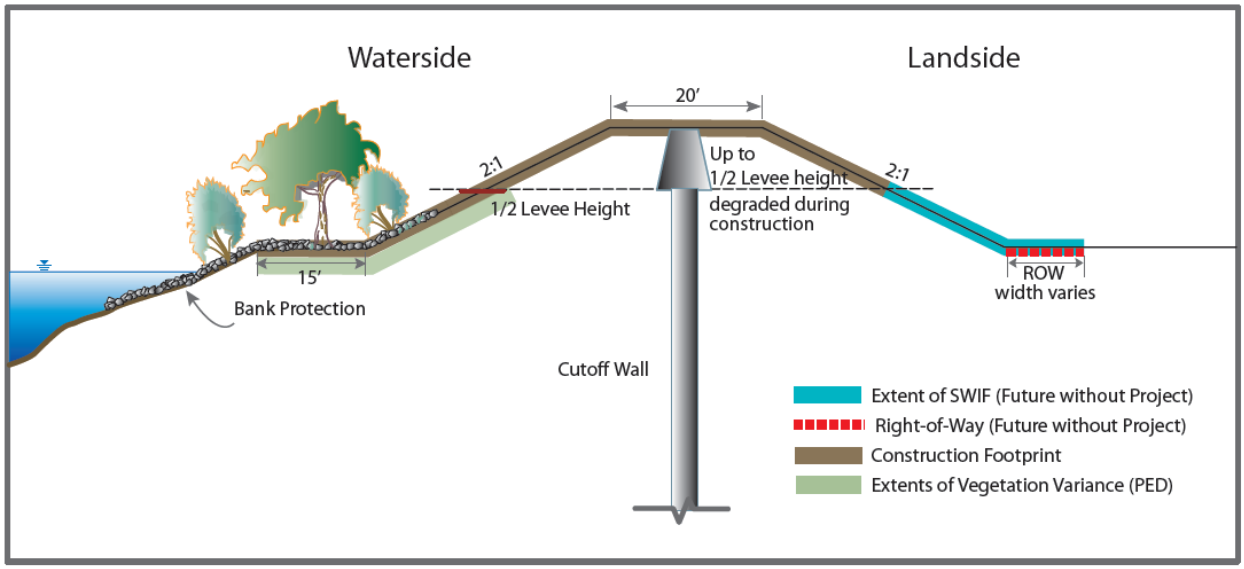

Figure 3-5: Levee Safety Compliance for Segments with No Recommended Levee Raise.

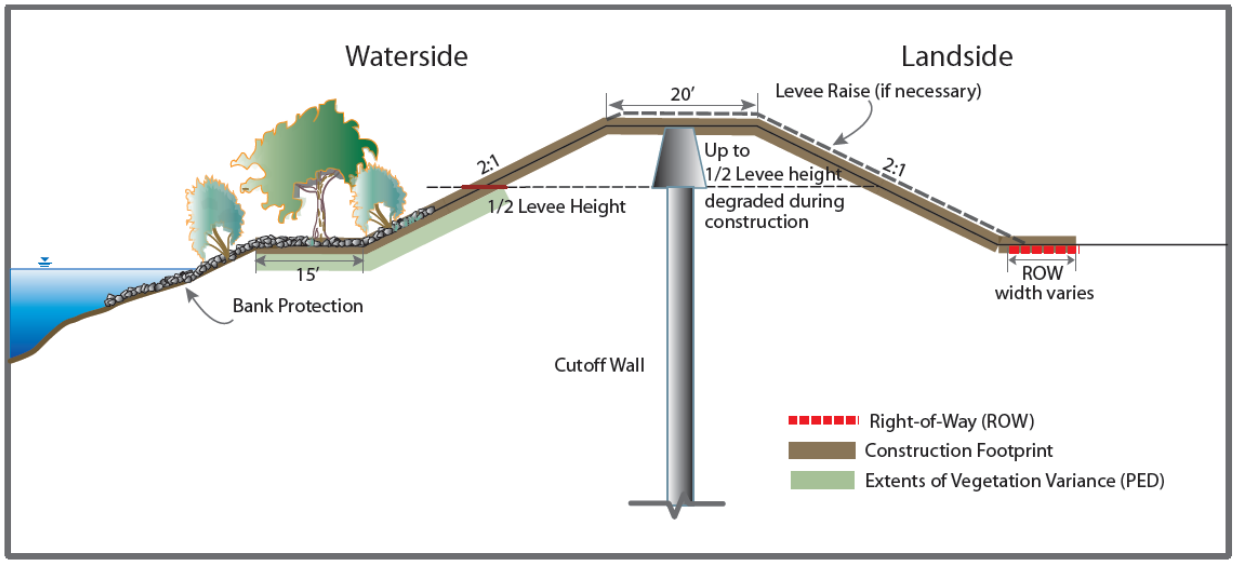

Figure 3-6: Levee Safety Compliance for Segments with Recommended Levee Raise.

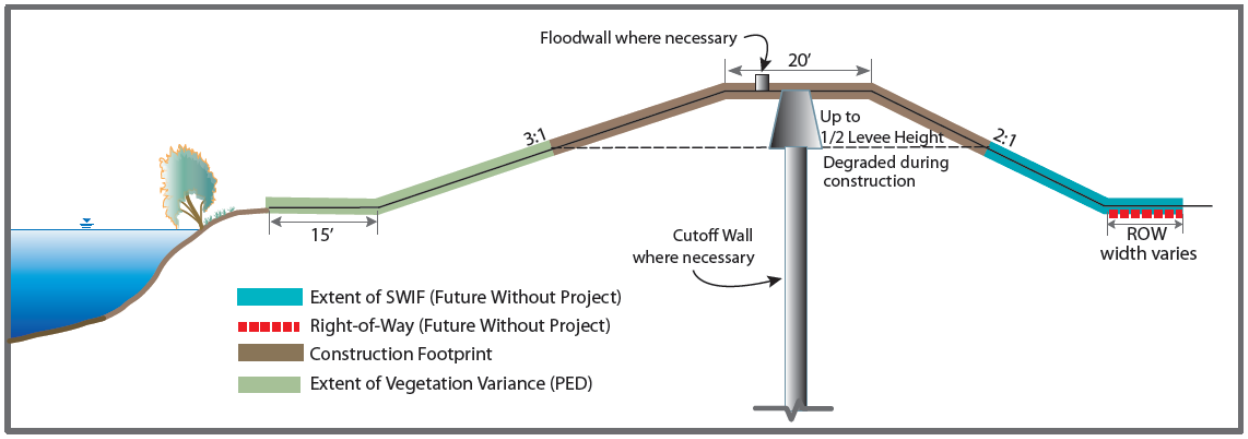

Figure 3-7: Levee Safety Compliance for Segments with Floodwall Raise.

Table 3-16 below describes the first costs, the interest during construction (IDC), the average annual cost, the operations and maintenance costs and the total annual cost for Alternative 1.

Table 3-16: Final Alternative 1 – Costs.

Basin	Final Alternative 1: Improve Levees (in $1,000s, October 2014 Price Level, 50-Year Period of Analysis, 3.375% Discount Rate)						
	Risk Source	First Costs[3]	IDC[1]	Total Costs	Average Annual	O&M	Total Aac
ARS	American	256,660	72,488	329,148	13,718	N/A	13,718
	Sacramento	674,007	170,647	844,654	35,203	N/A	35,203
	Sac Raises	71,565	16,326	87,891	3,663	N/A	3,663
	Total Basin	**1,002,232**	**259,461**	**1,261,693**	**52,584**	N/A	**52,584**
ARN	American	144,222	23,961	168,183	7,009	N/A	7,009
	Tributaries[2]	181,819	11,410	193,229	8,053	N/A	8,053
	Total Basin	**326,041**	**35,371**	**361,412**	**15,062**	N/A	**15,062**
GRAND TOTAL	**All Basins**	**1,328,273**	**294,832**	**1,623,105**	**67,646**	**286**	**67,932**

[1]Interest During Construction

[2]Includes Arcade, Dry, and Robla Creeks and the Natomas East Main Drainage Canal (NEMDC)

[3]First costs include mitigation for environmental effects within the construction footprint.

3.14.2 Final Alternative 2: Improve Levees and Widen the Sacramento Weir and Bypass

Alternative 2 would include the levee improvements discussed in Alternative 1, except for the extent of levee raises along the Sacramento River. While Alternative 1 would include about 7 miles of levee raising, Alternative 2 would only require about 1 mile of levee raising. The Sacramento Weir and Bypass would be widened to divert more flows into the Yolo Bypass. This would reduce the amount of raising required on the Sacramento River levees to meet the State's criteria of the 200 year water surface elevation (WSEL) plus 3 feet. The levees along the American River North Basin Tributaries, including the NEMDC, Arcade, Dry/Robla, and Magpie Creeks, would be improved to address identified seepage, stability, erosion, and height concerns through the methods described under Alternative 1. The levees along the Sacramento River would be improved to address identified seepage, stability, and erosion concerns though the measures described under Alternative 1. Rock erosion protection would be placed on the American River levees to reduce the risk of erosion. Due to environmental, real estate, and hydraulic constraints within the American River North and South basins, the majority of the levees would be improved within the existing levee footprint with minimal additional real estate requirements. No additional recommendations for levee improvements in the Natomas Basin are included in the final alternatives. Seepage, stability, and erosion problems in the Natomas Basin were addressed in the Natomas Post Authorization Change Report (PACR). Levee raises were evaluated as part of this GRR but were not carried forward for recommendation as a result of evaluation of the final array of alternatives. It was determined that proposed actions by the State of California and local authorities could render the levee raises unnecessary.

The following sections contain more detailed information on the specific features and reaches included in this alternative.

Sacramento River Levees

All of the levee improvements for the Sacramento River proposed in Alternative 1 would also be included in Alternative 2 with the exception of the 7 miles of levee raising. The inclusion of the Sacramento Weir and Bypass widening in Alternative 2 allows for a reduction in water surface elevation in the Sacramento River to the point where only 1 mile of levee raising would be required. The location of these proposed levees improvements are shown in Figure 3-9.

Erosion concerns would be addressed by either the Sacramento Bank Protection Project method or launchable trench method described in the American River section above. There are about 9.5 miles of bank protection and about 1 mile of launchable trench indentified.

American River Levees

The erosion protection measures identified in Alternatives 1 would also be included in Alternative 2. These measures consist of waterside armoring of the levees to prevent erosion and subsequent damage to the levee. One measure consists of placing rock protection on the bank to prevent erosion. Another

measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it. Another measure being considered in lower velocity reaches is a bioengineering method, which uses plant material and minimal amounts of rock to stabilize the eroded slope and prevent further loss of material. Figure 3-9 identifies the sites where either bank protection or launchable rock would be required. There are about 2 miles of bank protection and about 9 miles of launchable trench indentified.

Tributaries

The measures described for the Tributaries in Alternative 1 would also be constructed as part of Alternative 2.

Sacramento Weir and Bypass

The existing Sacramento Weir and Bypass, which allow high flows in the Sacramento River to be diverted into the Yolo Bypass, would be expanded to roughly twice their current width to accommodate increased bypass flows (Figure 3-9). The increased flow in to the bypass will reduce the flow in the Sacramento River, thus eliminating the need for most of the levee raises downstream. The existing north levee of the Sacramento Bypass would be degraded and a new levee would be constructed approximately 1,500' to the north. The existing Sacramento Weir would be expanded to match the wider bypass. A new weir segment would be built with operable gates. The new north levee of the bypass would include a 300' wide seepage berm on the landside with a system of relief wells. An HTRW site near the existing north levee would be remediated by the non-Federal sponsor prior to construction. Seepage and stability improvements were made to the existing south levee of the Sacramento Bypass as part of the Early Implementation Program (EIP) conducted by the State of California and the West Sacramento Area Flood Control Agency (WSAFCA).

Figure 3-8: Sacramento Weir and Bypass.

Vegetation, Encroachments and Access

Alternative 2 recommends about 1 mile of levee raise compared to the 7 miles of levee raises recommended in Alternative 1. With the exception of this one mile, Alternative 2 will rely on a SWIF to address landside vegetation, encroachment and access issues outside of the construction footprint. Again, outside of the construction footprint, levee safety policy compliance would be a sponsor action and not part of this project. These actions are considered part of the future without project condition and would affect future O&M requirements of the sponsor and its local cooperating agencies. Where the mile of levee raise is required, the construction footprint will extend to the landside levee toe and ten feet beyond to provide construction access. Similar to Alternative 1, a vegetation variance will be sought under Alternative 2 to allow vegetation to remain on the lower waterside levee slope. Figures 3-5, 3-6 and 3-7 display the construction footprints, the areas covered by a vegetation variance and the areas covered by a SWIF or other formal agreement with the sponsors.

Table 3-17: Project Costs – Final Alternative 2 (in $1,000s, October 2014 Price Level, 50-Year Period of Analysis, 3.375% Discount Rate).

Basin	Risk Source	First Costs[3]	IDC[1]	Total Costs	Average Annual Costs (AAC)	O&M	Total AAC
ARS	American	255,142	72,059	327,201	13,637	N/A	13,637
	Sacramento	674,007	168,027	842,034	35,093	N/A	35,093
	Sac Bypass	216,019	22,881	238,900	9,957	N/A	9,957
	Total Basin	**1,145,168**	**262,967**	**1,408,135**	**58,687**	N/A	**58,687**
ARN	American	143,370	23,820	167,190	6,968	N/A	6,968
	Tributaries[2]	180,978	11,355	192,333	8,016	N/A	8,016
	Total Basin	**324,348**	**35,175**	**359,523**	**14,984**	N/A	**14,984**
GRAND TOTAL	**All Basins**	**1,469,515**	**298,142**	**1,767,658**	**73,671**	**494**	**74,165**

[1] Interest during Construction

[2] Includes Arcade, Dry, and Robla Creeks and the Natomas East Main Drainage Canal (NEMDC)

[3] First costs include mitigation for environmental effects within the construction footprint.

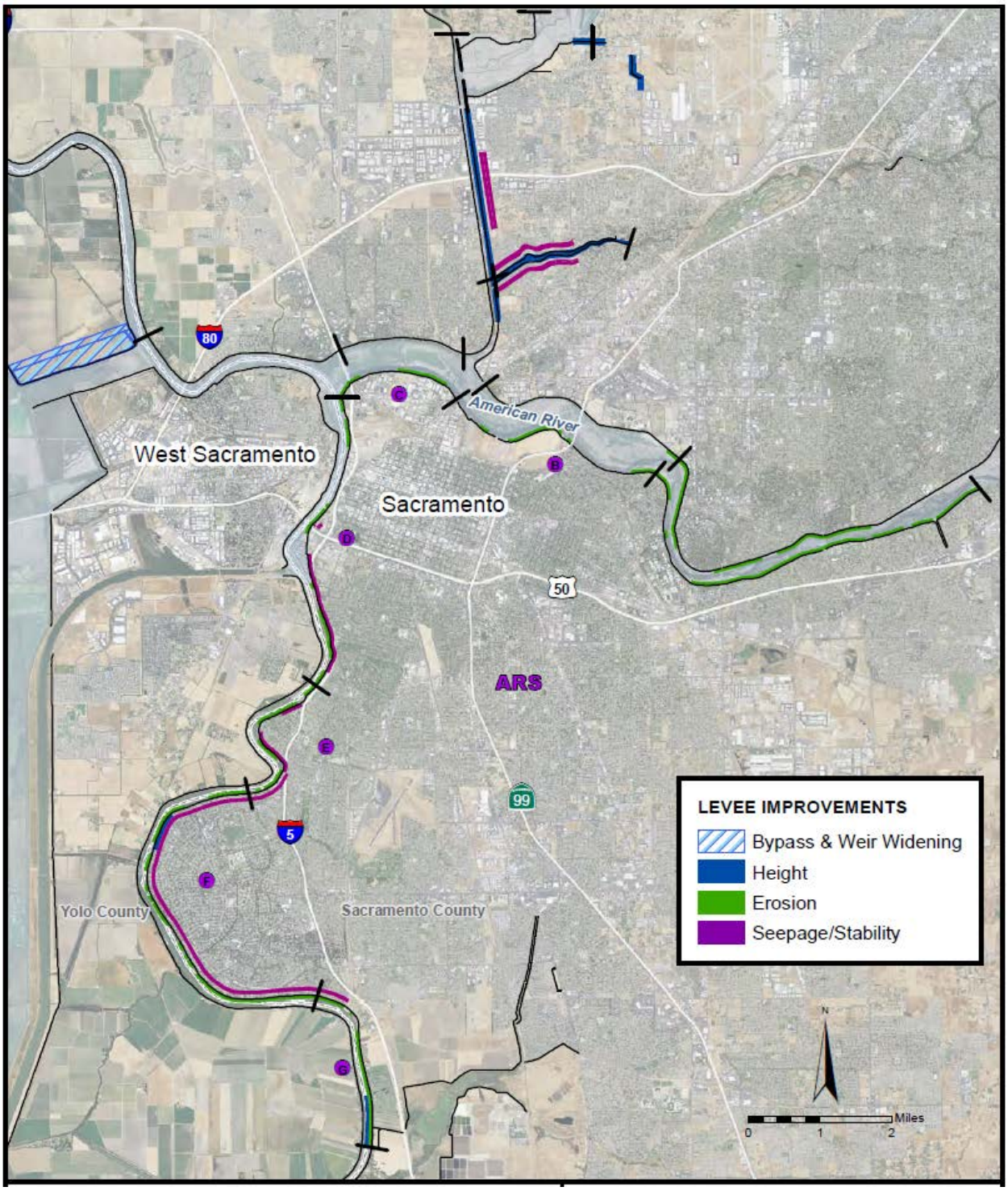

Figure 3-9: Final Alternative 2 – Improve Levees and Widen the Sacramento Weir and Bypass.

3.15 EVALUATION OF FINAL ARRAY OF ALTERNATIVE PLANS

The final alternatives have been evaluated based on refined costs, refined benefits, contributions to the Federal objectives and planning objectives (Tables 3-18 and 3-19), environmental considerations and planning criteria. The results of these analyses indicate that Alternative 1 is the NED plan. These results are displayed in the comparison section below. The evaluation of the final array of alternatives also included consideration of the hydraulic effects of each alternative, consideration of the inclusion of further recommendations for the Natomas Basin, and management of vegetation, access and encroachment issues.

Table 3-18: Evaluation Metric Criteria and Study Objectives.

Study Objectives	Evaluation Metric
(1) Reduce the probability of flooding in the study area	Annual Exceedence Probability (AEP)
(2) Reduce the consequences of flooding within the study area	Reduction in Expected Annual Damages (EAD)
(3) Reduce the risk of damage to critical infrastructure due to flooding	Identify number of critical infrastructure features within the residual floodplain within each basin and availability of emergency facilities during flood events
(4) Encourage the wise use of the floodplain	Conduct E.O. 11988 analysis
(5) Educate the public about ongoing residual risk in the Greater Sacramento Area.	Support ongoing Sponsor activities (Yes/No)

Table 3-19: Evaluation of Final Array of Alternatives.

Objective	Metric		Alternative		
			No Action	Alt 1	Alt 2
Reduce the probability of flooding in the study area	Annual Exceedence Probability[1] (AEP)	ARS	1 in 32	1 in 135	1 in 147
		ARN	1 in 61	1 in 200	1 in 256
Reduce the consequences of flooding within the study area	Residual Expected Annual Damages (EAD)	ARS	332,383	68,037	66,078
		ARN	77,303	45,928	46,360
Reduce the risk of damage to critical infrastructure due to flooding	Critical infrastructure features within 1/100 ACE floodplain		523	0	0
Encourage the wise use of the floodplain	Conduct E.O. 11988 analysis		N/A	Compliant except for Natomas Basin	Compliant except for Natomas Basin
Educate public about residual risk.	Support ongoing Sponsor activities		N/A	Yes	Yes

Notes:
[1]Chance of flooding in an given year

Natomas Basin

As noted in the description of the problems, the vast majority of the study area is located in the natural floodplain of the Sacramento and American Rivers. There are approximately 500,000 people living and working within this floodplain, which is divided into the three separate and distinct basins that make up the study area. Two of these basins, the American River North and American River South have essentially been built out. The remaining area, the Natomas Basin, had largely been an agricultural area until recent times. After having been given assurances that the levees provided adequate flood protection, residential and commercial development increased in this area in the late 1990s and mid 2000s. Subsequent investigations and signs of levee distress during high flows have shown that the area is still at significant risk of flooding. Further flood risk reduction is needed, not only to meet the FEMA regulatory requirements, but also to meet the State of California requirement for 200-year level of protection for urban areas. The Natomas 2010 PAC report includes recommendations for Federal involvement in flood risk reduction through levee improvements which would provide a 1:67 annual exceedence probability (a 1 in 67 chance of being exceeded in any given year). These recommendations were authorized by WRRDA 2014. State and local agencies implemented improvements to more than a third of the perimeter levee system in advance of the Federal authorization. Some of those improvements were previously approved for consideration for credit under Section 104 (WRDA 1986). This draft GRR considered further flood risk reduction features for the Natomas Basin.

Up to this point in the planning process, both of the final alternatives included additional flood risk reduction for the Natomas Basin. Specifically, they were intended to attain FEMA level accreditation as well as meet the State of California's requirement for 200 year level of protection for urban areas. The Administration has concerns with USACE projects enabling growth in floodplains. This additional growth would increase the consequences of flooding within the Basin and therefore increase the future flood risk. Discussions with the project partners determined that, in light of ongoing locally-driven regional planning efforts that are investigating regional-scale flood risk reduction measures to deal with large flood events, this ARCF GRR would not make further recommendations for the Natomas Basin. This is because the other local regional planning efforts could recommend implementation of other measures that would render levee raises around the Natomas Basin unnecessary.

Raising levees around the Natomas Basin is a separate element common to both of the action alternatives in the final array. As such, removal of those features from both alternatives does not change the identification of the NED Plan. Therefore, as a final step following plan comparison, the final array of alternatives was reformulated to remove the Natomas levee raise features.

Vegetation, Encroachment and Access Management

Vegetation and encroachment management, including the establishment of continuous obstruction free landside levee toe access, as defined in Engineer Technical Letter (ETL) 1110-2-583, is an extremely sensitive issue in California's Central Valley. Finding an acceptable balance between flood risk reduction

actions, private property interests, and impacts to ecosystems important to threatened and endangered species is critical to identifying a project that can be successfully implemented.

This issue is particularly acute for the American River Common Features GRR study area where the levees in many places do not meet modern engineering or operations and maintenance standards. However, the engineering analysis conducted to date indicates that levee performance is highly sensitive to the correction of geotechnical deficiencies and erosion and significantly less sensitive to the correction of most vegetation and maintenance issues.

The results of this analysis indicated that the likely time and cost necessary to bring the levees into complete compliance with the ETL though implementation of the TSP would likely negatively impact the overall project implementation schedule therefore delaying the ability to implement levee improvements for the higher risk geotechnical and erosion deficiencies. Additionally, public opposition to complete compliance with the ETL though implementation of the TSP could also potentially negatively impact the overall project implementation schedule.

As a result, USACE has been in discussions with the non-Federal partners concerning the use of a SWIF to address all vegetation, encroachment, and access issues outside of the anticipated construction footprint necessary to correct the identified geotechnical and erosion deficiencies. This approach eliminates the direct schedule and cost connection between these lower risk and high risk deficiencies; however, it still provides a means to ensure steady modernization of the maintenance conditions over time.

Alternative 2 would avoid most of the vegetation, encroachment and access effects that would be part of the Alternative 1 project. However, the SWIF associated with Alternative 2 would have more substantial future effects than the SWIF associated with Alternative 1. The SWIF process would be implemented in accordance with the life cycle management policy of the State's Central Valley Flood Protection Plan which specifies that encroachments would be removed and landside levee access and visibility would be provided in accordance with the State's Urban Levee Design Criteria. The extent of the affected vegetation has been surveyed by USACE (2011). The extent and character of landside access and visibility activities would be determined over time and could involve a combination of acquiring land, establishing visibility corridors, or other measures designed to ensure that levee maintenance agencies can appropriately monitor and respond to signs of levee distress along the landside toe of affected levees.

3.16 COMPARISON OF FINAL ARRAY OF ALTERNATIVE PLANS

Table 3-20 displays the recommended features in each alternative, and the associated problem each feature would address.

Table 3-20: Final Alternatives 1 and 2 – Proposed Improvement Measures by Waterway.

	Final Alternative 1			Final Alternative 2		
	American River	**Tribs[1]**	**Sacramento River**	**American River**	**Tribs[1]**	**Sacramento River**
Seepage Measures	*WRDA 96/99*	Cutoff Wall	Cutoff Wall	*WRDA 96/99*	Cutoff Wall	Cutoff Wall
Stability Measures	*WRDA 96/99*	Cutoff Wall	Cutoff Wall, geotextile and flatten slope	*WRDA 96/99*	Cutoff Wall	Cutoff Wall, geotextile and flatten slope
Erosion Protection Measures	Bank Protection, Launchable Rock Trench	---	Bank Protection, Launchable Rock Trench	Bank Protection, Launchable Rock Trench	---	Bank Protection, Launchable Rock Trench
Overtopping Measures	*WRDA 96/99*	Floodwall/ Levee Raise	Floodwall/ Levee Raise	*WRDA 96/99*	Floodwall/ Levee Raise	Floodwall/ Levee Raise & Sac Weir and Bypass Widening

Notes: 1 – Tribs = Tributaries include NEMDC, Arcade Creek, Dry/Robla Creeks, and Magpie Creek

Table 3-21 compares the final alternatives and how they meet the planning criteria.

Table 3-21: Comparison of Final Array of Alternatives in meeting the Planning Criteria.

Preliminary Alternative	Completeness (Stand alone)	Efficiency (Cost Effective)	Effectiveness (meets objectives)	Acceptability (Implementability)
1. Improve Levees	Yes	Yes	Yes	Yes
2. Improve Levees & Widen Sacramento Weir and Bypass	Yes	No	Yes	Yes

Table 3-22 compares the without project damages, the with project residual damages, the average annual benefits, the benefits prior to the base year and the total average annual benefits for the final alternatives.

Table 3-22: Average Annual Benefits for Final Alternatives 1 and 2 (in $1,000s at October 2014 Price Level, 50-Year Period of Analysis).

	Final Alternative 1			Final Alternative 2		
	American River North	American River South	Total	American River North	American River South	Total
Without Project Damages	77,303	332,383	**409,686**	77,303	332,383	**409,686**
With Project Residual Damages	45,928	68,037	**113,965**	46,360	66,078	**112,438**
Average Annual Benefits	31,375	264,346	**295,721**	30,943	266,305	**297,248**
Benefits Prior to Base Year	0	23,162	**23,162**	0	18,552	**18,552**
Total Average Annual Benefits	**31,375**	**287,508**	**318,883**	**30,943**	**284,857**	**315,800**

Preliminary, screening-level cost estimates were used for economic analysis and are summarized in Table 3-23 below. In addition to project first costs, interest during construction (IDC), which is an economic cost, was also factored into the net benefit/BCR analyses (Table 3-23). Information regarding the construction period (number of years) and the construction schedule for each alternative was used to compute IDC on an annual basis.

Table 3-23: Estimated Costs ($1,000s) for Final Alternatives 1 and 2.[1]

	Final Alternative 1			Final Alternative 2		
	American River North	American River South[2]	Total	American River North	American River South[3]	Total
First Costs	326,041	1,002,232	**1,328,273**	324,348	1,145,168	**1,469,515**
IDC	35,371	259,461	**294,832**	35,175	262,967	**298,142**
Total	361,412	1,261,693	**1,623,105**	359,523	1,408,135	**1,767,658**
Average Annual Costs	15,062	52,584	**67,646**	14,984	58,687	**73,671**
OMRR&R	n/a	n/a	286	n/a	n/a	494
Total Average Annual Costs	**15,062**	**52,584**	**67,932**	**14,984**	**58,687**	**74,165**

Notes:
[1] Based on October 2014 price levels, 3.375 percent discount rate, and a 50-year period of analysis.
[2.] Includes costs of levee raises along the Sacramento River.
[3.] Includes the cost of the Sacramento Weir and Bypass widening.

Investment costs, annual costs, and annual benefits are displayed in Table 3-24 below.

Table 3-24: Comparison of Total Annual Benefits and Costs ($1,000s) for Final Alternatives 1 and 2.[1,2]

Item	Final Alternative 1	Final Alternative 2
Investment Costs:		
Flood Risk Management First Costs	1,328,273	1,469,515
Interest During Construction	294,832	298,142
Total	**1,623,105**	**1,767,658**
Annual Cost		
Interest and Amortization	67,646	73,671
OMRR&R[3]	286	494
Total	**67,932**	**74,165**
Annual Benefits	318,883	315,800
Net Annual Flood Risk Management Benefits	250,951	241,635
Benefit to Cost Ratio	4.7	4.3

Notes:
[1] Based on October 2014 price levels, 3.375 percent discount rate, and a 50-year period of analysis.
[2] Some numbers have been rounded and may be slightly different than those displayed in the appendices.
[3] Operation, Maintenance, Repair, Replacement and Rehabilitation.

Based on the above comparison, Alternative 1 is confirmed as the plan which maximizes net benefits and is therefore identified as the NED plan. Alternative 2 has been identified by the non-Federal sponsor as the Locally Preferred Plan (LPP). The sponsor supports the LPP based on its ability to reduce the water surface elevation in the river adjacent to two urban areas, increase the regional flexibility of the flood management system, provide benefits to downstream communities in the form of reduced water surface elevations in the Sacramento River, and improve natural floodplain values by increasing the areas exposed to overbank flooding.

3.17 EXECUTIVE ORDER (EO) 11988

The objective of the study is to reduce flood risk within the study area. EO 11988 has an 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". The study is responsive to the EO 11988 objective because the proposed features focus on reducing the threat of flooding to the existing urban area. These features would reduce the hazard and risk associated with floods thereby minimizing the effects of floods on life safety, health, and welfare, and would preserve the natural and beneficial values of the base floodplain. Additional discussion of the EO is located in Chapter 4.

3.18 SYSTEM OF ACCOUNT ANALYSIS AND COMPARISON

The system of accounts is a set of categories which provide a comprehensive framework to demonstrate both the positive and negative effects of each plan. The intent is to provide decision makers with plan rankings based on advantages and disadvantages of each alternative. In addition, the accounts provide a visual display and assessment of the effects as required by NEPA.

3.18.1 National Economic Development (NED)

The NED account includes the estimates of project benefits and costs used to calculate net economic benefits. A full display of the analysis for the NED account is located in the Economic Appendix. This analysis establishes the economic feasibility of each plan and is used to identify Federal interest. The NED analysis dates back to the Flood Control Act of 1936 in which Congress determined that the Federal Government should participate in flood management and determine the benefits and costs of those activities. The analysis has been documented and refined over the years in various publications, including the the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies (P&G)*. It is in the P&G that the following additional accounts of environmental quality (EQ), regional economic development (RED) and other social effects (OSE) are identified.

3.18.2 Environmental Quality (EQ)

The EQ account displays the effects on the ecological, cultural, aesthetic, and other attributes of natural and cultural resources. The environmental effects of the various alternatives are classified as direct and indirect. Direct effects result immediately from constructing and operating the project. Indirect effects are effects caused by the action that are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air, water, and other natural systems, including ecosystems. Additional information on the EQ analysis is captured in the Environmental Impact Statement/Environmental Impact Report (EIS/EIR) accompanying this report.

3.18.3 Regional Economic Development (RED)

The RED analysis measures changes in the distribution of regional economic activity that result from alternative plans. Changes in economic activity and employment that occur locally or regionally when a project is implemented are excluded from the NED Account to the extent that they are offset through transfers of this economic activity and employment to other regions of the Nation. The effects on the regional economy, including income effects, income transfers, and employment effects not addressed in the NED account are evaluated in the RED. Two measures of the effects of the plan on regional economies are used in the account: regional income and regional employment. Additional information on the RED analysis performed for this study can be found in Attachment C of the Economic Appendix.

3.18.4 Other Social Effects (OSE)

OSE relates to the quality of life, health, and safety in the community. Destruction or disruption of the built environment, esthetic values, community cohesion, and availability of public facilities and services has also been analyzed. These include displacement effects to people and businesses, the general population (including minorities and special interest groups), and public health and safety. Assessments of beneficial and adverse effects are based on comparisons of the with project alternative to the without project alternative conditions expected to prevail in the future in the absence of the project. The social effects of the alternatives have both direct effects and indirect effects. Direct effects result immediately from constructing the project. Indirect effects result from the effects of the project on existing patterns, including ecosystem patterns, in the study area. Additional information on the OSE analysis performed for this study can be found in the Economic Appendix.

Table 3-25: Summary System of Accounts Comparison of Final Array of Alternative Plans.

	NO ACTION	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 2
1. PLAN DESCRIPTION			
	The No Action provides no physical project constructed by the Federal Government or local interests.	The NED plan reduces the risk of flooding within the study area by improving levees.	The LPP plan reduces the risk of flooding to the study area by improving levees and widening the Sacramento Weir and Bypass.
2. IMPACT ASSESSEMENT			
A. National Economic Development (NED)			
1. Project Cost	$0	$1,623,105,000	$1,767,658,000
2. Annual Cost	$0	$67,932,000	$74,165,000
3. Total Annual Benefit	$0	$318,883,000	$315,800,000
4. Annual Net Benefits	$0	$250,951,000	$241,635,000
5. Benefit - Cost Ratio	N/A	4.7	4.3
B. Environmental Quality (EQ)			
1. Air/Noise	No construction activities present; Normal noise levels created by traffic, business, and industrial activities.	Temporary increased noise levels and air quality effects during estimated 10 year construction period.	Temporary increased noise levels during estimated 10 year construction period. Slightly higher air quality effects than NED due to additional construction associated with Sacramento Bypass expansion.
2. Water Quality	Significant impacts if a flood event were to occur as urban runoff would contaminate rivers, streams, and eventually damage Delta estuary.	Temporary decreased water quality due to increased turbidity during in-water construction of erosion protection measures.	Same as NED.

	NO ACTION	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 2
3. Biological Resources	Long term erosion would cause the loss of habitat along the waterways.	Loss of riparian habitat due to construction – replacement habitat will take many years to provide similar value of those removed.	Similar to NED with a reduced quantity of habitat loss due to the reduced length of levee raises. Potential to create habitat within the expanded Sacramento Bypass.
4. Threatened & Endangered Species	Potential loss of habitat as erosion of berms and levees will result in vegetation loss in flooded areas.	Temporary impact to endangered fish species, valley elderberry longhorn beetle, and giant garter snake. Possible impact to vernal pools near Magpie Creek. Also impacts to avian species nesting and foraging habitat.	Similar to NED with additional loss of habitat along the Sacramento River associated with expansion of the Weir, but less impact from levee raises downstream. There is potential to create habitat within the expanded bypass for fish species and GGS.
5. Cumulative Effects	No increased effects.	Potential cumulative impacts to noise and recreation could be adverse if the NED is constructing in close proximity to other local projects, such as across the river from West Sacramento GRR construction sites. Cumulative impact contributing to air quality and GHG emissions in the Sacramento region.	Same as described for NED.
6. Cultural Resources & Historic Properties	Long term erosion, inundation, and/or scouring could cause adverse effects to existing cultural resources.	Potential adverse effects to existing cultural resources are significant and unavoidable under CEQA. Execution of a Programmatic Agreement and Historic Property Treatment Plan(s) reduces effects to less than significant under NEPA, and resolves these effects under Section 106 of the NHPA.	Same as described for the NED, with one additional known historic property potentially adversely affected, the Sacramento Weir.
7. Recreation	Loss of recreation facility in American River Parkway with continued erosion of berm.	Short term impacts during construction.	Same as described for NED.
8. Land Use	Loss of Parkway land with continued erosion of Parkway berm.	Conversion of private property to flood risk management features (this will be a taking of homes).	Similar to NED plus the possible conversion of 300+ acres of farm land to floodway.

	NO ACTION	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 2
9. Socio-economics	Continue high risk of levee failure and flooding of the Sacramento Metropolitan area and the State Capitol.	Temporary disruption to the community during construction.	Same as described for NED.
C. Regional Economic Development (RED)			
1. Construction Activities	Future flooding would destroy part of infrastructure resulting in a loss in the region's ability to produce goods and services. Little to no RED benefits.	Value added: temporary jobs added within the region and jobs added within the State. Adds to the gross regional product for the State and Nation.	Slightly higher value added due to additional construction work: temporary jobs added within the region and jobs added within the State. Adds to the gross regional product for the State and Nation.
2. Future Residential Development	New development must be built above the 1% flood elevation, which is not economical to accomplish. Effectively creates a building moratorium in Natomas. ARN and ARS basins already built out.	Levee construction would decrease the risk of flooding to the established urban areas.	Levee construction would decrease the risk of flooding to the established urban areas.
3. General Economic Gains	Emergency response and recovery activities and reconstructions and repairs. The economic stimulus generated would only be temporary and minor compared to overall losses.	The with-project regional economic impacts would emerge from more gradual spending over an extended timeframe. Levee construction is expected to take place over a 10-year period.	The with-project regional economic impacts would emerge from more gradual spending over an extended timeframe Levee construction is expected to take place over a 10-year period. Benefits to small communities downstream of the project area along the Sacramento River in terms of reducing the water surface elevation.
D. Other Social Effects (OSE)			
1. Life, Health, and Safety	Continued flood risk in the City of Sacramento and surrounding areas.	The plan significantly reduces risk to life, health and safety.	The plan significantly reduces risk to life, health and safety.
2. Community Cohesion (displacement of people & businesses)	Future flooding would displace selected businesses and subject the community to potential catastrophic flood risk.	Reduced risk to homes and businesses within the City of Sacramento.	Reduced risk to homes and businesses within the City of Sacramento and surrounding areas.

	NO ACTION	FINAL ALTERNATIVE 1	FINAL ALTERNATIVE 2
3. Residual Risk	Residual risk remains high throughout the study area	Residual Risk reduced in the City of Sacramento. However increased water surface elevation against urban levees.	Residual Risk reduced. Directs floodflows away from urban centers of Sacramento and West Sacramento to rural bypass areas.

3.19 PERFORMANCE OF THE FINAL ARRAY OF ALTERNATIVES

The estimated reduction in the probability of flooding provided by each plan, based on the Corps' risk analysis methods, is measured in two different ways. The first measure is the Annual Exceedence Probability (AEP), which describes the potential that a given location will experience flooding from the studied water sources (typically excluding interior flooding/storm sewer system performance) on an annual basis. The second measure is the assurance (i.e. non-exceedence probability) that a given flow will NOT result in flooding at a given location. The AEP combines the probabilities of all flow events that could possibly cause flooding into a single aggregate value, whereas assurance values relate to (i.e. are "conditional" to) flows with specific likelihoods of occurring (e.g. the 1/100 or 1% annual chance exceedence event, aka the 100-yr return interval flow or "100-yr flood"). In other words, assurance values provide a measure of how "assuredly" a location is protected from a specific flood.

Table 3-26 presents the performance statistics under both without-project and with-project conditions for each index point, basin and alternative. The Annual Exceedence Probability (AEP) values under with-project conditions indicate that each alternative provides significant risk reduction in terms of the chance of flooding in any given year.

Table 3-26: Assurance – Without-Project and With-Project Conditions for Final Alternatives 1 and 2.

Basin	Index Point	Assurance by Annual Chance Exceedence Event								
		Without			ALT. 1 (WITH SAC RAISES)			ALT. 2 Sac Bypass Widening		
		4% (25yr)	1% (100yr)	.5% (200 yr)	4% (25yr)	1% (100yr)	.5% (200 yr)	4% (25yr)	1% (100yr)	.5% (200 yr)
ARS	ARS A (American Riv)	93%	77%	39%	98%	91%	64%	98%	91%	65%
	ARS F (Pocket)	75%	69%	50%	95%	95%	93%	95%	95%	94%
ARN	ARN A (American Riv)	92%	75%	53%	99%	90%	65%	98%	89%	63%
	ARN E (Arcade Creek)	90%	68%	34%	99%	94%	74%	99%	95%	83%

3.20 THE NED PLAN

The NED plan has been optimized to ensure that it is the plan which reasonably maximizes net benefits. This optimization has occurred both for the incremental addition of features to the plan and the level of performance for these features. Specific refinements corresponding to different annual chance exceedence (ACE) water surface elevations were conducted to identify the optimized combination of levee improvements to address the identified levee problems related to seepage, stability, erosion and overtopping. These refinements used a building block approach to add improvements to each other, starting with the seepage and stability work which represents the largest risk factor. The next optimization added erosion protection to the seepage and stability work (but no levee raises). The next increment adds the levee raising to address overtopping which is the plan identified as the NED Plan. Finally, various scenarios larger than the NED were analyzed. Details of the NED optimization are described below.

Alternative 0.25 – Levee failure as a result of seepage and stability issues pose the greatest risk of flooding in the study area. For this scenario, only seepage and stability improvements were implemented. No erosion protection was implemented on the American River and the Sacramento River. This scenario is shown on the Net Benefit curve below as Plan 0.25. The cost of the alternative was greatly reduced compared to the identified NED, however the benefits were more significantly reduced, which comprehensively, greatly reduced the net benefits.

Alternative 0.5 - This plan includes seepage, stability, and erosion improvements, but does not include levee raising or any other measure to address overtopping. This plan only provides approximately 1/100 ACE performance because it does not address levee overtopping. Therefore, the costs and benefits are less as compared to the identified NED and there is less net benefit as well. The seepage, stability, and erosion improvements included in this alternative correct legacy problems with the levees attributable to the construction methodology of utilizing dredged material from the adjacent river to construct the levees (which left inherent seepage, stability, and erosion problems). Therefore, the improvements for seepage, stability, and erosion are the same for flood events more frequent than the 1/100 ACE.

Alternative 1.0 – This is the identified NED.

Alternatives larger than Alternative 1.0 - (Improvements beyond the 1/200 ACE water surface elevation) Improvements to Folsom Dam are intended to control approximately a 1/200 ACE flood event with a peak release of 160,000 cfs. Beyond this 1/200 ACE flood event, releases from Folsom increase quickly to the point where the downstream capacity is exceeded. Methods to convey more flow down the American River would take much more substantial improvements, such as vast levee setbacks, levee raises and massive amounts of rock to accommodate the high velocities associated with flows above 160,000cfs. These methods are impractical because of the huge cost of such measures and the relatively small increase in benefits. An alternate measure to manage a flood event more significant than a 1/200 ACE would be construction of upstream storage above Folsom Dam. Adding upstream storage on the American River would still require the levee improvements included in Alternative 1.0. The costs

and benefits from the preliminary Alternative 4 (Alternative 1.0 plus upstream storage) have been updated to 2014 price levels and Alternative 4 is shown on the Net Benefits graph below. In order to achieve any measurable increase in project outputs, these scenarios would equate to a considerable cost jump from the currently identified NED Plan. The sponsor's goal is to achieve FEMA level accreditation and State of California SB 5 criteria for 200 year level of protection. The identified LPP meets that goal, so a larger plan was not pursued. Because the identified NED Plan is the most cost-effective, Federally-supportable plan that is no greater in scale (FRM outputs) than the LPP, the identified NED Plan is also the appropriate basis for determining the maximum Federal cost-share for the LPP.

Conclusion: Plans smaller than Alternative 1, have less cost and less benefit, and plans larger than Alternative 1 cost more and have slightly more benefits but fewer net benefits. Therefore, Alternative 1, designed for a 1/200 ACE water surface profile is optimized and is the NED.

The average annual benefits (AAB) of the LPP are essentially the same as the NED Plan. The NED plan has average annual benefits of $318,883 while the LPP has AAB of $315,800. The cost share would be based on the most cost effective plan that provides the same level of out puts as the LPP. The most cost effective plan is the NED Plan.

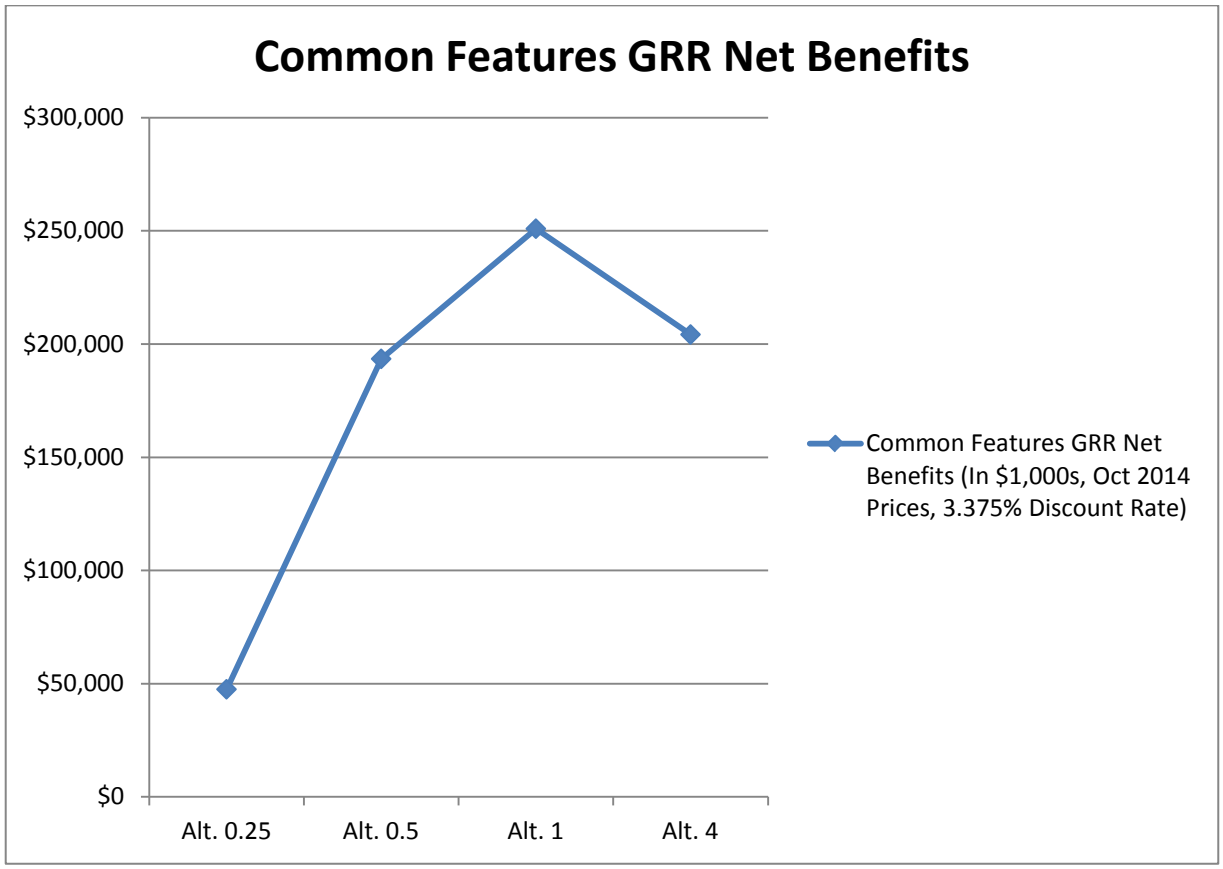

Figure 3-10: Net Benefits of the Optimized Plan.

3.21 THE TENTATIVELY SELECTED PLAN

The preliminary recommendation of the District Engineer of the Sacramento District, U.S. Army Corps of Engineers is that the LPP plan be considered the Tentatively Selected Plan (TSP) and authorized for implementation as a Federal project.

The non-Federal sponsor will agree to provide all lands, easements, rights-of-way, relocations, and suitable borrow and disposal areas. The non-Federal sponsor will also assume responsibility for operating, maintaining, replacing, repairing, and rehabilitating (OMRR&R) the project. The non-Federal sponsor will publicize floodplain information in the areas concerned and provide this information to zoning and other regulatory agencies for their guidance and leadership in preventing unwise future development in the floodplain and in adopting such regulations as may be necessary to ensure compatibility between future development and protection levels provided by the project.
The TSP is not the NED plan. The Sacramento District has submitted a request for a deviation from the policy that requires recommendation of the NED plan.

4 - THE TENTATIVELY SELECTED PLAN

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

4.1 FEATURES AND DESCRIPTION OF THE TENTATIVELY SELECTED PLAN (TSP)

The features included in the 1996 and 1999 ARCF authorizations, as well as the Natomas features authorized by WRRDA 2014 are all part of the future without project condition. The tentatively selected plan includes additional features to reduce flood risk in the ARCF study area. The principal features of this plan are:

1. Sacramento River: Construction of about 9 miles of slurry cutoff walls to address levee seepage and stability problems and about 10 miles of rock bank protection to address erosion problems along the Sacramento River east levee, as well as about 2.5 miles of geotextile stabilized slope and 2 miles of slope flattening to address levee stability and less than 1 mile of levee raise.
2. American River: Construction of rock bank protection and launchable rock trenches to address erosion problems along 4 miles of the right (north) bank and 7 miles of the left (south) bank of the American River.
3. Eastside Tributaries: Construction of about 4 miles of slurry cutoff walls to address levee seepage and stability problems and 7.5 miles of levee raises to address potential overtopping of floodwaters along the NEMDC, Arcade Creek, and Dry Creek levees.
4. Sacramento Bypass: Widen the Sacramento Weir and Bypass by 1,500 feet to reduce the water surface elevation in the Sacramento River and allow more water to flow into the Bypass system. The existing Sacramento Weir and Bypass are shown in Figure 4-1 below.

Figure 4-1: Sacramento River overflowing in to the Sacramento Bypass.

Table 4-1 summarizes the recommended levee improvements by waterway. A more detailed discussion of the recommendations for each waterway is included in the subsequent sections below.

Table 4-1: TSP Proposed Improvement Measures by Waterway.

	Sacramento River	American River	East Side Tributaries[1]
Seepage Measures	Cutoff Wall	*WRDA 96/99*	Cutoff Wall
Stability Measures	Cutoff Wall, Geotextile, and Slope Flattening	*WRDA 96/99*	Cutoff Wall and Geotextile
Erosion Protection Measures	Bank Protection, Launchable Rock Trench	Bank Protection, Launchable Rock Trench	---
Overtopping Measures	Levee Raise and Sacramento Weir and Bypass Widening	*WRDA 96/99*	Floodwall/Levee Raise

Notes: 1 East Side Tributaries include NEMDC, Arcade Creek, Dry/Robla Creeks, and Magpie Creek

The features of the TSP are displayed in Figure 4-2.

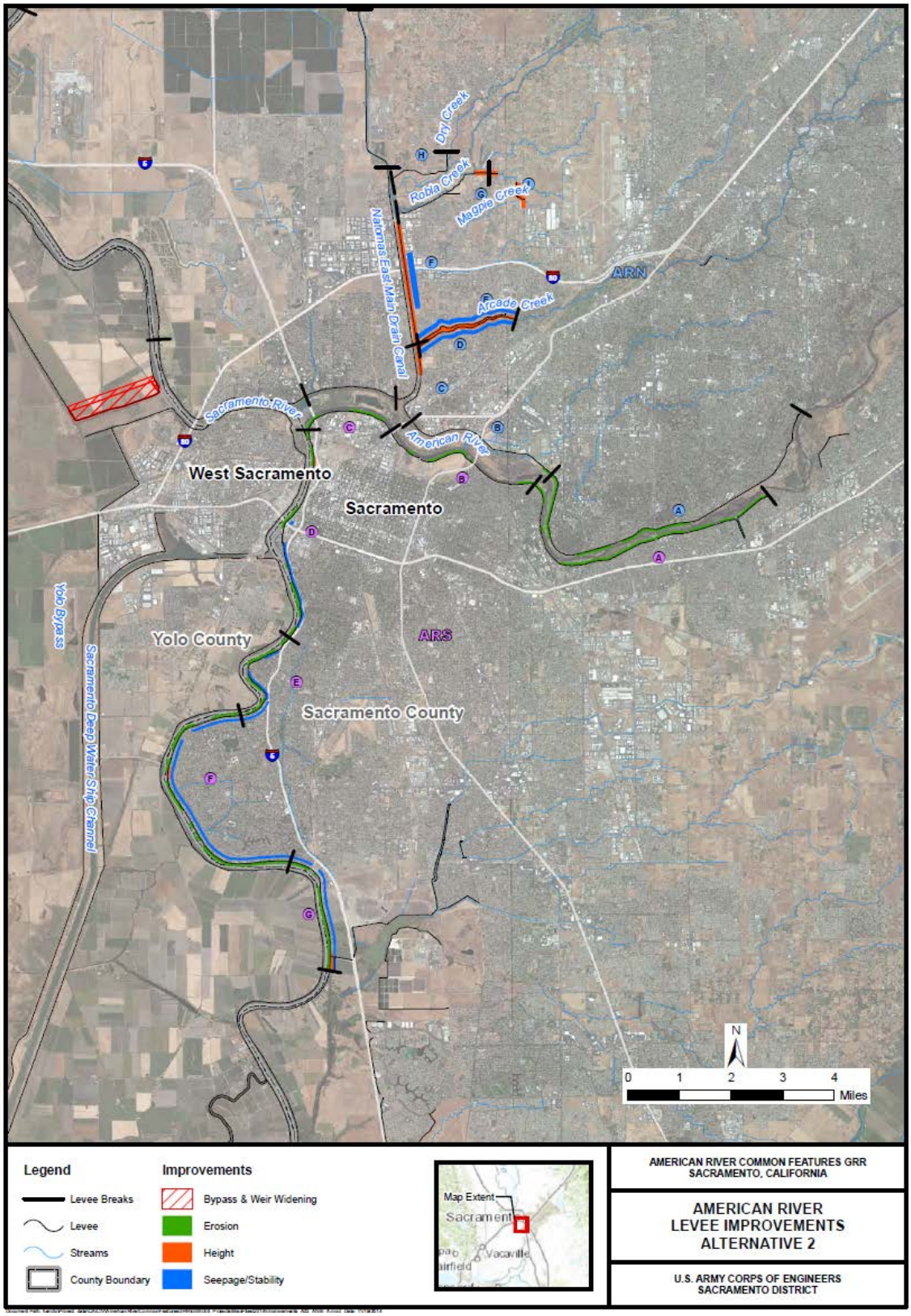

Figure 4-2: TSP Recommended Features.

4.1.1 Sacramento River

Levees along the Sacramento River require improvements to address seepage, slope stability, and erosion. In addition, a levee segment almost 1 mile long requires a raise. The features proposed for the Sacramento River levees include: (1) cutoff walls, (2) levee geometry measures, and (3) bank protection. These measures are described in detail in the subsections below.

Cutoff Walls

To address seepage concerns, a cutoff wall will be constructed through the levee crown. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 80 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Levee Geometry

Where the existing levee cross section does not meet the levee design requirements, (as discussed later in Section 4.2) slope flattening, crown widening, and/or a levee raise is required. This improvement measure addresses problems with slope stability, geometry, and overtopping. The levee crown would be widened to 20 feet and 2:1 landside and waterside slopes would be established. The existing levee centerline would be shifted landward, where necessary in order to meet the Corps' standard levee footprint requirements. The levee crown patrol road would be re-established. It is estimated that about 2 miles of slope flattening would be required in scattered locations along the Sacramento River.
In the lower reach of the Sacramento River, near the town of Freeport, the steepness of the levee slope has created a slope stability problem. To address this problem, the levee would be partially degraded and reconstructed with a geosynthetic material for about 2.5 miles to reinforce the levee slope within the existing levee footprint where possible.

Bank Protection

Bank protection on the Sacramento River would be addressed via either conventional bank protection or the launchable rock trench method. The conventional bank protection measure for the Sacramento River consists of placing rock protection on the bank to prevent erosion. This measure entails filling the eroded portion of the bank, when necessary, and installing revetment along the waterside levee slope and streambank from streambed to a height determined by site-specific analysis. After the erosion protection work has been completed, a small planting berm would be constructed in the rock when feasible to allow for some revegetation of the site.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it. Figure 4-8 shows a typical cross section of launchable rock trench. All launchable rock trenches would be constructed outside of the natural river channel. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Small trees could be permitted on the berm if planted outside the specified vegetation free zone as required by ETL 1110-2-583.

Levee Safety Compliance on the Sacramento River

In an effort to modernize the levee system to meet current engineering standards, vegetation and encroachment issues (including landside levee access) in the study area will be resolved through a combination of construction actions associated with implementation of the recommended plan and formal agreements (such as a Systemwide Improvement Framework known as a SWIF) which allow specific vegetation and/or encroachments to remain in place permanently or defer their resolution to some future date. In the case of construction associated with the recommended plan, vegetation and encroachment removal would only occur within the construction footprint. Outside of the construction footprint, the non-Federal sponsors will apply for a SWIF separately from this project to ultimately bring levees into compliance with the Engineer Technical Letter (ETL) 1110-2-583 "*Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures*".[1] In the case of a formal agreement, the integrated use of a SWIF and a variance from vegetation standards would both be required to ultimately assure compliance with the ETL.

A variance to ETL 1110-2-583 would be sought to allow vegetation to remain on the lower half of the waterside slope along the Sacramento River and NEMDC, Arcade, Dry/Robla, and Magpie Creeks. If granted, the variance would allow for vegetation to remain on the lower waterside slope and within the waterside 15 foot vegetation-free zone. The Variance requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained. An evaluation of underseepage and waterside embankment slope stability was completed for this study.

This analysis was completed for the section/index point at levee mile (LM) 5.92, on the Sacramento River which was chosen for the Variance analyses because it was considered to be representative of the most critical channel and levee geometry, underseepage and slope stability conditions, and vegetation conditions. The cross-section geometry of the index point incorporated tree fall and scour by using a maximum depth of scour for cottonwoods as approximately 11.0 feet; the associated soil removed was projected at a 2:1 slope from the base of the scour toward both the landside, and waterside slopes. The base scour width was equal to the maximum potential diameter at breast height (dbh) of cottonwoods (12.0 feet) projected horizontally at a depth of 11.0 feet below the existing ground profile. The results

[1] Section 3013 of WRRDA 2014 (Pub.L. No. 113-121) contains a requirement to conduct a review of current Federal policy relating to levee vegetation that may affect the guidelines presented in ETL 1110-2-583.

show that the tree fall and scour did not significantly affect levee performance and that the levee meets Corps seepage and slope stability criteria considering the seepage and stability improvement measures are in place ("with project" conditions). Therefore, it is a reasonable conclusion that with a Variance to allow vegetation to remain as stated above, the safety, structural integrity, and functionality of the Sacramento River levee and levees along the tributaries would be retained.

The SWIF Policy was released by the Corps in November 2011 with guidance to local maintaining agencies for obtaining a SWIF. The intent of the SWIF is to collaboratively work with resource agencies and levee sponsors to transition existing levees to Corps standards while maintaining PL 84-99 rehabilitation assistance and adhering to the ESA and other environmental laws. The SWIF is a two-step process completed by the applicant that is composed of a Letter of Intent, which is followed by submission of a SWIF plan. The SWIF process allows eligible local sponsors to implement levee improvements in a prioritized "worst first" way to optimize the achievement of risk reduction. The Corps acknowledges that implementing system-wide improvements will need to be done within a collaborative intergovernmental framework and that it will take time to develop and implement improvements in complex situations. Challenges include ensuring that both environmental and levee safety imperatives are adequately served.

The construction footprint for the majority of the levee improvements along the Sacramento River will be confined to the top half of the levee and areas along the waterside bank where erosion protection is required. This is displayed in Figure 4-3 below. Vegetation and encroachments within this footprint will be removed during construction; however, the vegetation on the waterside of the levee would largely remain in place and the rock erosion protection would be placed around the existing vegetation. For levee segments along the Sacramento River where levee raises are required, the construction footprint would extend to the landside levee toe and a certain distance beyond that to allow for construction access. Vegetation and encroachments on the landside of the levee in these areas would be removed as part of construction of the levee raise.

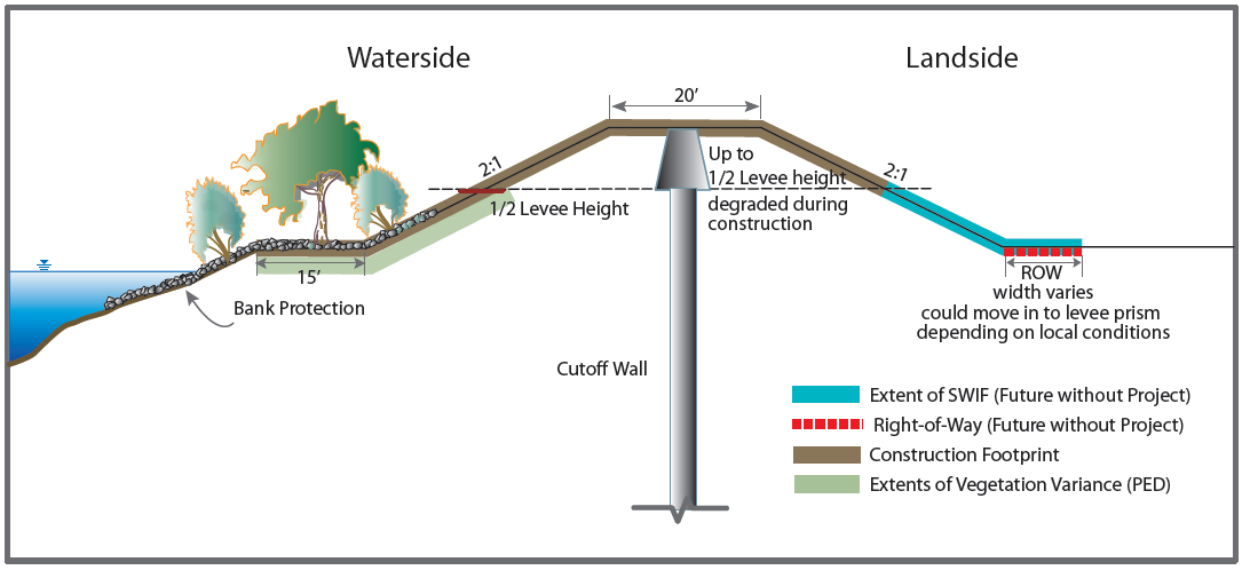

Figure 4-3: TSP Levee Safety Compliance for Segments with No Recommended Levee Raise.

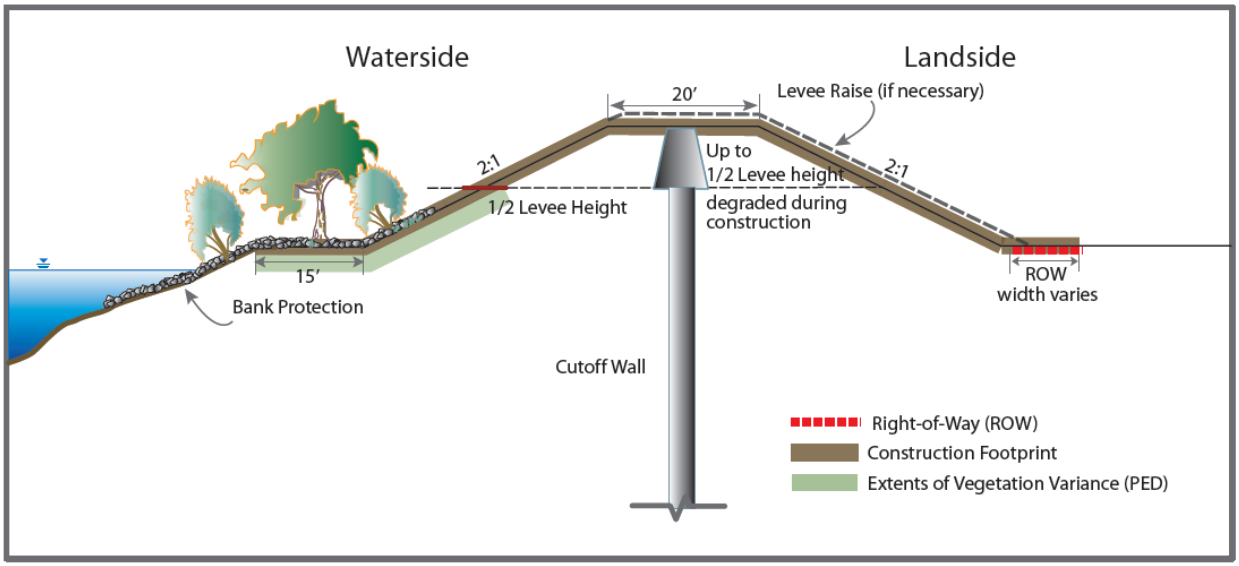

Figure 4-4: TSP Levee Safety Compliance for Segments with Recommended Levee Raise.

4.1.2 American River

Levees along the American River require improvements to address erosion. The proposed measures for these levees consist of waterside armoring to prevent erosion of the river bank and levee, which could potentially undermine the levee foundation. Figure 4-5 identifies the reaches where erosion protection measures would be required. There are two measures proposed for the American River levees: (1) bank protection, and (2) launchable rock trench. Both of these measures are described in detail in the subsections below.

An initial assessment with regards to the method of bank stabilization has been made for this document. During detailed design, the Corps will coordinate closely with the county, state, and federal agencies responsible for managing the resources of the parkway in selecting which method of bank stabilization should be deployed. In carrying out this effort, the Corps will coordinate through the formal and informal processes that have been created to facilitate management of the parkway in application of the above criteria. Where erosion protection is needed to meet established flood risk reduction objectives, the selection of the method of protection will be based on a determination of which method would do the most to protect valuable parkway land, fish and wildlife resources, and recreational facilities considering both the short term impacts of construction and the long term effects of any mitigation measures included in the design of the project.

Bank Protection

This measure consists of placing rock revetment on the river's bank, and in some locations on the levee slope, to prevent erosion. This measure entails installing revetment along the waterside levee slope and streambank based on site-specific analysis. Figures 4-6, 4-7, and 4-8 show a time lapse sequence of a site on the American River where bank protection has been constructed. Figure 4-8 shows a typical cross section of bank protection. In most cases large vegetation would be permitted to remain at these sites. After the erosion protection work has been completed, a small planting berm would be constructed in the rock where feasible to allow for revegetation of the site.

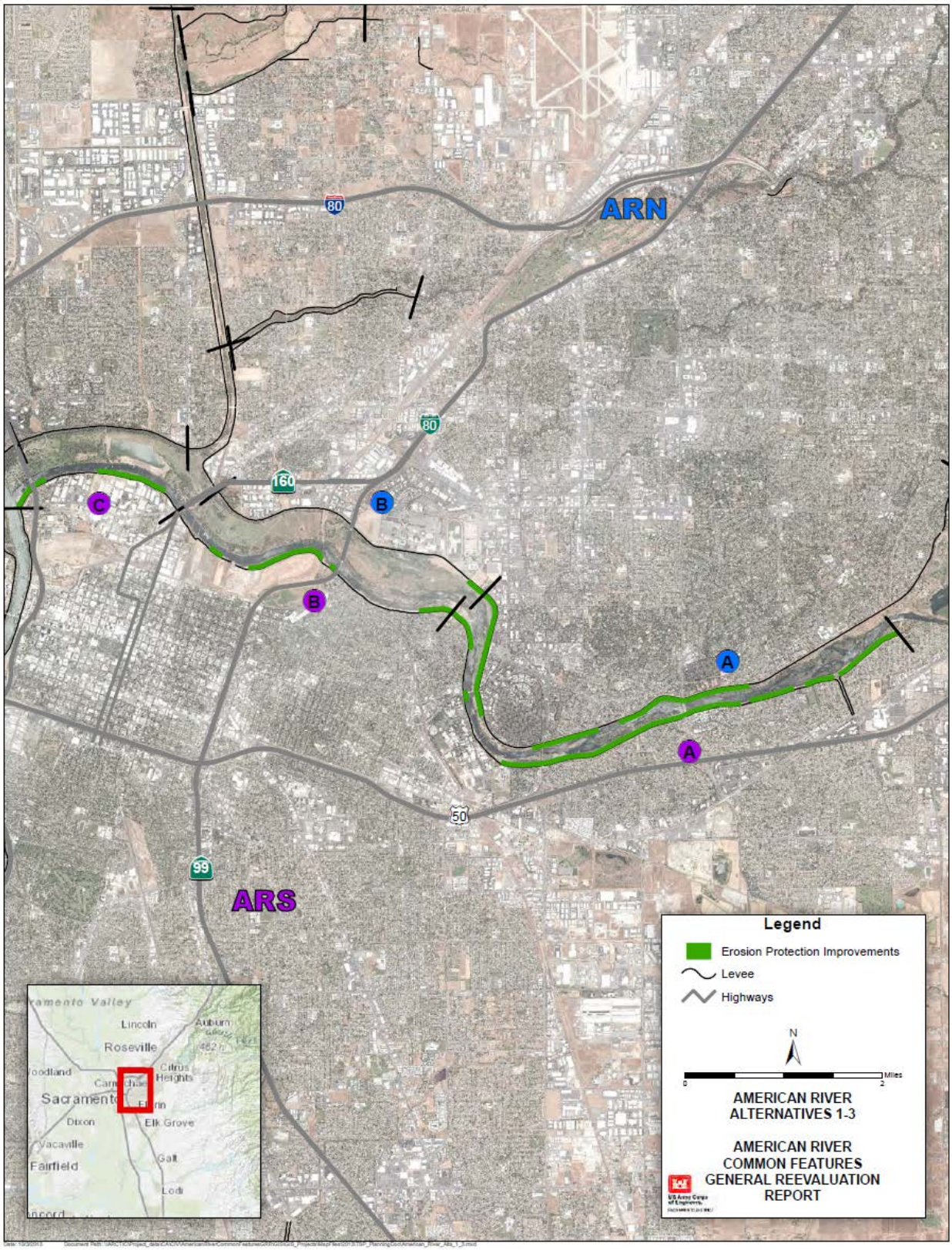

Figure 4-5: TSP Recommended Features along the American River.

Figure 4-6: American River Levee near California State University, Sacramento, 2001.

Figure 4-7: American River Levee near California State University, Sacramento, 2005.

Figure 4-8: American River Levee near California State University, Sacramento, 2010.

Launchable Rock Trench

This measure includes construction of a launchable rock filled trench, designed to deploy once erosion has removed the bank material beneath it. Figure 4-9 shows a typical cross section of launchable rock trench. All launchable rock trenches would be constructed outside of the natural river channel. All disturbed areas would be reseeded with native grasses and small shrubs where appropriate. Small trees could be permitted on the berm if planted outside the specified vegetation free zone as required by ETL 1110-2-583.

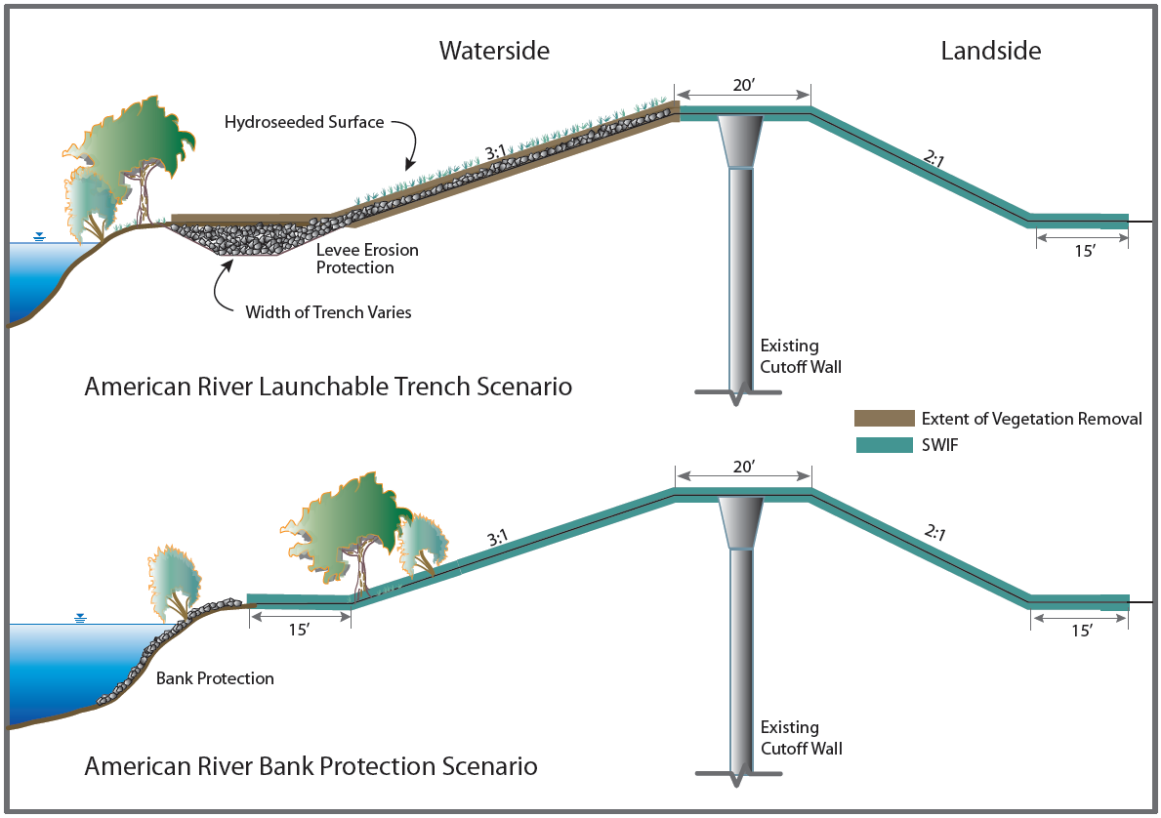

Figure 4-9: Bank Protection and Launchable Rock Trench Typical Design.

Levee Safety Compliance on the American River

Compliance with levee safety criteria for vegetation, access and encroachments will be limited, as with the other study reaches, to the construction footprint. The construction footprints of the erosion protection features on the American River are limited to the waterside levee slope or the actual river bank. As shown in Figure 4-9, all other vegetation, access and encroachments issues outside of the construction footprint would be brought into compliance with Levee Safety Policy through the use of a System-Wide Improvement Framework (SWIF) by the local maintaining agency, the American River Flood Control District (ARFCD).

4.1.3 East Side Tributaries

Natomas East Main Drain Canal (NEMDC)

The east levee of the NEMDC requires improvements to address seepage and stability at locations where historic creeks had intersected the current levee alignment. A conventional open trench cutoff wall would be constructed at these locations to address the seepage and stability problems. The total length of this cutoff wall would be about 1.5 miles. The open trench cutoff walls would be constructed as described for the Sacramento River levee in Section 4.1.3.3 above.

The NEMDC east levee also has height issues which will be addressed with a levee raise and a floodwall totaling about 3 miles. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown for construction (Figure 4-10). The height of the floodwalls varies from 1 to 2 feet, as required by water surface elevations. The waterside slope would be re-established to its existing slope and the levee crown would grade away from the wall and be surfaced with aggregate base.

In addition to the measures discussed above, in areas where the current levee geometry does not meet current Corps standards, measures would be implemented to bring these levees into compliance. These measures include widening the crown to 12 feet, when necessary, and flattening slopes that are steeper than 2V:1H.

Arcade Creek

The Arcade Creek levees require improvements to address seepage, slope stability, and overtopping when the event exceeds the current design. A cutoff wall would be constructed to address seepage for about half of the total length of the creek equaling about 1.3 miles on both the north and south banks. There is a ditch adjacent to the north levee at the landside toe which provides a shortened seepage path, and could affect the stability of the levee. The ditch would be replaced with a conduit or box culvert for about 0.5 mile and then backfilled. This would lengthen the seepage path and improve the stability of the levee. The Arcade Creek south levee has a slope stability problem in some areas due to the steepness of the levee slope. To address this problem, the levee would be partially degraded and reconstructed with a geosynthetic material to reinforce the levee slope.

The Arcade Creek levees upstream of Norwood Avenue have existing floodwalls, however there remains a height issue in this reach. A 1 to 4-foot floodwall and levee raise for about 2 miles on both the north and the south banks would allow the levees to pass flood events greater than the current design level. Constructing the floodwall raise would require doweling into the existing concrete floodwall and adding reinforced concrete to the floodwall section. Construction of the levee raise would be consistent with the description for the Sacramento River levee raises.

In addition to the measures discussed above, in areas where the current levee geometry does not meet current Corps standards, measures would be implemented to bring these levees into compliance. These measures include widening the crown to 12 feet, when necessary, and flattening slopes that are steeper than 2:1.

Dry and Robla Creeks

The Dry and Robla Creeks levees require improvements to address overtopping for when flood events exceed the design level. Height improvements would be made with a floodwall raise on the left bank levee for about 0.5 mile. The floodwall would be placed at the waterside hinge point of the levee and would be designed to disturb a minimal amount of waterside slope and levee crown for construction (Figure 4-11). The height of the floodwalls varies from 1 to 4 feet, as required by water surface elevations. Construction of the floodwall would be consistent with the description for NEMDC, above. The waterside slope would be re-established to its existing slope and the levee crown would be graded away from the wall and be surfaced with aggregate base.

Magpie Creek Diversion Canal

A number of features are proposed for the Magpie Creek Diversion Canal. This includes raising the existing left bank levee of the Magpie Creek Diversion Canal for a distance of approximately 2,100 feet. A new levee would be constructed along the west side of Raley Boulevard south from the bridge down to Santa Ana Avenue for a distance of approximately 1,000 feet.

A 5-foot high floodgate would be installed across the driveway of the Kelly-Moore paint store. An additional 4-foot high floodgate would be required at the driveway of a new development just south of the Kelly-Moore Paint Store property.

In addition, a culvert would be constructed under the Sacramento Northern Railway Bike Trail embankment. A new channel would be excavated upstream and downstream from the culvert, connecting the culvert with Robla Creek. The new channel would be slightly above the existing channel invert to allow low flows to continue through the existing bridge. Stone protection would be placed in the bed and sides of the new channel to minimize erosion.

The area inundated by a 250-year event without the project in place is estimated to be 76 acres (excluding roadways and channels, the inundated land would be 73 acres). Construction of the proposed improvements would slightly increase the water surface elevation during all flood events greater than a 5-year frequency. During the 250-year event, the increase in water surface is projected to be 0.5 feet at Raley Boulevard and 0.1 feet at the western boundary of McClellan Business Park. This would increase the inundated area to 79 acres (excluding roadways and channels, 76.5 acres). The TSP recommendations include acquisition of a flowage easement in this area if a takings analysis determines this is required to mitigate for induced flooding.

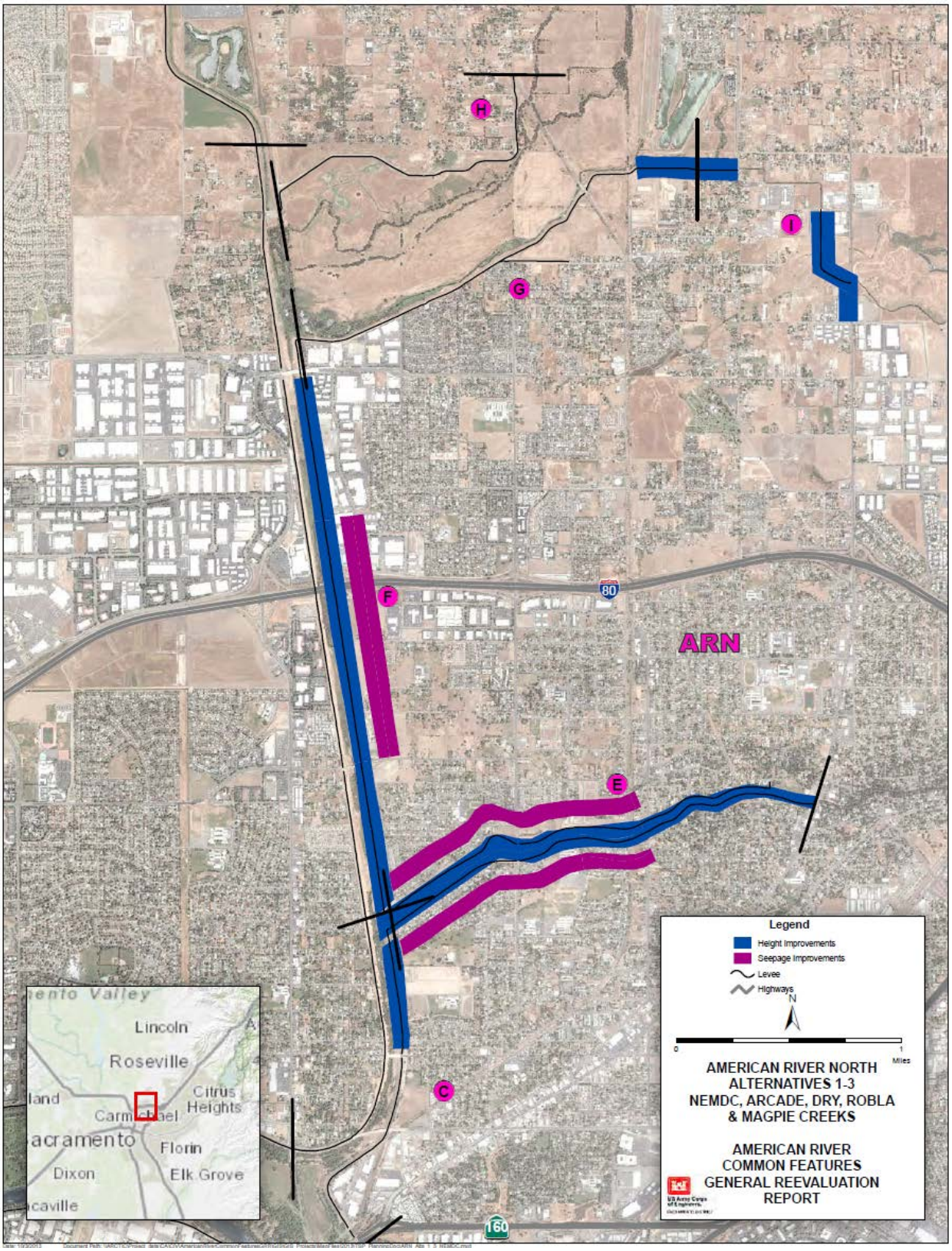

Figure 4-10: TSP Recommended Features for NEMDC, Arcade, Dry/Robla, and Magpie Creek Tributaries.

Levee Safety Compliance for the Tributaries

The construction footprint for the levee improvements along the Tributaries will be confined to the top half of the levee. This is displayed in Figure 4-11 below. Vegetation and encroachments within this footprint will be removed during construction. A vegetation variance is assumed to be in place for the lower half of the waterside levee slope.

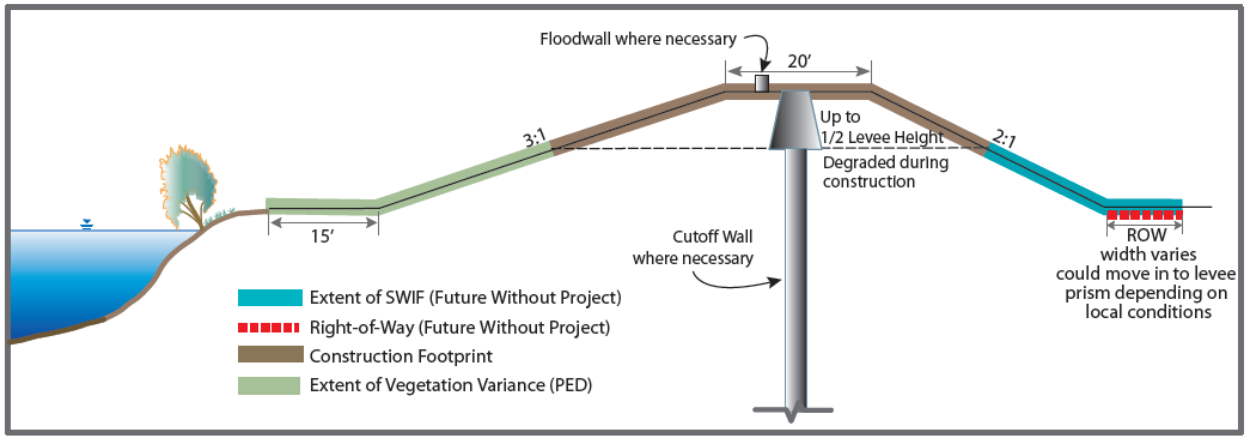

Figure 4-11: Levee Safety Compliance on the NEMDC, Arcade, and Dry/Robla Creeks.

4.1.4 Sacramento Weir and Bypass

Under this alternative, the Sacramento Weir and Bypass would be expanded to roughly twice their current width to accommodate increased bypass flows. The existing north levee of the Sacramento Bypass would be degraded and a new levee would be constructed approximately 1,500 feet to the north. The existing Sacramento Weir would be expanded to match the wider bypass. At this time, it is not known whether the new segment of weir would be constructed consistent with the 1916 design described above, or whether it would be designed to be a gravity-type weir. The new north levee of the bypass would be designed to be consistent with the existing Sacramento Bypass north levee, however, the slopes would be flattened to 3:1 and it would also include a 300-foot-wide seepage berm on the landside with a system of relief wells. An abandoned landfill associated with farming activities is located at the western end of the landside of the existing north levee. The site is approximately 17 acres and is under continued investigation by the California Integrated Waste Management Board for clean up. This site would be remediated by the non-Federal sponsor prior to construction.

Figure 4-12: Proposed Sacramento Weir and Bypass Expansion.

4.2 DESIGN AND CONSTRUCTION CONSIDERATIONS

4.2.1 Design Consideration

The project development team (PDT), including the non-Federal sponsors, employed a design approach focused on developing recommendations for levee improvements that would comply with USACE design criteria while at the same time, identifying options supported by the non-Federal sponsors and stakeholders. These recommendations meet the State of California levee design criteria as well. The focus was on improving the existing legacy levee system and identifying methods to address the greatest risk factors. It is acknowledged that these design recommendations will be refined during PED.

The top half of the levee would be removed during construction to provide an adequate platform width for the machinery needed for installation of the anticipated cutoff wall. This method of degrading the levee by half its height prevents the fracturing of the levee embankment during construction and also improves public and worker safety. Degrading the top half of the levee will also allow for this material to be replaced with better material for levee construction compared to the existing levee material. This new material will be applied and compacted according to modern engineering specifications.

Utility encroachments and penetrations within the construction footprint will be brought into compliance with applicable Corps policy or removed depending on the type and location. Utility replacements would occur via one of two methods: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices. Private encroachments within the construction footprint shall be removed by the non-Federal sponsor or property owner prior to construction.

During construction of levee improvements, the cross section geometry would be modified to meet Corps and State standards[2] within the construction footprint. The standard levee footprint consists of:

- A 20 foot crown width for the Sacramento and American Rivers, or
- A 12-foot crown width for NEMDC, Arcade, Dry/Robla, and Magpie Creeks, and
- Either 2:1 or 3:1 landside and waterside slopes (depending on the channel, past performance, and engineering analysis).

Landside levee toe access is needed during construction and all existing access points and routes would be used. In certain areas where levee raises are recommended, additional landside levee access would be acquired.

4.2.2 Construction Schedule and Project Implementation

Construction of the TSP is estimated to take approximately 10 years. The construction reaches have been prioritized based on a variety of factors, including the condition of the levee, the potential damages that would occur due to levee failure, and construction feasibility considerations, such as the availability of equipment at any given time. The tentative construction sequence is shown in Table 4-2.

[2] State Urban Levee Design Criteria (ULDC) is generally consistent with USACE Levee criteria. Any refinements would be conducted during PED. If the State is requesting a standard more stringent than what USACE is recommending, this would be a non-Federal expense.

Table 4-2: Tentative Construction Sequence for the TSP.

PRIORITY	WATERWAY	REACH	YEAR OF PROJECT CONSTRUCTION									
			1	2	3	4	5	6	7	8	9	10
1	Sacramento River	ARS F										
2	Sacramento River	ARS E										
3	American River	ARS A										
4	Sacramento River	ARS G										
5	Sacramento River	ARS D										
6	American River	ARS B										
7	American River	ARN A										
8	American River	ARS C										
9	American River	ARN B										
10	Sacramento Weir & Bypass	--										
11	Arcade Creek	ARN D										
12	NEMDC	ARN F										
13	Arcade Creek	ARN E										
14	NEMDC	ARN C										
15	Dry/Robla Creek	ARN G										
16	Magpie Creek	ARN I										

As shown in the table above, the study reaches have been prioritized for construction based on a number of criteria which mainly focus on the condition of the levee in those areas and the associated consequences of a levee failure. This approach was a strategy to address the greatest risk drivers first. The greatest risk in the study area is the potential for a geotechnical levee failure along the Sacramento River from a relatively frequent event. Therefore these reaches are shown as a high priority in the construction schedule. Erosion along either the Sacramento or American Rivers also constitutes a significant risk and this is reflected in the reach prioritization as well. In order to reduce the risk to the study area as quickly as possible, it is anticipated that erosion protection features could be implemented under the existing Sacramento River Bank Protection authority.

4.2.3 Levee Accreditation

The Engineer Circular 1110-2-6067 serves as guidance for USACE to provide the necessary Risk and Uncertainty (R&U) rationale to certify/accredit levees for FEMA. FEMA certification was not determined at this time. The local sponsor has an interest in having the repaired levees brought up to the minimum requirements needed for FEMA accreditation. By traditional FEMA methodology (Title 44 CFR Section 65.10), it is likely that the local sponsor could achieve FEMA Certification in the study area using this proposed project, recent projects (Natomas PAC) and the local partners' ongoing efforts under the Natomas Levee Improvement Program (NLIP). This would likely be completed by ensuring that there are three feet of freeboard above the 100-yr event for all the levees in the project area.

Urban Levee Design Criteria (ULDC) is a state standard established by the State of California Department of Water Resources. The ULDC requires urban levees to have at least three feet of freeboard above the mean 200-Year event or a combination of freeboard (2-3 feet) and assurance (90%-95%) to contain the mean 200-Year event.

4.2.4 Borrow Material

It is estimated that a maximum of 1 million cubic yards of borrow material could be needed to construct the project. Because this project is in the preliminary stages of design, detailed studies of borrow needs have not been completed. To identify potential locations for borrow material, soil maps and land use maps were obtained for a 20-mile radius surrounding the project area. Borrow sites would be lands that are the least environmentally damaging and would be obtained from willing sellers. The criteria used to determine potential locations were based on current land use patterns, soil types from U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS), and Corps' criteria for material specifications. The data from land use maps and NRCS has not been field verified, therefore, to ensure that sufficient borrow material would be available for construction the Corps looked at all locations within the 20 miles radius for 20 times the needed material. This would allow for sites that do not meet specifications or are not available for extraction of material.

4.2.5 Interior Drainage

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). An assessment of the capacity of existing facilities to address the residual flooding from interior runoff will be accomplished during the design phase.

4.3 ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES

The effects to the environment have been considered throughout the planning phase of the project and opportunities have been evaluated to reduce effects to resources within the project area. A vegetation variance will be sought for the Sacramento River reach of the project, which will allow vegetation to stay on the lower half of the waterside levee slope. The waterside vegetation on the Sacramento River is valuable Shaded Riverine Aquatic Habitat (SRA) habitat for many State and Federally listed fish species and State-listed Swainson's hawk. Although mitigation for State listed species is not necessarily required for a Federal project, these impacts also affect Federally listed species and would be required under Section 7 Endangered Species Act (ESA) consultation with National Marine Fisheries Service (NMFS). Additionally, during the design phase of the project opportunities will be taken to choose a design that will minimize effects to the American River Parkway where feasible. Table 4-3 lists the environmental effects of the TSP on ESA species and the proposed mitigation for those effects. A Cost Effectiveness Incremental Cost Analysis (CE/ICA) will be conducted on the mitigation features prior to the final version

of this report. Additional information on environmental effects and mitigation is located in Sections 3.6 – 3.8 in the accompanying EIS/EIR.

Table 4-3: Environmental Effects of and Proposed Mitigation for the TSP[1].

Habitat Type	Potential Impacts	Duration of Impact	Mitigation (Acres/Linear Feet)	Cost
(Giant Garter Snake) Rice Fields	300 Acres	Permanent	620 Acres	$12,000,000
Riparian	134 Acres	Permanent	Restore 268 acres $103,400 per acre	$27,800,000
Grasslands	2.5 Acres	Single Construction Season	Restore 2.5 Acres	$30,000
Shaded Riverine Aquatic Habitat (ESA Fish Species)	up to 100,000 Linear Feet	Single Construction Season	Up to 100,000 Linear Feet Self Mitigating with on-site planting[2]	
Elderberry Shrubs	3334 stems	Permanent	70 Acres $85,000 per acre	$6,000,000
Sub-Total				**$45,830,000**
Contingency				**$9,642,000**
Total				**$55,472,000**

Notes:
[1] Assumes variance from USACE's Levee Safety Policy is granted for Sacramento River and Compliance for American River will be completed under a SWIF
[2] The amount of Shaded Riverine Aquatic (SRA) habitat impacted would be minimal due to the assumed approval of a vegetation variance. Trees providing SRA will be left in place and the sites will be planted with an approved planting pallet that provides additional SRA habitat once established. Repairs using the Sacramento Bank Protection Project repair are considered self mitigating and all cost are included in the construction cost. If additional mitigation is required by NMFS or USFWS, the cost is estimated to be $144 per linear foot.
[3] Potential mitigation costs for vernal pool fairy shrimp and vernal pool tadpole shrimp are under development and will be included in the final version of this document and the EIS/EIR. It is not anticipated that these costs would alter the plan selection or the recommended plan.

4.4 REAL ESTATE REQUIREMENTS

The Real Estate Appendix discusses, by reach, the real estate interests to support the construction, operation, and maintenance of the TSP. 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-level estimated costs associated with the areas and estates that are required for the construction, operation and maintenance for the project. Several of the features included in the plan

alter the footprint of the existing Federal flood management system: a new setback levee would be constructed for the Sacramento Bypass and a new segment of the Sacramento Weir would be built.

Other land requirements for the project include temporary borrow areas, temporary construction areas, temporary staging areas, and permanent mitigation sites. 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, Sacramento Municipal Utility District (SMUD),) in the study area. This project has received a waiver letter from the Assistant Secretary of the Army (ASA), dated 14 July 1998, relating to a cost sharing issue associated with utility relocations required for construction of the American River Common Features Project in Sacramento, California. Generally, USACE treats relocations as creditable items of non-Federal work and includes such costs in total project costs. The exception is when the sponsor has the authority to compel relations at no cost to the sponsor. For this study, the State of California is the non-Federal sponsor which has a local cooperation agreement with the Sacramento Area Flood control Agency (SAFCA).

Requiring the State to revoke permits issued to SAFCA's member agencies would recognize neither the highly interrelated sponsorship of the project that includes the State, SAFCA and SAFCA's constituent members, nor equitably reflect the joint contributions these municipalities are making to project financing. The ASA 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 a number of residential and nonresidential structures to accommodate the expanded project footprint along the Sacramento River east levee. Privately owned 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. Table 4-4 lists the Real Estate costs for the TSP.

Table 4-4: Real Estate Costs for the TSP.

MII Account[1]	Category	Costs
01 – Lands and Damages		
	Non-Federal Administrative Costs	$27,106,000
	Non-Federal Lands	$60,607,000
	Subtotal Non Fed Lands and Damages	**$87,713,000**
	Federal Administrative Costs	$9,225,000
	Subtotal Federal and Non-Federal Lands and Damages	**$96,938,000**
02 – Utility/Facility Relocations		$63,040,000
30 – PED Relocations		$15,760,000
31 – Construction Management Relocations		$6,304,000
	Sub Total Relocations	**$85,104,000**
	Total Real Estate Costs (01, 02, 30 and 31 Accounts)	**$182,042,000**

Notes: [1]MII is the software program and associated format used by USACE in developing cost estimates. Costs are divided into various categories identified as "accounts." Detailed costs estimates are presented in Appendix C, Attachment D, Cost Engineering.

4.5 OPERATIONS, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION (OMRR&R) CONSIDERATIONS

The Standard Operation and Maintenance Manual, Sacramento River Flood Control Project, approved April 1948, and supplements, will be supplemented for the work completed along the Sacramento River east levee and the American River north and south levees. Updated operation and maintenance manuals will be required as well for work completed along the NEMDC, Dry/Robla, Arcade and Magpie Creeks.

4.5.1 Agencies and Organizations

The agencies and organizations that would have management responsibility for recommended project features are the City of Sacramento, the American River Flood Control District, and the California Department of Water Resources (Maintenance Area 9). Table 4-5 below lists these maintaining agencies and the affiliated study reaches.

The City of Sacramento

The City of Sacramento (City) maintains the levee along the Sacramento River from the I Street Bridge to Sutterville Road. The City also ensures that the interior drainage systems work efficiently, monitors floodgates and maintains drainage canals and basins. In an emergency, the City installs floodgates and operates and monitors the flood management system.

American River Flood Control District (ARFCD).

The mission of the American River Flood Control District is to operate and maintain a total of 40 miles of levee along the American River and portions of NEMDC, Robla Creek, Arcade Creek, Dry Creek, and Magpie Creek. ARFCD also maintains the short stretch of the Sacramento River levee upstream of the I Street Bridge. *The lands acquired by SAFCA and the State of California for levee improvements along NEMDC, Robla Creek, Arcade Creek, Dry Creek, and Magpie Creek* would be conveyed to ARFCD in fee title.

By agreement with the State, ARFCD would operate and maintain the constructed facilities in accordance with the operation and maintenance requirements of the SRFCP. 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 canals; and maintaining and repairing levee and canal patrol roads. These efforts would be carried out under a long-term management agreement between the State and ARFCD.

California Department of Water Resources – Maintenance Area 9 (DWR-MA 9)

Maintenance Areas are formed for the purpose of providing maintenance when local agencies fail in their responsibilities. The maintenance work is provided by the State of California Department of Water Resources (DWR)*. The authorized services include levee maintenance, flood patrolling, and emergency repairs. Maintenance Area 9 is located on the east bank of the Sacramento River between Sutterville Road and Snodgrass Slough*. DWR also provides maintenance on the existing Sacramento Weir and Bypass levees and would be the maintaining agency for the widened Sacramento Weir and Bypass. Table 4-6 displays maintaining agencies by study reach.

Table 4-5: Maintaining Agencies for Study Reaches.

Basins	Maintaining Agency	Reach Description
ARN	ARFCD	Right Bank American River
	ARFCD	Tributaries
ARS	ARFCD	Left Bank American River
	ARFCD	Sacramento River from confluence to I Street Bridge
	City of Sacramento	Sacramento River from I Street Bridge to Sutterville Road
	DWR-MA 9	Sutterville Road to Freeport
	DWR-MA 9	Widened Sacramento Weir and Bypass

4.5.2 Monitoring and Adaptive Management

Overall, after implementation of mitigation components, the mitigation sites would be monitored throughout the year for 3–10 years depending on the type of habitat and as developed in negotiation with the appropriate resource agencies. USACE would be responsible for providing success monitoring, which, as required for ESA mitigation 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. A monitoring and adaptive management plan would be developed prior to the final version of this GRR in coordination with the USFWS and NOAA Fisheries.

All habitat types and mitigation sites would receive quantitative and qualitative monitoring. Quantitative monitoring would be performed in accordance with the performance criteria). 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.

USACE would prepare an annual report in conjunction with the resource managers that would be submitted to the USFWS, DFG, and the Central Valley RWQCB by December 31 of each year during the success monitoring period. Monitoring will continue until the Division Engineer determines that ecological success criteria have been met, after the District Engineer has consulted with appropriate Federal and State agencies. The report would assess the attainment of or progress toward meeting the success criteria for the mitigation sites.

4.5.3 OMRR&R Costs

The Sacramento District developed operation, maintenance, repair, replacement and rehabilitation (OMRR&R) costs associated with the project features. The costs were developed with input and review from two of the local maintaining agencies (LMA). Specifically, several meetings and conversations between the District, the Department of Water Resource's Maintenance Area 9 (MA-9), and American River Flood Control District (ARFCD) staff resulted in a mutual understanding of the increased efforts and impact on costs. The increased efforts include additional mowing, rodent control, and vegetation management. Some of the OMRR&R costs were developed quantitatively, however, many of the costs were developed using qualitative judgment to determine the increase in cost beyond what is currently included in the existing O&M Manual. These costs are listed in Table 4-6 below.

Table 4-6: Annual Increase in OMRR&R Costs.

Maintaining Agency for Existing Feature	Existing OMRR&R Features	Existing OMRR&R Costs	Maintaining Agency for Recommended Feature	Description of New Recommended Feature	Increased Cost
MA-9	Sacramento Bypass	$250,000	MA-9	Weir Widening	$56,250
				North Bypass Levee	$137,400
				Bypass Channel	$15,000
	Levee Maintenance	$1,755,000		Levee Maintenance	49,400
City of Sacramento, ARFCD	Access Roads, Levee Main.	$884,700	City of Sacramento, ARFCD	Access Roads	$5,400
				Levee Maintenance	$230,500
Total		**$2,889,700**			**$494,000**

4.6 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 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 whether 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 Sacramento area would pose a significant threat to human life, independent review of the design and construction activities based on the Safety Assurance Review standards referenced above will be required.

4.7 RESIDUAL RISK

Residual Risk is the risk of inundation in the study area after implementation of the TSP. This section includes a discussion on the nature of residual risk in the study area, including levee superiority assumptions and an analysis of the post flood occupation of the study area. It also includes a discussion of measures included in the TSP to address residual risk along with additional actions by the non-Federal sponsors to address residual risk beyond the scope of this GRR.

4.7.1 Nature of the Residual Risk in the Study Area

The Chief's Report recommending authorization of the American River Common Features Project acknowledged that the implementation of those features would leave significant residual risk in the Sacramento area. The following is from the Chief's Report (House Doc. 105-151):

> *"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."*

While the implementation of the Folsom Dam Modifications and the Folsom Dam Raise Project will add significantly to the ability to manage releases from Folsom Dam, there still remains a chance that an unprecedented flood could overwhelm the ability of the dam to prevent flooding downstream. The dam modifications have given dam operators the ability to release amounts of water necessary to save the dam. However, releases of this magnitude would cause massive flooding in Sacramento. It is of the utmost importance that public education efforts emphasize the residual risk inherent in any system of flood risk management.

Rivers in the study area can rise from low flow levels to damaging floods within one to three days. If a levee failure were to occur, the flood depths would range from several inches along the eastern limits of the floodplain near high ground, to more than 20 feet in areas immediately adjacent to the levees. The duration of the flooding is likely to be a few weeks after the water levels in the river have receded... Large amounts of pumping would be required since the water level in the rivers would be higher than the land behind the levees. . The average expected residential and public displacement times would be 18 months.

4.7.2 Levee Superiority

Superiority is the levee design approach that identifies an initial overtopping location in the least hazardous location of a levee reach. This can be achieved by specifically setting the top of levee lower in the chosen overtopping location.

According to ETL 1110-2-299, "Overtopping of Flood Control Levees and Floodwalls," two design types can be used to control initial overtopping. The first is the use of different levee heights relative to the design water surface from reach to reach to force overtopping in a desired location. The second design uses notches, openings, or weirs in the structure. The inverts for these features are at or above a design water surface elevation but below the neighboring top of levee. Examples are railroad or road crossings of levees and rock weirs.

For this study, the second option (the use of the weirs as described in ETL 1110-2-299) was applied. The two weirs on the Sacramento River in the project area, Fremont Weir and the Sacramento Weir, divert high flows away from Sacramento into the Yolo Bypass. The two weirs are the only designed flood relief structures in the system. The levees in the project area have not been designed for overtopping, but there are incidental low areas that will likely overtop first.

4.7.3 Post-Flood Reoccupation of Sacramento

The levees surrounding Sacramento vary from approximately 10 feet tall to approximately 25 feet tall. A levee failure, depending on the location, could potentially inundate the majority of the basin where the levee failure occurred. Conditions in the impacted basin(s), if this were to occur, would be very similar to conditions in New Orleans after Hurricane Katrina.

Considerable infrastructure is required to support the population in the study area. Key infrastructure within the project area includes the California State Capitol and State offices, hospitals, many power transmission lines, water supply lines, sewage lines, interior drainage canals and pump stations, phone lines, and roadways. (See Chapter 2 for additional infrastructure information) In addition to the infrastructure flooding in the event of a levee failure, there are approximately 120,000 residential dwellings that would be inundated, in many cases with up to 25 feet 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 American River North and American River South Basins is accomplished by pump stations and canals. The affected 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(s) 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 lack of contractors available to do this type of work, the duration period for rebuilding or repairing homes could be years.

4.7.4 TSP Actions to Reduce the Residual Risk in the Study Area

The TSP would substantially lessen the probability of a flood event in the study area due to levee failure, however, there will be a remaining chance of levee overtopping from a flood that exceeds the design event. In order to continue to reduce the residual risk, the TSP includes continuation of non-structural measures by the sponsor, consisting of updating and adhering to the floodplain management plan, annual publication of residual risks to residents in the floodplain, updates and improvements to the telemeter stream flow gages, and modifications to flood warning system. Under the TSP, the sponsor would also be required to provide floodplain information to regulatory agencies.

There are two types of residual risk that have been analyzed as part of this GRR: the residual risk associated with the recommended project features and the residual risk from physical conditions not related to the recommended project features.. Figures 4-13 and 4-14 display the residual risk remaining in the study area after construction of the project. The 1/200 Annual Chance Exceedence (ACE) event and the 1/500 ACE event are displayed. These figures show the percent chance of a hypothetical levee failure and the resulting floodplain for the stated flood event. Figure 4-16 shows the resulting floodplains from the American River levees being flanked by floodwaters in the 1/500 ACE event. The average annual residual damages in the Study Area are presently estimated to be $97,000,000 per year.

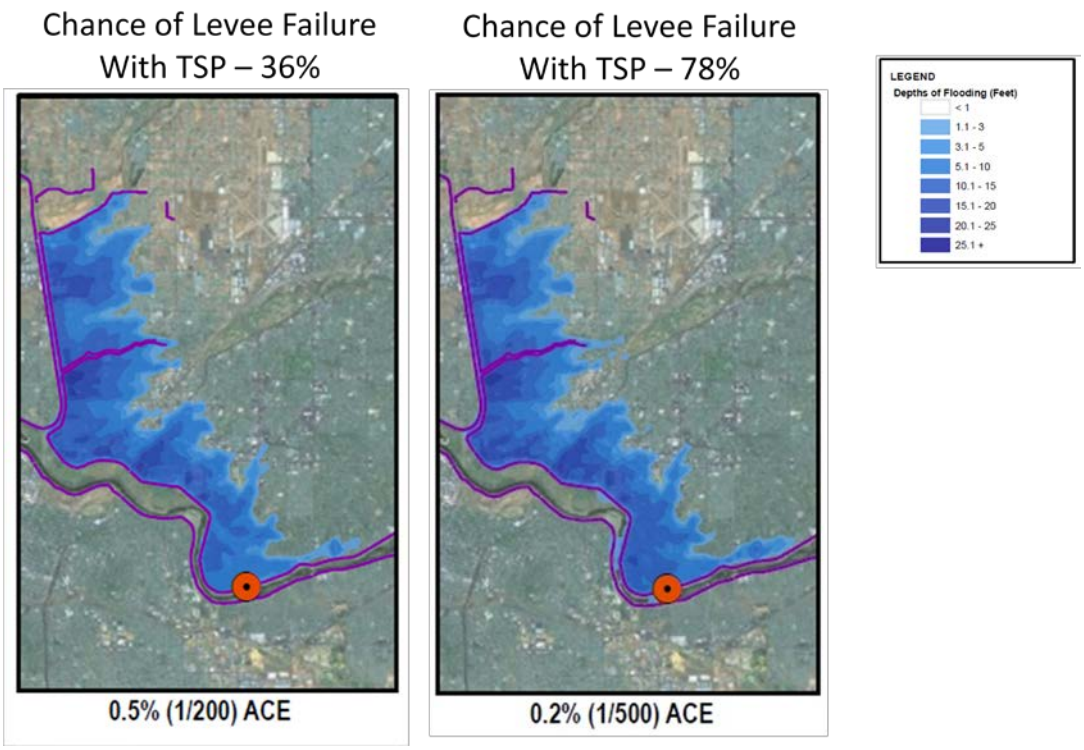

Figure 4-13: Residual Risk for the American River North Basin.

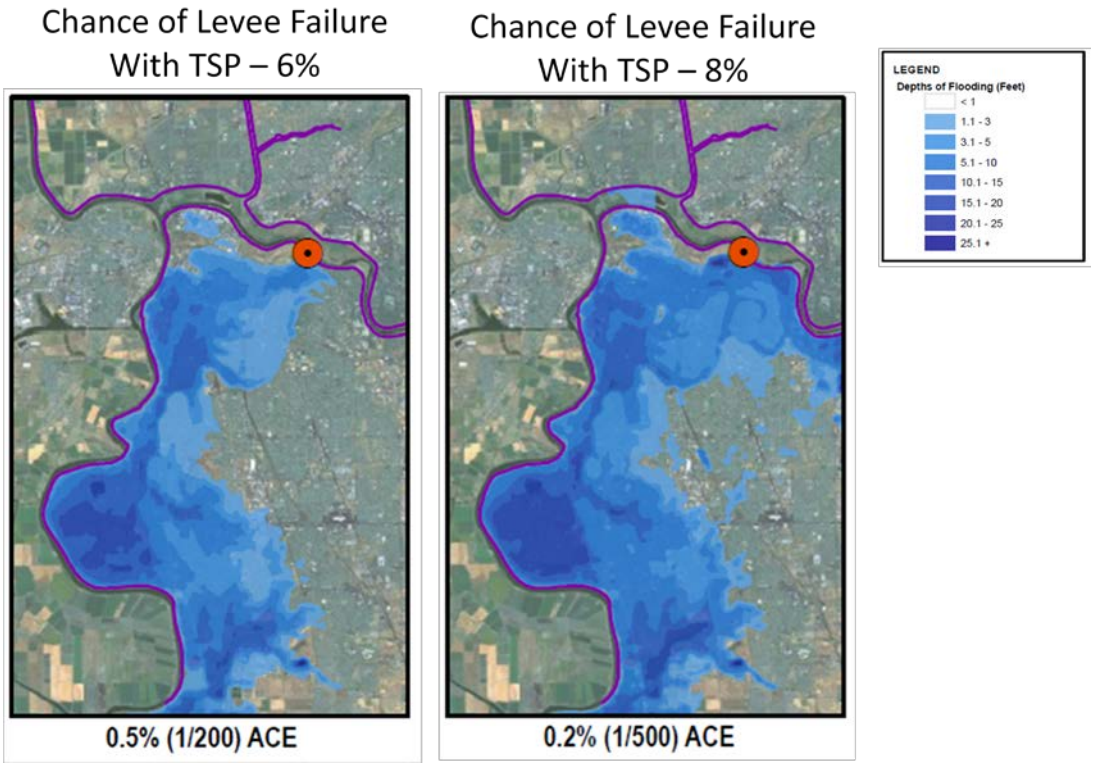

Figure 4-14: Residual Risk for the American River South Basin.

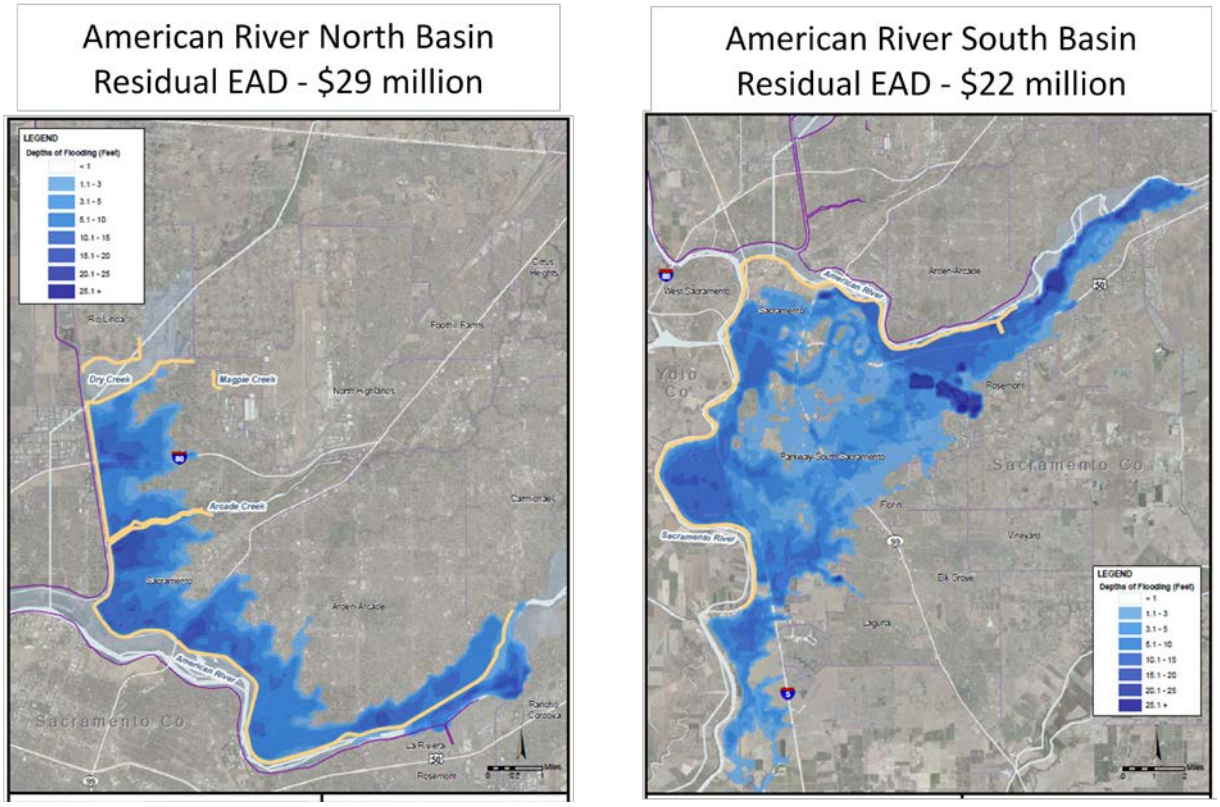

Figure 4-15: Residual Risk of Upstream Flanking of the American River Levees for the 0.2% (1/500) ACE.

4.7.5 Additional Actions to Reduce the Residual Risk in the Study Area

The following sections discuss further actions being taken to address residual risk by the non-Federal sponsor and other local agencies that are outside the scope of this GRR.

Senate Bill 5

The California State Senate, in 2007, approved Senate Bill 5. There are various components included in Senate Bill 5. One element is the identification of the 100- and 200-year floodplains in the Sacramento and San Joaquin valleys. One additional feature establishes a standard for urban areas to have a 200-year level of protection, as defined by the 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 CVFPP was completed in 2012 and established urban and non-urban standard levels of protection as 200-year and 100-year, respectively.

SAFCA Development Impact Fee

The TSP 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 a flood would increase over time as planned new development occurs in the Sacramento area in accordance with the Sacramento Area Council of Government's regional blueprint. To address residual risk, the SAFCA Board adopted a development fee program on May 15, 2008 that applies 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 that will consist of the following measures.

Waterside Levee Strengthening

This action will consist of a long-term program of waterside bank and levee protection improvements along the Lower American and Sacramento Rivers 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 action 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.

Landside Levee Strengthening

This action 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.

Improved System Operations

These actions 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 State of California CVFPP.

4.8 FLOOD WARNING AND EVACUATION PLANS

Both Sacramento County and the City of Sacramento have websites containing links to information regarding flood preparation, notification, and evacuation. The information for Sacramento County, including a link to the Floodplain Management Plan, is located at: http://www.stormready.saccounty.net/Pages/Home.aspx. Additional information on preparing for a flood can be found at: http://www.sacramentoready.org/Emergencies/Pages/Floods-and-Rain.aspx. The information for the city of Sacramento is located at: http://portal.cityofsacramento.org/Utilities/Education/Flood-Ready/Your-Flood-Prep.

4.8.1 Flood Warning System

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 website updates every 15 minutes. Local meteorologists and television stations 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 website 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.

4.8.2 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 Drainage Canal at Arcade Creek, Arcade Creek at East Main Drainage Canal, and the Cosumnes 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.

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 4-7: Emergency Activation Triggers.

Location	Sacramento River at I Street Bridge	American River at H Street Bridge
Situational Assessment	River is rising and significant precipitation and/or Sierra snow melt is expected	River is rising and significant precipitation and/or Sierra snow melt is expected
Low-Level Emergency	I Street gauge is 19-24 feet and rising	H Street gauge is up to 30-39 feet and rising
Medium-Level Emergency	I Street gauge is up to 27 feet	H Street gauge is up to 41 feet
High-Level Emergency	I Street gauge is up to 31 feet; levee overtopping and flooding	H Street gauge is up to 42 feet; levee overtopping and flooding

4.8.3 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 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.

4.8.4 Evacuation Routes

Emergency evacuation routes have been established throughout the county. Evacuation areas, evacuation routes, and rescue areas have been established for five levee breach locations in the American River North Basin, and eight levee breach locations in the American River South Basin. Evacuation route inundation times are color coded on the various levee breach location maps and vary depending on the location of the levee breach.

4.8.5 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, and 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.

4.8.6 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 different levee breach locations in the Natomas Basin, five levee breach locations in the American River North basin, and eight levee breach locations in the American River South 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 a total of 18 different levee failure locations on the levees surrounding Sacramento. Depending on the levee failure location the elapsed time to get to 1 foot flood depths can range from 6 minutes to over 240 hours.

4.9 HYDRAULIC EFFECTS EVALUATION

Widening the Sacramento Weir and Bypass will allow more flow from the Sacramento and American Rivers to be released into the Yolo Bypass which will reduce the water surface elevation in the river adjacent to the city of Sacramento. The purpose of this section is to provide a framework which examines the effects of this change in flow from both an incremental project standpoint and a cumulative perspective that takes into account the effects of the ongoing work at Folsom Dam.

4.9.1 Existing and Future Without Project Condition Assumptions

The future without project condition assumptions include construction and operation of all previously authorized work on the American River as part of the WRDA 1996 and 1999 Common Features authorizations, levee repairs as described in the Natomas PACR authorized in WRRDA 2014, the new JFP spillway under construction at Folsom Dam, and the future planned raise of Folsom Dam.

The existing condition for ARCF is different than the future without project condition. The existing condition describes the existing releases from Folsom Dam and is used to assess the overall effects of the combined Common Features and Folsom Dam improvements (spillway and raise) for a cumulative effects assessment. The existing condition assumes the Bureau of Reclamation and SAFCA reservoir operation agreement is in place which allows for greater flood storage in the reservoir beyond what the original operations manual designated.

The major hydrologic/hydraulic difference between the existing as compared to both the future without project condition and the with-project condition is that the peak flow on the American River is higher for frequent events but lower for less frequent events due to Folsom Dam routing changes. Table 4-8 displays the different flow releases from Folsom Dam for the Existing and the Future Without Project (with JFP and dam raise in place).

Table 4-8: Comparison of Existing and Future Without Project Flow Releases from Folsom Dam.

Frequency (Years)	Existing (Existing Releases, cfs)	Future Without Project (with JFP, cfs)
2	30,000	26,000
10	43,000	72,000
25	100,000	115,000
50	115,000	115,000
100	145,000	115,000
200	320,000	160,000
500	520,000	530,000

4.9.2 Discussion of Flow Changes

If the expanded Sacramento Weir were to be operated as the existing weir is operated, the TSP would result in a diversion of flows from the Sacramento River to the Yolo Bypass that would slightly raise water surface elevations in the Yolo Bypass during frequent events (10 year) compared to both the existing and future without project conditions. To avoid potential effects to the Yolo Bypass, the widened portion of the Sacramento Weir will only be operated when the release from Folsom Dam is increased to above 115,000 cfs. With the Folsom Dam improvements in place, releases from Folsom Dam would be above 115,000 cfs for flood events greater than 1/100 ACE event. Therefore, for events up to and including the 1/100 ACE event, only the existing weir will be operated. As a result of the increased flood storage space and anticipatory releases at Folsom Dam, this translates into a reduction of flows into the Yolo Bypass with the TSP in place compared to the existing conditions. See Table 4-9 for a comparison of the flows at various locations for the Existing, Future Without Project, and with the TSP.

Table 4-9: Comparison of 10, 100, and 200 Year Frequency Flows under Various Conditions.

10 year event	Existing	Future Without Project	Alt. 2 (TSP)
American River	43,000cfs	72,000cfs	72,000cfs
Sacramento Bypass	50,000cfs	66,000cfs	66,000cfs
Yolo Bypass below Sac Bypass	270,000cfs	296,000cfs	296,000cfs
100 year event	**Existing**	**Future Without Project**	**Alt. 2 (TSP)**
American River	145,000cfs	115,000cfs	115,000cfs
Sacramento Bypass	131,000cfs	115,000cfs	115,000cfs
Yolo Bypass below Sac Bypass	555,000cfs	535,000cfs	535,000cfs
200 year event	**Existing**	**Future Without Project**	**Alt. 2 (TSP)**
American River	320,000cfs	160,000cfs	160,000cfs
Sacramento Bypass	183,000cfs	149,000cfs	164,000cfs
Yolo Bypass below Sac Bypass	656,000cfs	631,000cfs	643,000cfs

4.9.3 Conclusion

The widening of the Sacramento Weir and Bypass diverts flood flows from the Sacramento and American River into the Yolo Bypass. The widened portion of the weir will only be operated when flood releases from Folsom Dam are above the existing objective release of 115,000 cfs which would occur during flood events greater than 1/100 ACE event. Therefore, for events up to the 1/100 ACE event, there would be no change in flow conditions in the Sacramento and Yolo Bypasses. For flood events greater than 1/100 ACE event when releases from Folsom Dam would go above 115,000 cfs (such as a 1/200 ACE event in which the Folsom release goes up to 160,000 cfs), because of the additional flood storage provided by anticipated operation and physical improvements to Folsom Dam coupled with the widened Sacramento Weir and Bypass, the net effect would be to slightly decrease the peak compared to the existing peak flow in the Yolo Bypass.

4.10 ENVIRONMENTAL SUMMARY

The Sacramento District published a notice of intent (NOI) to prepare the ARCF GRR EIS in the Federal Register (Vol. 73, No. 41) on February 29, 2008. A series of public scoping meetings were held in March 2008 to present information to the public and to receive public comments on the scope of the EIS. There is no mandated time limit to receive written comments in response to the NOI under NEPA. The EIS contains the NOI, the one comment letter received in 2008, and copies of the posters for the March 2008 scoping meetings.

The draft GRR and EIS/EIR will be circulated for a 45 day public review period to Federal, State, and local agencies, organizations, and individuals who have an interest in the project. A notice of availability of the draft EIS/EIR will be published in the Federal Register when the document is released for public review. Public workshops will be held during the review period to provide additional opportunities for comments on the draft document. All comments received during the public review period will be considered and incorporated into the final EIS/EIR, as appropriate. A comment and response appendix will be included with the final document.

A biological assessment has been prepared and coordinated with the resource agencies. ESA Section 7 consultation has been on-going as part of the Common Features Project. A biological opinion (B.O.) has not been issued by USFWS or NMFS at this time. However, prior to finalizing this report, a B.O. will be required.

This project is being coordinated with USFWS under the Fish and Wildlife Coordination Act. The draft Fish and Wildlife Coordination Act Report (CAR) is included in the EIS. Mitigation recommended in the CAR is included in Table 4-10 which displays the potential effects and mitigation proposed for the TSP. This mitigation reflects what is currently in the biological assessment and has been coordinated with USFWS, NMFS, and the California Department of Fish and Wildlife (CDFW).

Table 4-10: Summary of Environmental Effects and Mitigation Measures.

Potential Effects	Mitigation Measure	Effects with Mitigation
Land Use		
Acquisition of properties for flood control easements along the Sacramento River and Arcade Creek. Conversion of agricultural lands to floodway.	Federal Relocation Act compliance. Payment of Sacramento County Habitat Restoration Program fees in the American River Parkway.	Less than significant with mitigation.
Hydrology and Hydraulics		
No effect.	Not applicable.	Not applicable.
Water Quality		
Potential impacts include increased turbidity during bank protection construction, runoff of exposed soils, and cement, slurry, or fuel spills during construction.	Preparation of a Stormwater Pollution Protection Plan, Spill Prevention Control and Countermeasures Plan, and a Bentonite Slurry Spill Contingency Plan. Implementation of BMPs listed in Section 3.5.6 of the EIS/EIR.	Less than significant with mitigation.
Vegetation and Wildlife		
Construction of levee improvements and vegetation removal would result in significant loss of vegetation and wildlife habitat on the landside of the Sacramento River levees, in the American River Parkway, and along Arcade Creek. Construction of the Sacramento Weir extension would require the removal of riparian vegetation.	When possible, compensation would be planted on planting berms, on top of launchable rock trenches, or on other lands within the Parkway. A hydraulic evaluation will be conducted to determine whether mitigation could occur in the Sacramento Bypass. Additional mitigation sites are identified in Section 3.6.6 of the EIS/EIR.	Significant.
Fisheries		
Indirect effects to fish habitat from the removal of vegetation from the levee slopes. Direct effects from the placement of rock at bank protection sites, causing an increase in turbidity. Widening the Sacramento Bypass creates floodplain, which could provide a benefit to fish species.	Vegetation variance would allow waterside vegetation to remain on the Sacramento River. Bank protection sites and launchable rock trenches would be revegetated following construction. BMPs would be implemented to address turbidity, and are discussed in Section 3.5.6 of the EIS/EIR	Less than significant with mitigation.
Special Status Species		
Direct affects to GGS, fish species, and Swainson's Hawks during construction. Indirect effects due to loss of habitat. Vegetation variance for the waterside levee slopes would significantly limit the effects to endangered fish species.	Replace habitat for species either on-site or in close proximity to lost habitat. Implement BMPs discussed in Section 3.5.6 of the EIS/EIR during construction to prevent mortality.	Less than significant with mitigation

Potential Effects	Mitigation Measure	Effects with Mitigation
Cultural Resources		
Adverse effects to historic properties from construction of levee improvements and the bypass widening.	Preparation and implementation of a Programmatic Agreement, Historic Properties Management Plan, and Historic Properties Treatment Plans.	Significant.
Transportation and Circulation		
Increased traffic on public roadways.	Preparation of a Traffic Control and Road Management Plan and other BMPs listed in Section 3.10.6 of the EIS/EIR.	Significant.
Air Quality		
Emissions of criteria pollutants from construction equipment, haul trucks, and barges.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.11.6 of the EIS/EIR.	Less than significant with mitigation.
Climate Change		
Increased greenhouse gas emissions from construction equipment, haul trucks, and barges.	Implementation of SMAQMD's Basic Construction Emission Control Practices and other BMPs, as listed in Section 3.12.6 of the EIS/EIR.	Less than significant with mitigation.
Noise		
Increased noise in proximity to sensitive receptors due to construction activities.	Coordination with local residents, compliance with noise ordinances, and other BMPs, as listed in Section 3.13.6 of the EIS/EIR.	Less than significant with mitigation.
Recreation		
Temporary closure of recreation facilities in the American River Parkway during construction, including bike trail, walking trails, and boat launches. Possible closure of the Sacramento Bypass during portions of hunting season.	Notification and coordination with recreation users and bike groups. Flaggers, signage, detours, and fencing to notify and control recreation access and traffic around construction sites.	Significant.
Aesthetics and Visual Resources		
Vegetation loss and construction activities would disrupt the existing visual conditions in the Parkway and along the Sacramento River.	Trees would be planted after construction is completed on planting berms and on top of launchable rock trenches; however there would still be a temporal loss of vegetation. Disturbed areas would be reseeded with native grasses.	Significant.
Public Utilities and Services		
Temporary disruptions to utility services possible, particularly during relocation of utilities that penetrate the levee.	Notification of potential interruptions would be provided to the appropriate agencies and to landowners.	Less than significant.

Potential Effects	Mitigation Measure	Effects with Mitigation
Hazardous, Toxic, and Radiological Wastes		
No effect from construction activities. HTRW sites encountered would be removed and properly disposed of prior to construction, including the Old Bryte Landfill.	Borrow material would be tested prior to use to ensure that no contaminated soils are used for this project.	Less than significant with mitigation.
Socioeconomics, Population, and Environmental Justice		
Disruption to residents alongside construction sites from traffic, noise, and dust. Acquisition of properties for flood control easements.	Federal Relocation Act compliance.	Less than significant.

4.11 EXECUTIVE ORDER 11988

Executive Order (EO) 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.*

The levees along the American River and Sacramento River as well as the Sacramento Weir and Bypass are in the base flood plain.

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.*

The poor performance of the exiting levee systems in the study area highlights the need to address the flood risk with a worst first strategy. The most efficient and effective means of reducing this risk is to improve the levees. Any upstream or larger regional improvements to the flood management system do not reduce the water surface elevations to the point where these levee improvements are not needed. Therefore, there are not any practicable alternatives but to improve the existing levees.

3. *If the action must be in the flood plain, advise the general public in the affected area and obtain their views and comments.*

Both the draft and final GRR and EIS/EIR documents will be circulated for public review and public meetings will be held during these comment periods. NEPA- and CEQA-required notices have been mailed to affected property owners throughout the ARCF GRR 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. USACE, the State of California and SAFCA have also participated in numerous stakeholder meetings to discuss project-related concerns. Public comments received on the NOI/NOP were considered and addressed, where appropriate in the DEIS/DEIR; public comments received on the DEIS/DEIR will be 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.*

The TSP proposes to widen the Sacramento Weir and Bypass which would reconnect about 300 acres of the floodplain to seasonal inundation thereby improving natural floodplain values. In addition, the TSP reduces the water surface elevation in the river adjacent to two urban areas, increases the regional flexibility of the flood management system, and provides benefits to downstream communities in the form of reduced water surface elevations in the Sacramento River. The TSP would have significant adverse impacts on Vegetation and Wildlife, Cultural Resources, Transportation, Recreation and Aesthetic and Visual resources; however, these do not result in the loss of floodplain values.

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.*

The most effective and efficient method of reducing flood risk in the American River North and American River South Basins is to improve the levees that provide the first line of defense for the basins. Therefore, a practicable non-floodplain alternative does not exist.

Within the project area, population growth and urban development are driven by local, regional, and national economic conditions. Local land use decisions are within the jurisdiction of the City and County of Sacramento. Both of these agencies have 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 American River North and American River South basins are fully urbanized. The City of Sacramento General Plan identifies areas that will be preserved and enhanced to maintain their current character or areas that will improve and evolve, undergoing significant change through infill, reuse and redevelopment. There are several areas identified in the City of Sacramento General Plan that are identified as growth areas and envisioned to undergo significant changes as a result of major development and redevelopment. These include the River District and the Railyards.

The 773-acre River District Area proposes development of a transit-oriented mixed use urban environment that would include 8,144 dwelling units, 3.956 million square feet of office, 854,000 square feet of retail/wholesale, 1.463 million square feet light industrial, and 3,044 hotel units. The vision for the River District is that of an eclectic mix of uses that will evolve from a primarily light-industrial, low-intensity commercial district, to that of a series of distinctive walkable neighborhoods within a district that is contiguous to the American River and serves as the northern gateway into the Central City.

The 224-acre Railyards Area proposes development of a transit oriented mixed use urban environment that would include between 10,000 and 12,100 dwelling units, 2.3 million square feet of office, 1.3 million square feet of retail, 1,100 hotel rooms, and 46 acres of open space. The goal is to integrate and connect the Railyards area with the downtown business and government center with pedestrian and bicycle facilities, roadways, and public transportation routes.

Regional infrastructure planning reflects these growth plans. In December 2004, Sacramento Area Council of Governments (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). 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 TSP 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 TSP 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 would not restrict growth in the base floodplain in the short term. The 400,000 people living and working in the American River North and American River South Basins would remain at risk of flooding. However, the State of California's Senate Bill (SB) 5 stipulates that development in urban areas will be restricted if the localities have not made meaningful progress toward achieving a 200 year level of performance (per State of California standards) by 2025. Therefore, the No-Action Alternative would restrict growth in the base floodplain in the long term.

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.*

The public will be advised of the recommendations contained in the GRR during the public comment period for the draft and final reports. Public meetings will be held during these time periods.

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 study is to reduce flood risk and its associated consequences on the public health, safety, and property in the study area. In order to achieve this objective, the study recommends improvements to the ARS and ARN basin levees. These two basins are essentially built-out; however, infill development is ongoing. There are no development restrictions in these basins and so this infill development would occur even without implementation of this recommended plan. Therefore, the project does not trigger or induce development that would not otherwise occur. The TSP study recommendations are consistent with the requirements of the Executive Order since there is no

practicable alternative to improving the levees which are the first line of defense for reducing the risk of flooding in the established urban area. The consistency of these recommendations is further demonstrated by the reduction in the probability of flooding in the study area and the associated societal, economic and environmental hazards posed by flooding. The TSP would reduce the risk associated with floods thereby minimizing the impacts of floods on human safety, health, and welfare. The TSP also recommends widening the Sacramento Weir and Bypass which would assist in the restoration and preservation of the natural and beneficial values of the base floodplain.

4.12 ENVIRONMENTAL OPERATING PRINCIPLES

The Tentatively Selected Plan supports each of the seven USACE Environmental Operating Principles (EOPs). The re-energized Environmental Operating Principles are:

1. Foster sustainability as a way of life throughout the organization.
2. Proactively consider environmental consequences of all Corps activities and act accordingly.
3. Create mutually supporting economic and environmentally sustainable solutions.
4. Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the Corps, which may impact human and natural environments.
5. Consider the environment in employing a risk management and systems approach throughout the life cycles of projects and programs.
6. Leverage scientific, economic and social knowledge to understand the environmental context and effects of Corps actions in a collaborative manner.
7. Employ an open, transparent process that respects views of individuals and groups interested in Corps activities.

The environmental operating principles are met in the following ways:

<u>Environmental balance and sustainability (EOP 1,2,3 &4)</u>

- Project avoids or minimizes environmental impacts while maximizing future safety and economic benefits to the community

<u>Planning with the environment (EOP 1,2 4, and 5)</u>

- Worked with resource agencies during planning phase to minimize impacts to the environment.
- The recommended plan allows for expanded floodplain flooding in widened bypass area.

Integrate scientific, economic and social knowledge base (EOP 6)

- Sought advice from panel of experts on the status and likelihood of erosion on the American River.

Seeks Public input and Comment (Win-win solutions) (EOP 7)

- Held stakeholder meetings and public workshops throughout the process
- Worked with local groups to achieve a balance of project goals and public concerns

4.13 USACE CAMPAIGN PLAN

The mission of the U.S. Army Corps of Engineers is to provide vital public engineering services in peace and war to strengthen the Nation's security, energize the economy and reduce risks from disasters. In order to meet this mission, the agency has developed the USACE Campaign Plan (FY13-18) as a component of the corporate strategic management process to establish priorities, focus on the transformation initiatives, measure and guide progress and adapt to the needs of the future. The goals and supporting objectives of the Campaign Plan are:

Goal 1 – Support National Security

Objective 1a – Support Combatant Commands and other U.S. government agencies

Objective 1b – Partner with Installation Management Communities

Objective 1c – Achieve National/Army energy security and sustainability goals

Objective 1d – Support the Engineer Regiment

Goal 2 - Transform Civil Works

Objective 2a – Modernize the Civil Works project planning program and process

Objective 2b – Enhance Civil Works budget development with a systems Watershed –Informed approach

Objective 2c – Deliver quality solutions and services

Objective 2d – Deliver reliable, resilient and sustainable infrastructure systems

Goal 3 - Reduce Disaster Risk

Objective 3a – Enhance interagency disaster response and risk reduction capabilities

Objective 3b - Enhance interagency disaster recovery capabilities

Objective 3c - Enhance interagency disaster mitigation capabilities

Objective 3d – Strengthen Domestic Interagency Support

Goal 4 - Prepare for Tomorrow

Objective 4a – Maintain and advance DoD and Army critical enabling technologies

Objective 4b – Build trust and understanding with strategic engagement, communication, and cyber-security

Objective 4c – Streamline USACE business, acquisition and governance processes

Objective 4d – Build ready and resilient people and teams through talent management / leader development

The American River Common Features GRR has been responsive to these goals and objectives by:

Deliver reliable, resilient and sustainable infrastructure systems:

- Designing a project which avoids or minimizes environmental impacts while maximizing future safety and economic benefits to the community
- The TSP allows for expanded floodplain flooding in the widened bypass area.

Deliver quality solutions and services*:*

- Coordinated with study sponsors and vertical team to identify a path forward on compliance with ETL 1110-2-583, *Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures*.

Build trust and understanding with strategic engagement, communication, and cyber-security:

- The Feasibility Study team organized and participated in stakeholder meetings and public workshops throughout the process and worked with local groups to achieve a balance of project goals and public concerns.

Build ready and resilient people and teams through talent management / leader development:

- The study successfully employed the use of District Quality Control (DQC), Agency Technical Review (ATR), Risk Analysis, and Independent External Peer Review (IEPR) to assist in the review of the development of a technically sound recommendation of Federal Interest.

4.14 PLAN ECONOMICS AND COST SHARING

The project first cost, estimated on the basis of October 2014 price levels, amounts to $1,471,565,000. Table 4-11 displays each cost by project feature. Estimated average annual costs were based on a 3.375% discount rate, a period of analysis of 50 years, and construction ending in 2030.

Table 4-11: Estimated First Costs of Tentatively Selected Plan[1] ($1,000s).

MCACES Account[2]	Description	Total First Cost
01	Lands and Damages[3]	$96,938
02	Relocations[4]	$63,040
06	Fish and Wildlife	$55,472
11	Levees and Floodwalls	$908,090
15	Floodway Control & Diversion Structure	$53,664
18	Cultural Resources	$21,435
18	Cultural Resource Compliance Contingency[5]	$4,730
30	Planning, Engineering, Design[6]	$171,555
31	Construction Management[7]	$94,591
	Total First Cost[8]	**$1,469,515**

Notes:
[1]Based on October 2014 price levels, 3.375% discount rate, and a 50-year period of analysis.
[2]Micro Computer-Aided Cost Engineering System (MCACES) is the software program and associated format used by USACE in developing cost estimates. Costs are divided into various categories identified as "accounts." Detailed costs estimates are presented in Appendix C, Attachment D, Cost Engineering.
[3]Real Estate land costs, which include no damages.
[4]Relocations include relocating affected utilities and irrigation ditches.
[5]Contingency costs for cultural resource compliance is specifically for data recovery as needed.
[6]15 percent of 02, 11, and 18 accounts.
[7]8.5 percent of 02, 11, and 18 accounts.
[8] Numbers reported may be slightly different than those presented in the appendices due to rounding.

The estimated total project first cost for the TSP is $**1,469,515,000** (October 2014 price levels). The Federal portion of the estimated first cost is **$865,351,000** and is based on the cost sharing percentages established by the NED Plan. A summary of the cost sharing responsibilities is presented in Table 4-12.

Table 4-12: Summary of Cost Sharing Responsibilities for the TSP[1] (in $1,000s).

MCACES Account	Item	Federal[2]	Non-Federal	Total
NED (Alternative 1)				
01	Lands and Damages (LERRDs)[3]	$9,050	$119,808	$128,858
02	Relocations (LERRDs)	$0	$45,895	$45,895
06	Fish and Wildlife	$51,659	$0	$51,659
11	Levees and Floodwalls	$846,713	$0	$846,713
18	Cultural Resources[4]	$19,213	$0	$19,213
30	Planning, Engineering, Design[5]	$137,636	$11,474	$149,110
31	Construction Management	$77,995	$4,590	$82,585
	Non-Fed 5% Cash Contribution	-$66,202	$66,202	
	Non-Fed Additional Cash Contribution	-$215,443	$215,443	
	Subtotal (NED Plan Cost Sharing)	$860,621	$463,412	$1,324,033
	Percentage	65%	35%	
18	Cultural Resource Compliance Contingency[6]	$4,240	$0	$4,240
	Total (NED Plan Cost Sharing)	$864,861	$463,412	$1,328,273
TSP/LPP (Alternative 2)				
01	Lands and Damages (LERRDs)[3]	$9,225	$87,713	$96,938
02	Relocations (LERRDs)	$0	$63,040	$63,040
06	Fish and Wildlife	$55,472	$0	$55,472
11	Levees and Floodwalls	$908,090	$0	$908,090
15	Floodway Control & Diversion Structure	$53,664	$0	$53,664
18	Cultural Resources[4]	$21,435	$0	$21,435
30	Planning, Engineering, Design[5]	$155,795	$15,760	$171,555
31	Construction Management	$88,287	$6,304	$94,591
	Non-Fed 5% Cash Contribution	-$73,239	$73,239	
	Non-Fed Additional Cash Contribution for Cost Share Balance	-$266,619	$266,619	
	Non-Fed Additional Cash Contribution for LPP	-$91,979	$91,979	
	Subtotal (NED Plan Cost Sharing)	$860,131	$604,654	$1,464,785
	Percentage	58.7%	41.3%	
18	Cultural Resource Compliance Contingency[6]	$4,730	$0	$4,730
	Total (NED Plan Cost Sharing)	$864,861	$604,654	$1,469,515

Notes: [1] Based on October 2014 price levels, 3.375% discount rate, and a 50-year period of analysis.
[2] Federal Project First Costs are based on 65% of the NED Plan of $1,324,033,000. The costs displayed are preliminary and will be refined as the study progresses.
[3] Non-Federal interests must provide all LERRDs and a minimum cash contribution of 5% of the total project cost. LERRDs include Lands, Easements, Rights-of-way, Relocations, and Disposal sites.
[4] Cultural Resources efforts include identification and evaluation of cultural resource sites as well as alternative mitigation.
[5] Planning, Engineering, and Design. Includes supplemental environmental compliance work.
[6] Cultural Resource Compliance Contingency includes data recovery activities, if necessary.

Table 4-13. Economic Costs and Benefits of the TSP

Description	Cost (1,000s)
Investment Cost	
TSP First Cost	$1,469,515
Interest During Construction	$298,142
Total Investment Cost	$1,767,657
Annual Cost	
Interest and Amortization	$73,671
OMRR&R[2]	$494
Total Annual Costs	$74,165
Annual Benefits	$315,800
Net Annual Benefits	$241,635
Benefit-Cost Ratio **Water Resources Planning Rate: 3.375%**	4.3
Benefit-Cost Ratio **OMB Circular No. A-94 Rate: 7%**	2.5

[1] Based on October 2014 price levels, 3.375 percent discount rate, and a 50-year period of analysis. See Economic Appendix regarding economic uncertainty.
[2] Operation, Maintenance, Repair, Replacement, and Rehabilitation.

4.15 VIEWS OF NON-FEDERAL SPONSORS AND OTHER AGENCIES

The non-Federal sponsor supports the TSP. Throughout development of this GRR, there has been significant coordination with the State of California and SAFCA.

The TSP is a consistent and fundamental piece of the Lower Sacramento/Delta North Regional Flood Management Plan (RFMP), a non-Federal initiative by the State of California and local agencies that includes a concept for the expansion of the Fremont and Sacramento Weirs and the widening of the Sacramento and Yolo Bypasses. The TSP provides for Federal involvement in a critical piece of this plan by widening the Sacramento Weir and Bypass.

4.16 POTENTIAL ADDITIONAL STUDIES

As mentioned in Chapter 1, this study would only partially address the American River Watershed authorization and is therefore called an “interim General Reevaluation Report” which indicates that the study is addressing the water resource issues of a specific area within the authority, rather than the entire area authorized for study. This GRR is not intended to be a complete resolution of all issues in the watershed that may require study and future studies may address further issues. Additional studies to address other water resource issues within the American River Watershed could be initiated based on Congressional direction.

5 - CHANGES TO COMMON FEATURES PROJECT

The chapter integrates the reevaluated 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 economics, cost apportionment, 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 seepage cutoff wall up to depths of 110 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 as authorized in WRDA 1996 and WRDA 199 has been completed with the balance being completed in 2015. Work authorized in WRRDA 2014 for the Natomas Basin is just being initiated. Table 5-1 provides an overview of this work by reach.

Table 5-1: 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 1996. Overview: Approximately 24 miles of slurry wall for seepage and stability improvements in the levees along the lower 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.
2	12 miles of levee improvements, Sac. River east levee in Natomas.	Authorization: WRDA 1996. Overview: Approximately 12 miles of seepage, stability, and height levee modifications along the east bank of the Sacramento River downstream from the Natomas Cross Canal. Status: completed by SAFCA as part of NLIP.
3	3 telemetry streamflow gages u/s of Folsom Dam	Authorization: WRDA 1996. Overview: Installation of three telemetry stream flow gauges upstream from Folsom Dam and Reservoir. Status: complete.
4	Modification of the existing flood warning system	Authorization: WRDA 1996. Overview: Modifications to the flood warning system along the Lower American River for the City of Sacramento. Status: completed by non-Federal sponsor.
5	Mayhew Levee upstream of the Mayhew Drain	Authorization: WRDA 1999. Overview: Seepage and stability improvements and raising by and average of 2.5 feet the left bank of the non-Federal levee upstream of the Mayhew Drain for a distance of 4,500 feet and installing 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 1999. Overview: Raising the right bank of the American River levee in the vicinity of Howe Avenue by an average of 1 foot. Status: complete.

Item	Feature	Authorization, Overview, and Status
7	5 miles of levee improvement, Natomas Cross Canal south levee in Natomas	Authorization: WRDA 1999. Overview: Modifying the south levee of the Natomas Cross Canal for a distance of 5 miles for seepage, stability, and 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. Status: completed by SAFCA as part of NLIP.
8	5 miles of levee improvement, Natomas Cross Canal north levee across from Natomas	Authorization: WRDA 1999. Overview: Modifying the north levee of the Natomas Cross Canal for a distance of 5 miles for seepage, stability, and to ensure that the height of the levee is equivalent to the height of the south levee. Status: not complete. No sponsor has been identified to cost share this feature.
9	North Levee Strengthening between NEMDC and Business I-80	Authorization: WRDA 1999. Overview: 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. Status: Complete.
10	North Levee upstream of Watt Avenue (Jacobs Lane)	Authorization: WRDA 1999. Overview: Installing a slurry wall in the north levee of the American River in the vicinity of Jacob Lane north for a distance of approximately 1 mile to the upstream end of the existing levee. Status: Complete.
11	Pocket Geotech Reaches 2 and 9, and Pioneer Reservoir	Authorization: 2006 Post-Authorization Change. Overview: Installing a total of 3.6 miles of discontinuous slurry wall at two levee sites on the Sacramento River in the Pocket Area and installing six relief wells and collector drains and appurtenant features and a landside berm on the Sacramento River at the levee toe in the Pioneer Reservoir area. Status: complete.
12	American River adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 2.0 miles of levee in place and install seepage cutoff wall through levee and foundation on the Lower American River. Status: In design.
13	Sacramento River adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: 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. Status: 13 miles of adjacent levee, 9 miles of deep seepage cutoff walls, and 4 miles of seepage berm constructed by SAFCA as part of NLIP. Remaining construction to be completed by USACE, and schedule is under development.
14	Pleasant Grove Creek Canal adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen the existing levee in place and installation of a soil bentonite cutoff wall that ranges in depth between 65 and 70 feet on the Pleasant Grove Creek Canal. Status: Construction to be completed by USACE, and schedule is under development.
15	NEMDC adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 12.8 miles of existing levee and installation of 10.7 miles of soil bentonite cutoff wall on NEMDC. Status: Lowest 5 miles under design for construction in 2017. Remaining construction to be completed by USACE and schedule is under development.

Item	Feature	Authorization, Overview, and Status
16	NCC adjacent to Natomas Basin	Authorization: WRRDA 2014. Overview: Widen 5.5 miles of existing levee in-place and install deep seepage cutoff walls on south bank of NCC. Status: Completed by SAFCA as part of NLIP with exception of 3 windows. Windows to be completed by USACE and schedule is under development

5.2 ECONOMIC SUMMARY.

The authorized project first costs, along with total annual costs, annual benefits, net economic benefits, and benefits-to-cost ratios are shown in Table 5-2 below. The estimated first costs, along with total annual costs, annual benefits, net economic benefits and the benefits-to-cost ratios of the total authorized project combined with the recommended plan from this study are shown on Table 5-3 below. These values are based on October 2014 price levels, a discount rate of 3.375% and a 50-year period of economic analysis, assuming initiation of USACE construction in FY 2018.

5.3 COST APPORTIONMENT

Cost apportionment for the existing authorized Common Features project (for both WRDA 1996, WRDA 1999 and EWDAA 2004 features as well as WRRDA 2014 features), the TSP, and the Total Common Features Recommended Plan (authorized Common Features project plus the TSP) is shown in accordance with the authorized percentages. These percentages are as follows: WRDA 1996, WRDA 1999, and EWDAA 2004 all cost shared at 75% Federal and 25% non-Federal; WRRDA 2014 cost shared at 65% Federal and 35% non-Federal; and the GRR Recommended Plan cost shared at 65% Federal and 35% non-Federal.

Table 5-2: Economic Analysis of the Authorized Project ($1,000s).

	WRDA 1996/1999 Features				
Construction Item	**Authorized Cost (2004) [1]**	**Reported to Congress (2010) [2]**	**Current Project Cost Estimate (2014) [3]**	**Natomas PAC Authorized Cost (WRRDA 2014) [4]**	**Total Current Estimate Authorized Cost[5]**
Lands and Damages	$5,750	$17,173	$15,668	$235,522	$251,190
Relocations	$460	$381	$381	$118,967	$119,348
Fish & Wildlife Facilities	$1,730	$2,075	$3,952	$18,956	$22,908
Levees & Floodwalls	$153,760	$169,497	$189,075	$396,462	$585,537
Pumping Plants	$0	$0	$0	$56,884	$56,884
Cultural Resource - Data Recovery[6]	$750	$1,190	$0	$6,701	$6,701
Planning Engineering & Design (PED)	$35,380	$71,604	$96,953	$152,609	$249,562
Construction Management	$7,170	$16,060	$14,671	$161,179	$175,850
Subtotal First Cost	**$205,000**	**$277,980**	**$320,700**	**$1,147,280**	**$1,467,980**
Interest During Construction	$0	$17,998	$0	$131,000	$131,000
Total First Cost	**$205,000**	**$295,978**	**$320,700**	**$1,278,280**	**$1,598,980**
Interest and Amortization[7]	$0	$14,615	$0	$53,275	$53,275
OMRR&R	$0	$85	$0	$5,180	$5,180
Total Annual Costs	**$0**	**$14,700**	**$0**	**$58,455**	**$58,455**
Total Annual Benefits	$42,300	$59,500	$59,500	$443,000	$502,500
Net Annual Benefits	**NA**	**$44,800**	**NA**	**$384,545**	**$444,045**
Benefit to Cost Ratio	**NA**	**4.0**	**NA**	**7.6**	**8.6**

[1] Authorized Cost is as reflected in the 2001 Limited Reevaluation Report, and authorized by Congress in 2004 (EWDAA). This is the last authorization by Congress for the WRDA 1996/1999 features. Authorized costs/benefits are in October 2001 prices using a 6.125% discount 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.

[2] The Authorized Cost, adjusted for inflation, and last reported to Congress was in 2010 in the Natomas PACR. Reported to Congress estimate of cost and benefits are in October 2010 prices using a 4.375% discount rate, unless otherwise noted.

[3] The Authorized Cost, adjusted for inflation to 2014 is $320,700,000.

[4] The recommended plan contained in the Natomas GRR was authorized by WRRDA 2014 (Pub.L. No. 113-121). This document assumes the features described in the Natomas PAC are constructed.

[5] Authorized Cost Estimate (totaling $1,147,280,000) plus the current Project Cost Estimate for the WRDA 1996/1999 Authorized Project (totaling $320,700,000) for a total of $1,467,980,000.

[6] Cultural Resources data recovery costs will be removed from the Economic Cost calculations for the final version of this report

[7] Construction of WRDA 1996/1999 features will be complete in fiscal year 2015 and therefore no additional Interest and Amortization is included for this work. It is sunk cost. The Natomas PAC work substantially is work to be completed in the future so this reflects future investment and therefore includes interest and amortization.

Table 5-3: Economic Analysis of the Tentatively Selected Plan ($1,000s).

Account		Existing Authorized Common Features Project[1]	TSP[2]	Recommended Plan
01	Lands and Damages	$251,190	$96,938	$348,128
02	Relocations	$119,348	$63,040	$182,388
06	Fish and Wildlife Facilities	$22,908	$55,472	$78,380
11	Levees and Floodwalls	$585,537	$908,090	$1,493,627
13	Pumping Plants	$56,884	$0	$56,884
15	Floodway Control & Diversion Structure	$0	$53,664	$53,664
18	Cultural Resources	$0	$21,435	$21,435
18	Cultural Resources – Data Recovery	$6,701	$4,730	$11,431
30	PED	$249,562	$171,555	$421,117
31	Construction Management	$175,850	$94,591	$270,441
	Subtotal First Cost	**$1,467,980**	**$1,469,515**	**$2,937,495**
	Interest During Construction	$131,000	$298,142	$429,142
	Total First Cost	**$1,598,980**	**$1,767,657**	**$3,366,637**
	Interest and Amortization	$53,275	$73,671	$126,946
	OMRR&R	$5,180	$494	$5,674
	Total Annual Costs	**$58,455**	**$74,165**	**$132,620**
	Total Annual Benefits	$502,500	$315,800	$818,300
Net Annual Benefits		**$444,045**	**$241,635**	**$685,680**
Benefit to Cost Ratio		**8.6**	**4.3**	**6.2**

[1] Authorized Cost is as reflected in the 2001 Limited Reevaluation Report, authorized by Congress in 2004 (EWDAA), and last updated in 2014, along with the Natomas PAC features authorized by Congress in 2014 (WRRDA). These are the last authorizations by Congress on the Common Features project.
[2] Recommended Plan calculated at October 2014 Price levels, 3.375% discount rate and a 50 year period of analysis.

Table 5-4: Cost Apportionment ($1,000s)*.

Item	Federal Cost	Non-Federal Cost	Total Cost
Existing Authorized Common Features Project (includes WRDA 1996, WRDA 1999, and EWDAA 2004)			
Construction	$193,027	$0	$193,027
LERRD	$2,263	$13,786	$16,049
PED	$96,953	$0	$96,953
Construction Management	$14,671	$0	$14,671
Subtotal	$306,914	$13,786	$320,700
Minimum 5% cash contribution	-$16,035	$16,035	
Additional cash contribution	-$50,354	$50,354	
Subtotal FRM First Cost	$240,525	$80,175	$320,700
Percent of Total FRM	75.0%	25.0%	
Cultural Resources Data Recovery	$0	$0	$0
Total FRM First Cost	$240,525	$80,175	$320,700
Existing Authorized Common Features Project (includes WRRDA 2014)			
Construction	$472,302	$0	$472,302
LERRD	$19,572	$334,917	$354,489
PED	$132,370	$20,239	$152,609
Construction Management	$153,240	$7,939	$161,179
Subtotal	$777,484	$363,095	$1,140,579
Minimum 5% cash contribution	-$57,029	$57,029	
Additional cash contribution	$0	$0	
Subtotal FRM First Cost	$720,455	$420,124	$1,140,579
Percent of Total FRM	63.2%	36.8%	
Cultural Resources Data Recovery	$6,701	$0	$6,701
Total FRM First Cost	$727,156	$420,124	$1,147,280
GRR Recommended Plan			
Construction	$1,017,226	$0	$1,017,226
LERRD	$9,225	$150,753	$159,978
PED	$177,230	$15,760	$192,990
Construction Management	$88,287	$6,304	$94,591
Subtotal	$1,291,968	$172,817	$1,464,785
Minimum 5% cash contribution	-$73,239	$73,239	
Additional cash contribution	-$358,107	$358,107	
Subtotal FRM First Cost	$860,621	$604,164	$1,464,785
Percent of Total FRM	58.8%	41.2%	
Cultural Resources Data Recovery	$4,730	$0	$4,730
Total FRM First Cost	$865,351	$604,164	$1,469,515
Total Recommended Plan			
Construction	$1,682,555	$0	$1,682,555
LERRD	$31,060	$499,456	$530,516
PED	$406,553	$35,999	$442,552
Construction Management	$256,198	$14,243	$270,441
Subtotal	$2,376,366	$549,698	$2,926,064

Item	Federal Cost	Non-Federal Cost	Total Cost
Minimum 5% cash contribution	-$146,303	$146,303	
Additional cash contribution	-$408,461	$408,461	
Subtotal FRM First Cost	$1,821,602	$1,104,463	$2,926,064
Percent of Total FRM	62.3%	37.7%	
Cultural Resources Data Recovery	$11,431	$0	$11,431
Total FRM First Cost	$1,833,033	$1,104,463	$2,937,495

[1]October 2014 Price Levels

5.4 FULLY FUNDED COST ESTIMATE

The required funding by fiscal year has been determined for the project. Table 5-5 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.

Table 5-5: Funding by Fiscal Year ($1,000s).

	Fiscal Year									
	2018	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**
Federal										
Preconstruction Engineering and Design	32,163	17,755	17,755	5,087	26,041	22,297	11,972	14,400	8,330	0
Construction Management	0	3,924	12,782	12,782	11,740	7,378	11,553	10,959	8,163	9,009
Construction	0	41,161	139,303	139,303	128,449	80,373	126,975	119,756	88,407	98,027
Fish and Wildlife Facilities	0	4,150	8,130	8,130	6,950	4,689	6,246	6,604	5,463	5,113
Cultural Resources	0	1,040	3,604	3,604	3,339	2,111	3,285	3,131	2,589	3,465
Federal LERRD	1,167	1,804	1,804	175	700	308	233	896	2,138	0
Total Federal	33,330	69,834	183,378	169,081	177,219	117,156	160,264	155,746	115,090	115,614
Non-Federal Up Front Cash	4,352	16,992	55,310	57,077	54,716	37,258	51,674	73,377	30,329	52,236
Net Federal	28,978	52,842	128,068	112,004	122,503	79,898	108,590	82,369	84,761	63,378
Non-Federal										
Preconstruction Engineering and Design	419	536	536	0	2,513	2,851	1,452	3,628	3,826	0
Construction Management	0	0	199	199	199	503	783	861	1,452	2,111
Relocations	0	0	1,989	1,989	1,989	5,025	7,824	8,606	14,512	21,107
Non-Federal LERRD	10,832	10,926	10,926	1,044	6,547	3,138	2,491	4,960	36,849	0
Total Non-Federal	11,251	11,462	13,650	3,232	11,248	11,517	12,550	18,055	56,639	23,218
Non-Federal Up Front Cash	4,352	16,992	55,310	57,077	54,716	37,258	51,674	73,377	30,329	52,236
Total Non-Federal	**15,603**	**28,454**	**68,960**	**60,309**	**65,964**	**48,775**	**64,224**	**91,432**	**86,968**	**75,454**
Total Project	**44,581**	**81,296**	**197,028**	**172,313**	**188,467**	**128,673**	**172,814**	**173,801**	**171,729**	**138,832**

5.5 INSTITUTIONAL REQUIREMENTS

The schedule for project implementation assumes reauthorization of the Common Features Project in the proposed WRRDA 2016. 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 USACE 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.

USACE 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 USACE 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 5-6: Implementation Schedule.

Item	Completion Date
Plans and Specifications for First Contract Complete	TBD
PPA Signed	TBD
Real Estate Acquisitions Completed for First Contract	TBD
Advertise First Construction Contract	TBD
Completion of All Construction	TBD

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 Reevaluation 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 addressed 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 (5-7 p.m.).
- March 10, Library Galleria—828 I Street, Sacramento (3-6 p.m.).
- March 12, Elk's Lodge— 6446 Riverside Boulevard, Sacramento (5-7 p.m.).
- March 13, Sierra Health Foundation— 1321 Garden Highway, Sacramento (5-7 p.m.).

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 twelve 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 EIS/EIR (Appendix I of the EIS/EIR).

6.3 OTHER PUBLIC INVOLVEMENT

To help the community stay informed about current project activities, information is provided in a variety of ways:

- Representatives of the Sacramento District attend and report on the status of the GRR at the American River Task Force meetings which occur quarterly and are open to the public;
- GRR 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, begin at 3 p.m., and are open to the public.

- The Sacramento District briefs the Central Valley Flood Protection Board (CVFPP) on the status of the GRR upon request. The CVFPP meets monthly on the last Friday of the month beginning at 9 a.m. at various locations including the Sacramento City Hall, 915 I Street, Sacramento, California, 95814, and are open to the public. Archived video footage of previous meetings is located at the following link: http://www.cvfpb.ca.gov/meetings/2013/videos/index.cfm
- Quarterly coordination meetings are held with the United Auburn Indian Community of the Auburn Rancheria and the Shingle Springs Band of Miwok Indians.

6.4 INSTITUTIONAL INVOLVEMENT

6.4.1 Study Team

During the reevaluation 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.

6.4.2 Agency Participation

Coordination with the USFWS is being conducted in accordance with the Fish and Wildlife Coordination Act. The project is also being coordinated with the National Marine Fisheries Service and the California Department of Fish and Wildlife (CDFW).

6.5 ADDITIONAL REQUIRED COORDINATION

Additional required coordination will be summarized in the final report.

6.6 PUBLIC VIEWS AND RESPONSES

Public views and responses to comments on the draft report will be summarized in the final report.

6.7 IMPACT ON RECOMMENDATIONS

Any impacts on the recommendations due to public views will be summarized in the final report.

7 - RECOMMENDATIONS

I recommend modifying the authorized American River Common Features project to include the following: the construction of levee improvement measures to address seepage, stability, erosion and overtopping concerns identified for the Sacramento River, Natomas East Main Drainage Canal (NEMDC), Arcade Creek, Dry Creek, Robla Creek, and Magpie Creek as well as erosion measures for specific locations along the American River. The Sacramento Weir and Bypass would be widened to divert more flood flows into the Yolo Bypass. The estimated first cost of these recommended improvements is $1,469,515,000. Adding the cost of these improvements to the Common Features project makes a total project first cost of $2,937,495,000. The estimated additional annual Operation and Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) cost is $500,000. The Federal portion of the estimated total first cost is $1,833,033,000. The total first cost of the Common Features project of $2,937,495,000 includes costs already incurred implementing previously authorized Common Features elements. The features authorized in WRDA 1996 and WRDA 1999 and constructed were cost shared at 75% Federal and 25% non-Federal. Newly authorized elements, as well as the features authorized in WRRDA 2014 will be cost shared in accordance with WRDA 1986, at 65% Federal and 35% non-Federal. Applying these requirements along with the additional cost born by the non-Federal sponsor for the LPP results in cost sharing for the Recommended Plan (authorized features plus new features) at 62.4% Federal and 37.6% non-Federal. Federal implementation of the recommended project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

a. Provide a minimum of 35 percent, but not to exceed 50 percent of total project costs as further specified below:
    1. Provide 35 percent of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
    2. Provide, during construction, a contribution of funds equal to 5 percent of total project costs which must be in the form of cash;
    3. 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;
    4. Provide, during construction, any additional funds necessary to make its total contribution equal to at least 35 percent of total project costs;
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 flood plain 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 flood plain 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 flood plain 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 3 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 C.F.R. § 33.20;

n. Comply with all applicable Federal and State laws and regulations, including, but not limited to: 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-276a-5), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. §§ 327-333), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. § 276c);

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 to 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.

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Date

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Colonel, U.S. Army
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Chapter 8 - REFERENCES

The following list of references is pertinent to the documentation preceding this chapter. Many of the references are actually cited throughout the documentation. However, some references are not cited. They are included in this list of references because they give an overall background and context to this study.

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 Institute 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.

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

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, City of, " How the City Prepares for Flooding", http://portal.cityofsacramento.org/Utilities/Education/Flood-Ready/City-Flood-Prep

Sacramento County Historical Society. 2008. Flooding History. http://www.sachistoricalsociety.org/journal_VI.cfm

Sacramento County: http://www.stormready.saccounty.net/Pages/Home.aspx

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. 1991. American River Watershed Investigation, California. Feasibility Report and Environmental Impact Statement/Environmental Impact Report. Sacramento District. Sacramento, CA.

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. 2003. Recommendations for Seepage Design Criteria, Evaluation and Design Practices. Sacramento District Levee Task Force. Sacramento, CA.

U.S. Army Corps of Engineers. 2004. Lower American River, Erosion Susceptibility Analysis for Infrequent Flood Events.

U.S. Army Corps of Engineers. 2006. American River Watershed (Common Features), California. Pocket and Pioneer Reservoir Levee Improvements. Final Engineering Documentation Report.

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. 2007. American River Watershed Project, California. Folsom Modification and Folsom Dam Raise Projects. Post Authorization Change Report.

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. Army Corps of Engineers. 2010. Post-Authorization Change Report and Interim General Reevaluation Report, American River Watershed Project, Common Features Project, Natomas Basin, Sacramento and Sutter Counties, California, Final Report.

U.S. Army Corps of Engineers. 2011. Risk Characterization for Levees, USACE Levee Safety Program. Http://www.nld.usace.army.mil/egis/

U.S. Army Corps of Engineers. 2012. Sacramento River Sediment Study Phase II.

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