CENTRAL VALLEY
FLOOD MANAGEMENT
PLANNING PROGRAM

FloodSAFE
CALIFORNIA

Flood Control System Status Report
Appendix A – Levee Status

December 2011

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

This page left blank intentionally.

Table of Contents

List of Tables

List of Figures

Appendix A – Levee Status

Appendix A provides additional supporting information on levee physical conditions. The levee status overview includes data that reflect the impacts of multiple levee status factors on levee conditions. These data include information from U.S. Army Corps of Engineers (USACE) Periodic Inspection results, historical levee breaches and overtopping locations, and a summary of Early Implementation Program projects, Central Valley Flood Protection Board (Board) projects, and other modifications to SPFC facilities. Sections A-2 through A-10 of Appendix A are organized by levee status factors, and correspond to the subsections in Section 4 of the Flood Control System Status Report (FCSSR) main document. Additional inspection and/or evaluation data, recent, ongoing, and planned remedial actions/improvements, and ongoing actions to improve future evaluations are described for each levee status factor.

A-1 Levee Status Overview

This section presents USACE Periodic Inspection results, contains data on historical levee breaches and levee overtopping locations, Early Implementation Program and USACE/Board projects, and other modifications to State Plan of Flood Control (SPFC) facilities.

USACE Periodic Inspection Report Cards

USACE Periodic Inspections are conducted to verify proper operations and maintenance (O&M); evaluate operational adequacy and structural stability; identify features to monitor over time; and improve communication regarding overall facility condition and safety. USACE conducts its Periodic Inspections to rate flood damage reduction systems. A flood damage reduction system is a complete and independent unit made up of one or more flood damage reduction segments that collectively provide flood damage reduction to a defined area. Failure of one segment within a system constitutes failure of the entire system. The following 10 USACE systems were inspected between December 2009 and February 2010.

- City of Marysville, Units 1, 2, and 3 System
- City of Marysville, Unit 3 Northeast Extension System

- American River Flood Control District – Dry Creek Right Bank, Unit 8 System
- American River Flood Control District – Dry Creek, Natomas East Main Drainage Canal, and Arcade Creek System
- American River Flood Control District – American River Right Bank, Natomas East Main Drainage Canal System
- Reclamation District 1000 – Natomas System
- Feather River Right Bank – Sutter Bypass East Bank Levee System
- Maintenance Area 9 – City of Sacramento, American River Left Bank System
- Reclamation District 404 and Duck Creek Right Bank – Boggs Tract System
- Reclamation Districts 17, 2094, 2096, 2075, and 2064 – San Joaquin River East Levee System

Report cards serve as a findings summary of USACE Periodic Inspections. Tables A-1 through A-10 display Periodic Inspection Report Cards for each system.

Table A-1. City of Marysville – Units 1, 2, 3 System Report Card

City of Marysville - Units 1, 2, 3 Unacceptable-Inactive	Unit 1 Jack Slough	Unit 2 Feather River	Unit 3 Yuba River						
Operations and Maintenance Manuals	M	M	M						
Emergency Supplies and Equipment	A	A	A						
Flood Preparedness and Training	M	M	M						
Unwanted Vegetation Growth	U	U	U						
Sod Cover	A	A	A						
Encroachments	U	U	U						
Closure Structures	A	A	A						
Slope Stability	U	A	M						
Erosion/Bank Caving	M	M	M						
Settlement	A	A	A						
Depressions/Rutting	U	A	A						
Cracking	U	A	A						
Animal Control	M	M	M						
Culverts/Discharge Pipes	NA	NA	NA						
Riprap Revetments & Bank Protection	NA	NA	M						
Revetments other than Riprap	NA	NA	NA						
Underseepage Relief Wells/Toe Drainage Systems	NA	NA	NA						
Seepage	A	A	A						

Segment & System Ratings/PL 84-99 Eligibility

Likely Prevents Performance In Next Flood Event

Serious deficiency noted in past inspections has not been corrected within the established timeframe

Likely Prevents Performance In Next Flood Event (Framework)

Not Likely to Prevent Performance In Next Flood Event

Not Likely to Prevent Performance In Next Flood Event (Framework)

The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility

Legend

A	Acceptable
M	Minimally Acceptable
U	Unacceptable
N/A	Not Applicable

July 6, 2010

Table A-2. City of Marysville – Unit 3 Northeast Extension Report Card

City of Marysville Unit 3, NE Extension Unacceptable-Inactive	Unit 3, NE Extension
Operations and Maintenance Manuals	M
Emergency Supplies and Equipment	A
Flood Preparedness and Training	M
Unwanted Vegetation Growth	U
Sod Cover	A
Encroachments	U
Closure Structures	NA
Slope Stability	A
Erosion/Bank Caving	M
Settlement	A
Depressions/Rutting	A
Cracking	A
Animal Control	M
Culverts/Discharge Pipes	NA
Riprap Revetments & Bank Protection	NA
Revetments other than Riprap	NA
Underseepage Relief Wells/Toe Drainage Systems	NA
Seepage	A
Segment & System Ratings/PL 84-99 Eligibility	
Likely Prevents Performance In Next Flood Event	
Serious deficiency noted in past inspections has not been corrected within the established timeframe	
Likely Prevents Performance In Next Flood Event (Framework)	
Not Likely to Prevent Performance In Next Flood Event	
Not Likely to Prevent Performance In Next Flood Event (Framework)	
The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility	

Legend	
A	Acceptable
M	Minimally Acceptable
U	Unacceptable
N/A	Not Applicable

July 6, 2010

Table A-3. American River Flood Control District – Dry Creek Right Bank, Unit 8 System Report Card

American River FCD - Dry Creek Right Bank, Unit 8 Minimally Acceptable-Active	Dry Creek Right Bank, Unit 8
Operations and Maintenance Manuals	M
Emergency Supplies and Equipment	A
Flood Preparedness and Training	A
Unwanted Vegetation Growth	A
Sod Cover	A
Encroachments	U
Closure Structures	A
Slope Stability	A
Erosion/Bank Caving	A
Settlement	A
Depressions/Rutting	M
Cracking	A
Animal Control	M
Culverts/Discharge Pipes	N/A
Riprap Revetments & Bank Protection	A
Revetments other than Riprap	A
Underseepage Relief Wells/Toe Drainage Systems	A
Seepage	A
Segment & System Ratings/PL 84-99 Eligibility	
Likely Prevents Performance In Next Flood Event	
Serious deficiency noted in past inspections has not been corrected within the established timeframe	
Likely Prevents Performance In Next Flood Event (Framework)	
Not Likely to Prevent Performance In Next Flood Event	
Not Likely to Prevent Performance In Next Flood Event (Framework)	
The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility	

Legend	
A	Acceptable
M	Minimally Acceptable
U	Unacceptable
N/A	Not Applicable

July 6, 2010

Table A-4. American River Flood Control District – Dry Creek, Natomas East Main Drainage Canal, Arcade Creek System Report Card

American River FCD - Dry Creek, NEMDC, Arcade Creek Minimally Acceptable-Active	Dry Creek Left Bank Unit 6	NEMDC Unit 2 North	Arcade Creek right bank Unit 7						
Operations and Maintenance Manuals	M	M	M						
Emergency Supplies and Equipment	A	A	A						
Flood Preparedness and Training	A	A	A						
Unwanted Vegetation Growth	U	U	U						
Sod Cover	A	M	A						
Encroachments	U	U	U						
Closure Structures	A	N/A	A						
Slope Stability	A	A	A						
Erosion/Bank Caving	A	M	A						
Settlement	A	A	A						
Depressions/Rutting	A	A	A						
Cracking	A	A	A						
Animal Control	M	M	M						
Culverts/Discharge Pipes	N/A	N/A	N/A						
Riprap Revetments & Bank Protection	A	N/A	N/A						
Revetments other than Riprap	A	N/A	N/A						
Underseepage Relief Wells/Toe Drainage Systems	N/A	N/A	N/A						
Seepage	A	A	A						

Segment & System Ratings/PL 84-99 Eligibility

Likely Prevents Performance In Next Flood Event

Serious deficiency noted in past inspections has not been corrected within the established timeframe

Likely Prevents Performance In Next Flood Event (Framework)

Not Likely to Prevent Performance In Next Flood Event

Not Likely to Prevent Performance In Next Flood Event (Framework)

Legend	
A	Acceptable
M	Minimally Acceptable
U	Unacceptable
N/A	Not Applicable

The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility

July 6, 2010

Table A-5. American River Flood Control District – American River Right Bank – Natomas East Main Drainage Canal System Report Card

American River Right Bank, NEMDC Minimally Acceptable-Active	Unit 1, Arcade Creek Left Bank	Unit 2, South NMDEC below Arcade Creek	Unit 3, SRFCP	Unit 3, American River Right Bank - MA 10 and 11					
Operations and Maintenance Manuals	M	M	M	M					
Emergency Supplies and Equipment	A	A	A	A					
Flood Preparedness and Training	A	A	A	A					
Unwanted Vegetation Growth	U	M	U	U					
Sod Cover	A	M	A	A					
Encroachments	U	U	U	U					
Closure Structures	A	N/A	A	N/A					
Slope Stability	A	M	A	A					
Erosion/Bank Caving	M	A	A	A					
Settlement	A	A	A	A					
Depressions/Rutting	A	A	A	A					
Cracking	A	A	A	A					
Animal Control	M	M	M	M					
Culverts/Discharge Pipes	N/A	N/A	N/A	U					
Riprap Revetments & Bank Protection	A	N/A	N/A	N/A					
Revetments other than Riprap	A	N/A	N/A	N/A					
Underseepage Relief Wells/Toe Drainage Systems	A	N/A	N/A	N/A					
Seepage	A	A	A	A					

Segment & System Ratings/PL 84-99 Eligibility

Likely Prevents Performance In Next Flood Event

Serious deficiency noted in past inspections has not been corrected within the established timeframe

Likely Prevents Performance In Next Flood Event (Framework)

Not Likely to Prevent Performance In Next Flood Event

Not Likely to Prevent Performance In Next Flood Event (Framework)

Legend	
A	Acceptable
M	Minimally Acceptable
U	Unacceptable
N/A	Not Applicable

The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility

July 6, 2010

Table A-6. Reclamation District 1000 – Natomas System Report Card

RD 1000 - Natomas Unacceptable-Active	Unit 1, Sacramento River	Unit 2, American River	Unit 3 South, NEMDC	Unit 3 North, Cross Canal inflow	Unit 4, Natomas Cross Canal				
Operations and Maintenance Manuals	M	M	M	M	M				
Emergency Supplies and Equipment	A	A	A	A	A				
Flood Preparedness and Training	A	A	A	A	A				
Unwanted Vegetation Growth	U	U	U	U	U				
Sod Cover	A	A	A	A	A				
Encroachments	U	U	U	U	U				
Closure Structures	NA	NA	NA	NA	NA				
Slope Stability	M	A	M	A	M				
Erosion/Bank Caving	U	M	M	U	U				
Settlement	M	A	A	A	A				
Depressions/Rutting	A	A	M	M	A				
Cracking	M	A	M	A	A				
Animal Control	M	A	M	M	M				
Culverts/Discharge Pipes	NA	NA	NA	NA	NA				
Riprap Revetments & Bank Protection	M	NA	M	M	A				
Revetments other than Riprap	NA	NA	NA	NA	NA				
Underseepage Relief Wells/Toe Drainage Systems	NA	NA	NA	NA	NA				
Seepage	A	A	A	A	A				
Segment & System Ratings/PL 84-99 Eligibility						Legend			
Likely Prevents Performance In Next Flood Event						A	Acceptable		
Serious deficiency noted in past inspections has not been corrected within the established timeframe						M	Minimally Acceptable		
Likely Prevents Performance In Next Flood Event (Framework)						U	Unacceptable		
Not Likely to Prevent Performance In Next Flood Event						N/A	Not Applicable		
Not Likely to Prevent Performance In Next Flood Event (Framework)									
The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility								July 6, 2010	

Table A-7. Feather River Right Bank – Sutter Bypass East Bank Levee System Report Card

Feather River Right Bank – Sutter Bypass East Bank Levee System Unacceptable-Inactive	Feather River – Hamilton West Levee – South of Afterbay Outflow Dam	Maintenance Area 07	Reclamation District 777 Live Oak – Maintenance Area 16	Levee District 9 – Sutter County	Levee District 1 – Sutter County	Maintenance Area 03	Sutter Bypass – East Levee – South of Wadsworth Canal	Wadsworth Canal – Unit 1, Left Bank	Interceptor Canal – Unit 1, East Canal
Operations and Maintenance Manuals	M	M	M	M	M	M	M	M	M
Emergency Supplies and Equipment	A	A	A	M	A	A	A	A	A
Flood Preparedness and Training	A	A	A	M	A	A	A	A	A
Unwanted Vegetation Growth	U	U	U	U	U	U	U	U	U
Sod Cover	N/A	M	M	M	M	M	M	M	A
Encroachments	U	U	U	U	U	U	U	U	U
Closure Structures	U	N/A	N/A	A	A	N/A	N/A	A	N/A
Slope Stability	M	U	A	U	M	M	M	A	M
Erosion/Bank Caving	A	U	U	U	U	U	U	U	U
Settlement	A	A	A	A	A	A	A	A	A
Depressions/Rutting	U	U	M	U	M	M	U	M	U
Cracking	A	A	A	A	A	A	A	A	A
Animal Control	A	M	M	M	M	M	M	M	M
Culverts/Discharge Pipes	N/A	N/A	N/A	N/A	N/A	N/A	U	N/A	N/A
Riprap Revetments & Bank Protection	N/A	M	N/A	N/A	M	M	M	N/A	N/A
Revetments other than Riprap	A	N/A	N/A	U	M	N/A	M	N/A	N/A
Underseepage Relief Wells/Toe Drainage Systems	N/A	N/A	N/A	N/A	U	N/A	N/A	N/A	N/A
Seepage	A	A	A	A	A	A	A	A	A
Segment & System Ratings/PL 84-99 Eligibility							Legend		
Likely Prevents Performance In Next Flood Event							A	Acceptable	
Serious deficiency noted in past inspections has not been corrected within the established timeframe							M	Minimally Acceptable	
Likely Prevents Performance In Next Flood Event (Framework)							U	Unacceptable	
Not Likely to Prevent Performance In Next Flood Event							N/A	Not Applicable	
Not Likely to Prevent Performance In Next Flood Event (Framework)									
The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility								July 6, 2010	

Table A-8. Maintenance Area 09 – City of Sacramento, American River Left Bank Levee System Report Card

MA 09 - City of Sacramento, American River Left Bank Levee System Unacceptable-Active	ARFCD - Unit 4, American River Left Bank	ARFCD - Unit 5, Sacramento River	City of Sacramento	MA 09 - Sutterville Rd to Freeport	MA 09 - Freeport to Hood	MA 09 - Hood to Snodgress Slough			
Operations and Maintenance Manuals	M	M	M	M	A	A			
Emergency Supplies and Equipment	A	A	A	A	A	A			
Flood Preparedness and Training	A	A	A	A	A	A			
Unwanted Vegetation Growth	U	U	U	U	U	U			
Sod Cover	A	A	M	M	M	A			
Encroachments	U	U	U	U	U	U			
Closure Structures	N/A	N/A	N/A	N/A	N/A	N/A			
Slope Stability	M	A	M	M	M	M			
Erosion/Bank Caving	M	M	M	M	M	M			
Settlement	A	A	A	A	A	A			
Depressions/Rutting	M	A	A	M	A	A			
Cracking	A	A	A	A	A	A			
Animal Control	M	M	M	M	M	M			
Culverts/Discharge Pipes	N/A	N/A	N/A	N/A	N/A	N/A			
Riprap Revetments & Bank Protection	M	M	M	M	M	A			
Revetments other than Riprap	N/A	N/A	M	M	N/A	N/A			
Underseepage Relief Wells/Toe Drainage Systems	N/A	N/A	N/A	N/A	N/A	N/A			
Seepage	A	A	A	A	U	A			
Flood Wall	U	N/A	U	A	N/A	N/A			
Segment & System Ratings/PL 84-99 Eligibility							Legend		
Likely Prevents Performance In Next Flood Event							A	Acceptable	
Serious deficiency noted in past inspections has not been corrected within the established timeframe							M	Minimally Acceptable	
Likely Prevents Performance In Next Flood Event (Framework)							U	Unacceptable	
Not Likely to Prevent Performance In Next Flood Event							N/A	Not Applicable	
Not Likely to Prevent Performance In Next Flood Event (Framework)									
The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility									July 6, 2010

Table A-9. Reclamation District 404 and Duck Creek Right Bank – Boggs Tract System Report Card

RD 404 and Duck Creek right bank - Boggs Tract Unacceptable-Inactive	RD 404 - Unit 1 San Joaquin River Right Bank	RD 404 - Unit 2, French Camp Walker Slough	Duck Creek - Walker Slough right bank						
Operations and Maintenance Manuals	M	M	M						
Emergency Supplies and Equipment	M	M	M						
Flood Preparedness and Training	M	M	M						
Unwanted Vegetation Growth	U	U	U						
Sod Cover	N/A	N/A	N/A						
Encroachments	U	U	U						
Closure Structures	N/A	N/A	N/A						
Slope Stability	U	U	M						
Erosion/Bank Caving	U	U	M						
Settlement	U	A	A						
Depressions/Rutting	M	U	A						
Cracking	A	A	A						
Animal Control	U	U	M						
Culverts/Discharge Pipes	N/A	N/A	N/A						
Riprap Revetments & Bank Protection	U	N/A	M						
Revetments other than Riprap	N/A	N/A	N/A						
Underseepage Relief Wells/Toe Drainage Systems	N/A	N/A	N/A						
Seepage	A	M	A						
Segment & System Ratings/PL 84-99 Eligibility							Legend		
Likely Prevents Performance In Next Flood Event							A	Acceptable	
Serious deficiency noted in past inspections has not been corrected within the established timeframe							M	Minimally Acceptable	
Likely Prevents Performance In Next Flood Event (Framework)							U	Unacceptable	
Not Likely to Prevent Performance In Next Flood Event							N/A	Not Applicable	
Not Likely to Prevent Performance In Next Flood Event (Framework)									
The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility									July 6, 2010

Table A-10. Reclamation Districts 0017, 2094, 2075, 2064 San Joaquin River East System Report Card

RD 0017, 2094, 2096, 2075, 2064 - SJ River East Unacceptable-Inactive	RD 0017 Unit 1	RD 0017 Unit 2	RD 2096	RD 2094 Unit 1	RD 2094 Unit 2	RD 2075	RD 2064 Unit 1	RD 2064 Unit 2
Operations and Maintenance Manuals	A	A	M	A	A	M	M	M
Emergency Supplies and Equipment	A	A	A	A	A	M	M	M
Flood Preparedness and Training	A	A	M	M	M	M	M	M
Unwanted Vegetation Growth	U	U	U	U	U	U	U	U
Sod Cover	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Encroachments	U	U	U	M	M	U	U	U
Closure Structures	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Slope Stability	A	M	A	A	A	A	A	M
Erosion/Bank Caving	M	U	A	A	A	M	M	U
Settlement	M	M	M	M	M	M	M	M
Depressions/Rutting	M	U	A	A	A	U	U	U
Cracking	A	A	A	A	A	A	A	A
Animal Control	M	M	M	A	A	M	M	M
Culverts/Discharge Pipes	N/A	N/A	U	N/A	N/A	N/A	N/A	N/A
Riprap Revetments & Bank Protection	N/A	A	N/A	N/A	N/A	A	A	N/A
Revetments other than Riprap	N/A	M	M	A	N/A	N/A	A	M
Underseepage Relief Wells/Toe Drainage Systems	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Seepage	M	A	A	A	A	A	A	A
Pump Station	N/A	N/A	U	N/A	N/A	N/A	N/A	N/A

Segment & System Ratings/PL 84-99 Eligibility

Likely Prevents Performance In Next Flood Event

Serious deficiency noted in past inspections has not been corrected within the established timeframe

Likely Prevents Performance In Next Flood Event (Framework)

Not Likely to Prevent Performance In Next Flood Event

Not Likely to Prevent Performance In Next Flood Event (Framework)

The lowest rating is used to determine the overall segment & system ratings and PL 84-99 Rehabilitation Eligibility

Legend

A	Acceptable
M	Minimally Acceptable
U	Unacceptable
N/A	Not Applicable

July 6, 2010

Historical Levee Breaches and Overtopping

The California Department of Water Resources (DWR) Levee Evaluations Program collected and cataloged historical levee performance data pertinent to levee assessments in a document database. Data sources include existing levee-related data available from DWR and USACE, levee records available from State agencies, the California Levee Database, levee data obtained from local agencies, and interviews with representatives from local agencies, landowners, and DWR personnel. Data were collected on historical evidence of breaching and overtopping. For additional details on this data collection effort with respect to the Non-Urban Levee Evaluations (NULE) Project, see the *Geotechnical Assessment Report for the North NULE Study Area and South NULE Study Area* (DWR, 2011a and 2011b). The results of this data collection effort under the Urban Levee Evaluations (ULE) Project will be reported in Geotechnical Evaluation Reports being prepared for each individual study area. Figures A-1 and A-2 show historical levee breaches and failures in the Sacramento and San Joaquin river watersheds, respectively. Figures A-3 and A-4 show historical levee overtopping events in the Sacramento and San Joaquin river watersheds, respectively.

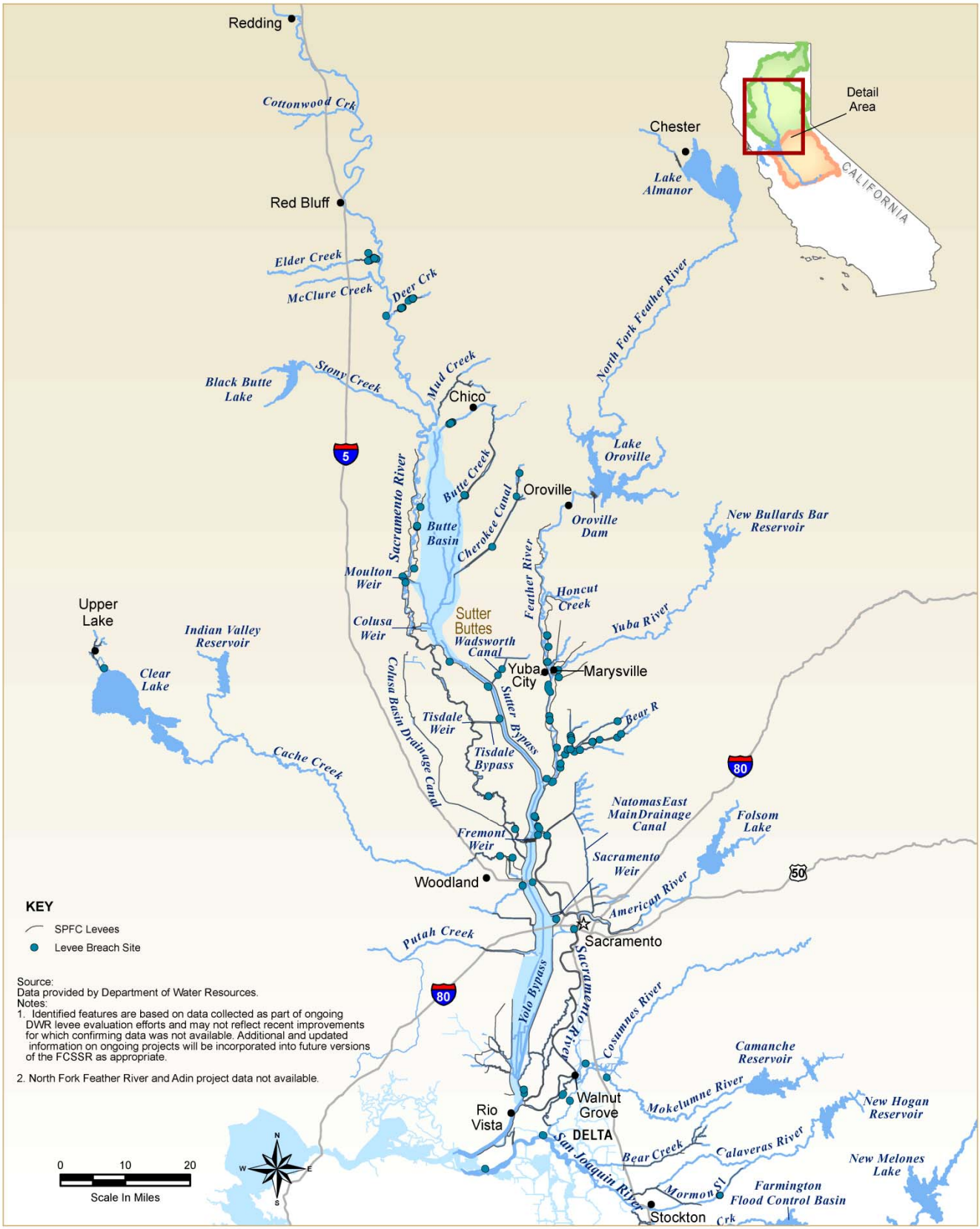

Figure A-1. Historical Levee Breaches in Sacramento River Watershed

Figure A-2. Historical Levee Breaches in San Joaquin River Watershed

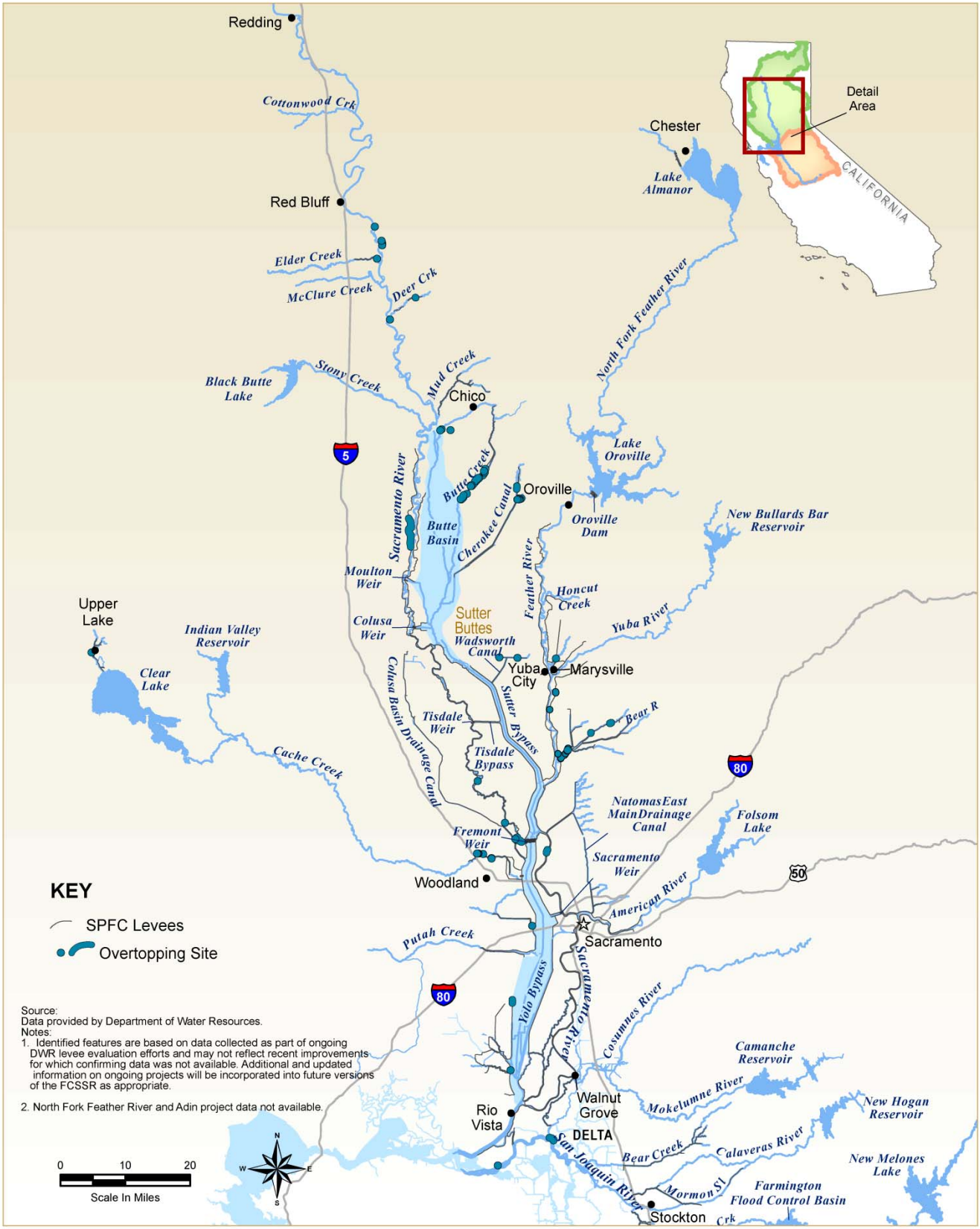

Figure A-3. Historical Levee Overtopping in Sacramento River Watershed

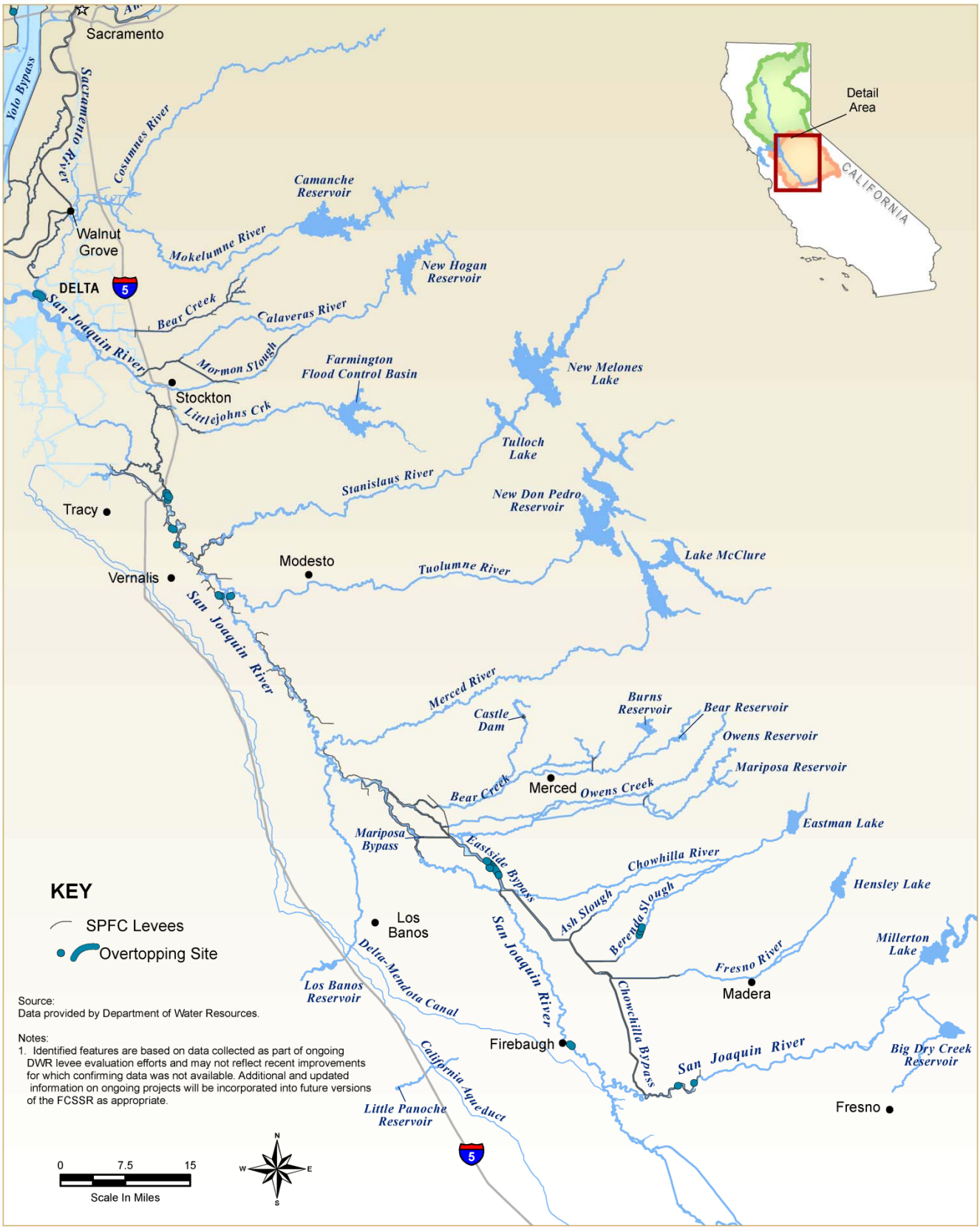

Figure A-4. Historical Levee Overtopping in San Joaquin River Watershed

Summary of Recent Remedial Actions/Improvements

USACE, the Board, and local agencies continue to implement site-specific projects as they become ready for construction. The Early Implementation Program and USACE/Board projects are not part of the SPFC, but may become part of the SPFC after completion of the processes outlined in the *SPFC Descriptive Document*, Sections 7.6 and 7.7 (DWR, 2010a). Locations of current Early Implementation Program and USACE/Board projects are shown in Figure A-5. Further description is included in the *SPFC Descriptive Document* (DWR, 2010a). Finally, other modifications to SPFC facilities have been completed by federal and local entities, but are not currently part of the SPFC because they lack State assurances of nonfederal cooperation to the federal government and/or State authorization.

Early Implementation Program

From bond funds made available by Propositions 1E and 84, DWR has developed the Early Implementation Program to help local agencies to implement their projects in advance of adoption of the Central Valley Flood Protection Plan (CVFPP). Early Implementation Program projects have an identified benefit for proceeding before adoption of the 2012 CVFPP, especially if the Early Implementation Program project provides for increased level of protection for urban areas in deep floodplains. None of these projects have received Congressional authorization yet. A brief description of each project and its current status as of May 2011 is provided in Table A-11.

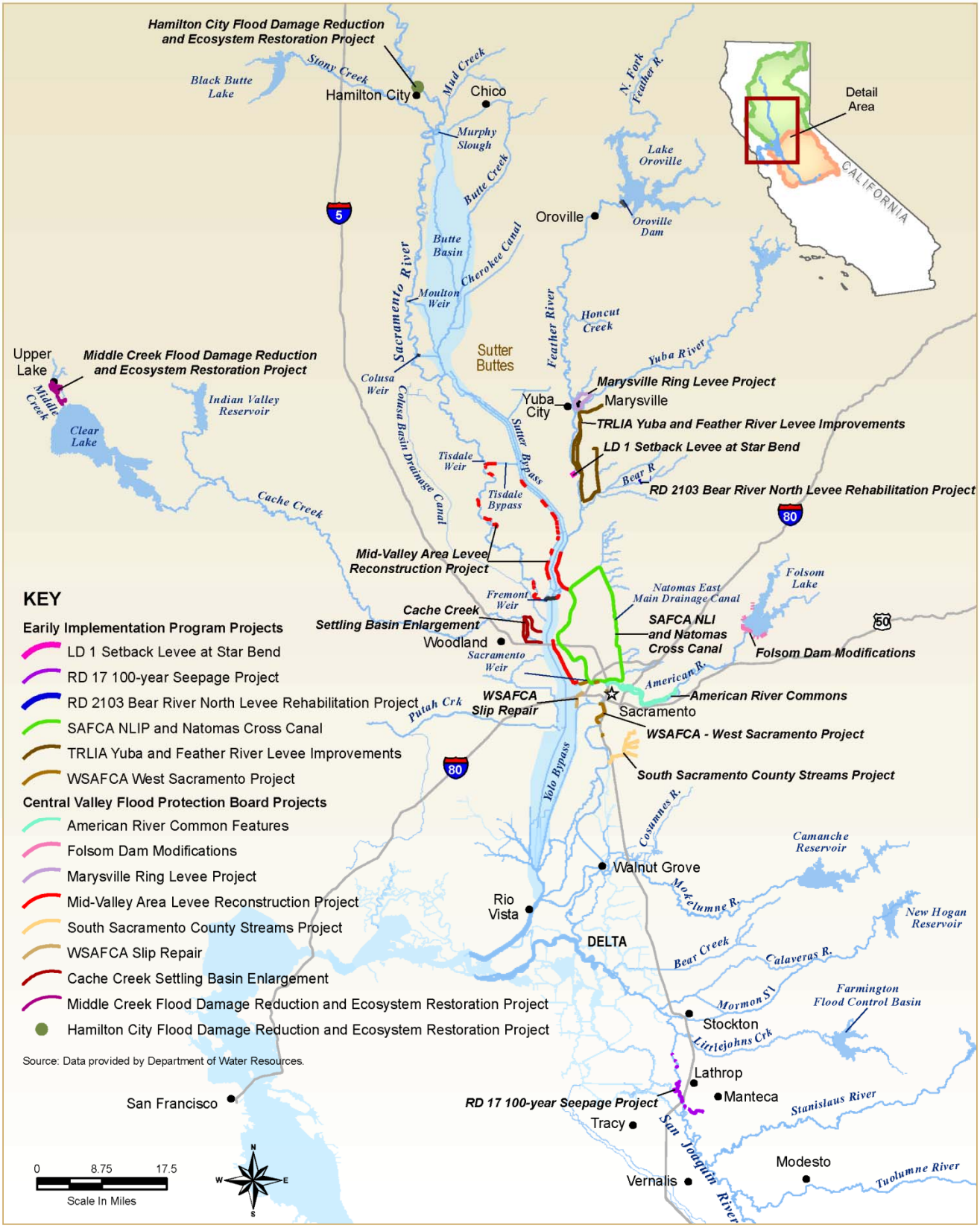

Figure A-5. Early Implementation Program and USACE/Board Projects in Sacramento and San Joaquin River Watersheds

Table A-11. Early Implementation Program Project Summary

Project Name	Project Description	Project Status (May 2011)
LD 1 Setback Levee at Star Bend (Feather River)	Setback levee with a cutoff wall and levee strengthening the existing levee system for the surrounding urban area.	Closeout phase
RD 17 100-Year Levee Seepage Area Project	Construction of cutoff walls, levee strengthening, seepage berms and setback levees to the existing system for the surrounding urban areas of South Stockton, Lathrop, and Manteca.	Construction phase
RD 2103 Bear River North Levee Rehabilitation Project	Construction of cutoff walls where under-seepage gradients on the landside toe exceed USACE criteria.	Closeout phase
SAFCA Natomas Levee Improvement Program (RD 1000)	Construction of cutoff walls and levee strengthening and reshaping features of the existing levee system surrounding the Natomas Basin.	Construction phase
TRLIA (RD 784) Feather River Levee Improvement Project	Construction of levee repairs and setback levees.	Closeout phase
TRLIA (RD 784) Upper Yuba Levee Improvement Project	Construction of levee repairs and setback levees.	Construction phase
WSAFCA West Sacramento Levee Improvement Project	Construction of levee improvements to achieve a 200-year level of protection.	Design phase

Key:
LD = levee district
RD = reclamation district
SAFCA = Sacramento Area Flood Control Agency
TRLIA = Three Rivers Levee Improvement Authority
USACE = U.S. Army Corps of Engineers
WSAFCA = West Sacramento Area Flood Control Agency

USACE/Board Projects

USACE, in partnership with the Board, is currently designing and constructing several projects that will improve the flood management system in the Sacramento and San Joaquin river watersheds. These projects reduce the occurrence and consequences of flooding. All USACE/Board projects have received Congressional authorization and have Board assurances of nonfederal cooperation contained in a project agreement. A listing and brief description of USACE/Board projects that are in design, construction, or closeout phases and their current status as of May 2011, is provided in Table A-12. In addition to the projects listed in Table A-12, several feasibility-level investigations are ongoing within the Sacramento and San Joaquin river watersheds. As these investigations

proceed toward specific projects and detailed design, construction, or closeout phases they will be included in future updates to the FCSSR.

Table A-12. USACE/Board Project Summary

Project Name	Project Description	Project Status (May 2011)
American River Watershed, Common Features Project	Raise and widen levees and close gaps in slurry walls to prevent flooding in the Sacramento area.	Construction and closeout phases
American River Watershed, Folsom Dam Joint Federal Project	Raise the dikes around Folsom Reservoir by 3.5 feet to increase surcharge flood storage.	Partially complete design phase
Hamilton City Flood Damage Reduction and Ecosystem Restoration Project	6.8-mile-long setback levee alignment that will increase the level of flood protection at Hamilton City and restore approximately 1,480 acres along the Sacramento River.	Design phase
Yuba River Basin Project, Marysville Ring Levee Element	Construction of cutoff walls and levee strengthening and reshaping features for the existing levee system surrounding the Marysville urban area.	Design phase
Middle Creek Flood Damage Reduction and Ecosystem Restoration Project	Construction of flow-regulation structures to restore vegetation and wetlands.	Design phase
South Sacramento County Streams Group Project	Construct channel improvements, floodwalls, levee raising, levees, seepage cutoff walls, and bridge retrofits.	Construction phase
West Sacramento Project (Slip Repair)	Levee raising, levee offsets, and slurry wall construction.	Construction phase
Cache Creek Settling Basin Enlargement	Enlargement of settling basin facilities.	Closeout phase
Sacramento River Bank Protection Project Phase II [1]	Bank protection at identified sites of the Sacramento River Flood Control Project.	Design, construction, and closeout phases for different sites

Note:
[1] Because these sites are scattered throughout the Sacramento River watershed and GIS information was not available, the sites are not included on Figure A-5.

Key:
USACE – U.S. Army Corps of Engineers

Modifications to SPFC Facilities

In addition to the Early Implementation Program and USACE/Board projects, modifications to SPFC facilities influence SPFC status, but some are not part of the SPFC because they lack State of California (State) assurances of cooperation to the federal government and/or are not yet

authorized by the Board for acceptance into the SPFC. Some modifications will not be authorized by the Board for acceptance into the SPFC, such as a gap in the Yolo Bypass east levee created by construction of the Sacramento Deep Water Ship Channel. The function of the previous levee was superseded by the Sacramento Deep Water Ship Channel federal navigation levee, but the navigation levee is not part of the SPFC. Other modifications to SPFC facilities were completed without State assurances of cooperation to the federal government and have not been authorized by the Board for acceptance into the SPFC, but may be authorized in the future. These modifications include the San Joaquin Area Flood Control Agency Flood Protection Restoration Project and the South Olivehurst Detention Basin Project improvements. While these and other modifications may not meet the legislative definition of the SPFC, they provide an important collective contribution to improve the function and status of SPFC facilities.

Ongoing Actions to Improve Future Evaluations

Levee analyses conducted through the DWR Levee Evaluations Program consider both past and future (projected) performance of levees as they relate to levee geometry, seepage, stability, erosion, and settlement. To perform a detailed evaluation of the levee system's current condition, a wide range of critical levee properties is being studied, including the following:

- Geomorphology
- Historical events
- Levee topography
- Levee materials and construction
- Subsurface conditions
- Erosion conditions

Traditional and Other Methods

Much of the evaluation of the levees and their foundations is done by relatively straightforward geotechnical exploration methods (e.g., drilling) to collect soil samples, which are then analyzed to assess subsurface conditions. Cone penetrometer testing is also used to determine the composition and properties of subsurface soils. Looking closely at subsurface soil conditions—such as moisture, density, soil grain size distribution, and shear strength—helps identify potential problems or weaknesses in levees. In addition to the basic geotechnical evaluation program of drilling and boring to collect levee soil samples, other proven methods and innovative technologies are being used to develop a

comprehensive understanding of the levees' existing subsurface conditions, and identify which areas are most in need of critical improvements or repairs.

Light Detection and Ranging Surveys

Light Detection and Ranging (LiDAR) technology deployed in low-flying helicopters has been used to electronically gather data about the topography and configuration of flood control levees. Results aid evaluation of levee geometry, stability, erosion, and settlement of the surveyed levees.

Bathymetric Surveys

The above-water topographic data collected during LiDAR surveys have been supplemented with bathymetric surveys. Underwater bathymetric surveys produce detailed topographic data of a riverbed and riverbanks that essentially form the base of the levee systems. The collected data provide an image of the levees' underwater structure that cannot be obtained by conventional land topographic methods. The results aid evaluation of levee geometry and erosion.

Surficial Geomorphic Mapping

A comprehensive surficial geomorphic map of project areas, based on field reconnaissance and review of vintage aerial photos and topographic maps, geologic maps, and satellite imagery, is also being prepared. Results of this effort will lead to a better understanding of the materials directly beneath existing levees and of geomorphic processes, such as erosion and deposition that are responsible for those materials. The collected data will aid evaluation of erosion, seepage, and structural instability.

Electromagnetic Surveys

Levee subsurface conditions are being evaluated by conducting geophysical electromagnetic surveys. The electromagnetic technology senses variations in the ground's electrical conductivity to depths of more than 100 feet underground. The goal is to map important changes in soil types and ground conditions, identifying zones where permeable soils are present or excessive water penetration is taking place. The results aid in evaluation of levee seepage, structural instability, erosion, and settlement.

A-2 Levee Geometry Check

This section describes ULE and NULE freeboard check results, recent remedial actions/improvements (including locations of levee raises, widening, and levee reconstructions), current and ongoing remedial actions/improvements, and ongoing actions to improve future evaluations of levee geometry.

Freeboard Check Results

Lack of levee freeboard can be caused by a variety of factors, such as settlement and inadequate maintenance. A freeboard check was conducted as part of the ULE and NULE projects. For the Sacramento River watershed, the freeboard check consisted of a comparison of the levee crest elevation, as provided by the levee crest survey data from the California Levee Database, to requirements of the *1953 Memorandum of Understanding* (USACE and Reclamation Board, 1953). The *1953 Memorandum of Understanding* generally requires a minimum of 3 feet of freeboard above the 1955/1957 design water surface elevation for riverine levees and 6 feet of freeboard above the 1955/1957 design water surface elevation for bypass levees.

For the San Joaquin River watershed, the freeboard check consisted of a comparison of the levee crest elevation with the design water surface elevation. Freeboard requirements were indicated from available design data. If a levee segment lacked a verifiable design water surface elevation but a 1 percent chance event (100-year) water surface elevation was available, it was used to assess freeboard. Such conditions were specific to the Calaveras and Bear Creek systems in San Joaquin County. Where neither a design nor 1 percent chance event water surface elevation were available, the freeboard check could not be performed.

Urban Levee Evaluations Project

ULE Project evaluations included assessing each ULE levee segment and assigning each segment to one of the following classifications:

- **Meets Criteria (M)** – Levees in this classification meet or exceed criteria.
- **Marginal (MG)** – Levees in this classification are marginal in meeting criteria.
- **Does Not Meet Criteria (DNM)** – Levees in this classification do not meet criteria. These are the levees that require the most immediate attention for repair or replacement.
- **Lacking Sufficient Data (LD)** – Levees in this classification lack sufficient data to allow placement into one of the above three classifications.

ULE freeboard check results are shown on Figure A-6. Levees that do not meet freeboard criteria include portions of the Pleasant Grove Creek Canal and Natomas East Main Drainage Canal, the south bank of the Yuba River east of Marysville, the Davis/Woodland area and along Upper Bear Creek.

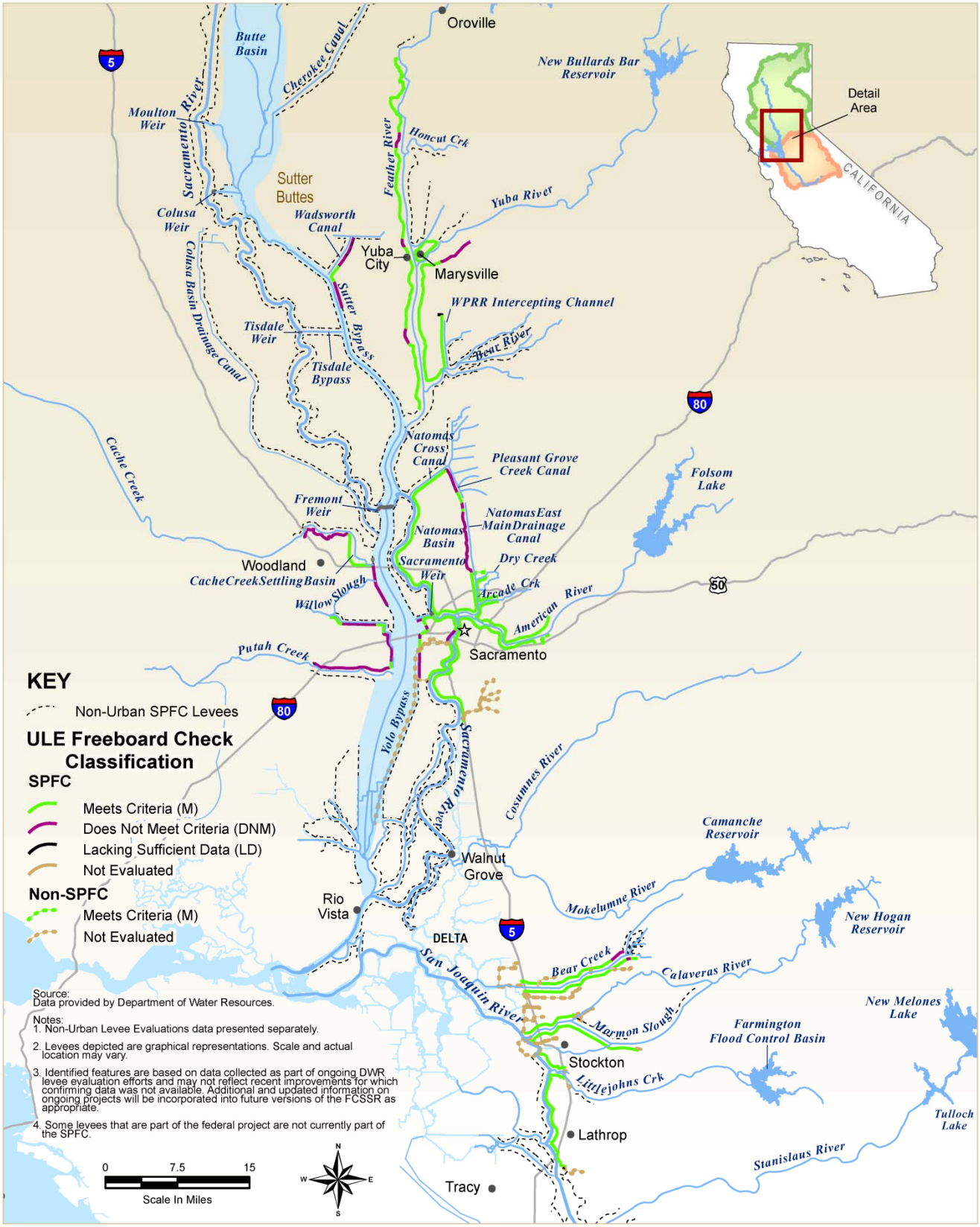

Figure A-6. ULE Freeboard Check Results

Non-Urban Levee Evaluations Project

Figures A-7 and A-8 show a pass or fail result for NULE levee segments in both the Sacramento and San Joaquin river watersheds regarding whether they meet freeboard requirements. Freeboard results show that portions of both banks of the Sutter Bypass, both banks of the Yolo Bypass, Butte Creek, Colusa Basin Drainage Canal, and the Bear River do not meet freeboard criteria. Compliance with freeboard criteria is variable in other areas within the Sacramento River watershed. In the San Joaquin River watershed, levee reaches along the lower Stanislaus River, lower Tuolomne River, San Joaquin River downstream of Merced River, upper Bear Creek and Paddy Creek do not meet freeboard criteria.

For additional details on the NULE freeboard check methodology and results, see the *Geotechnical Assessment Report for the North NULE Study Area and South NULE Study Area* (DWR, 2011a and 2011b).

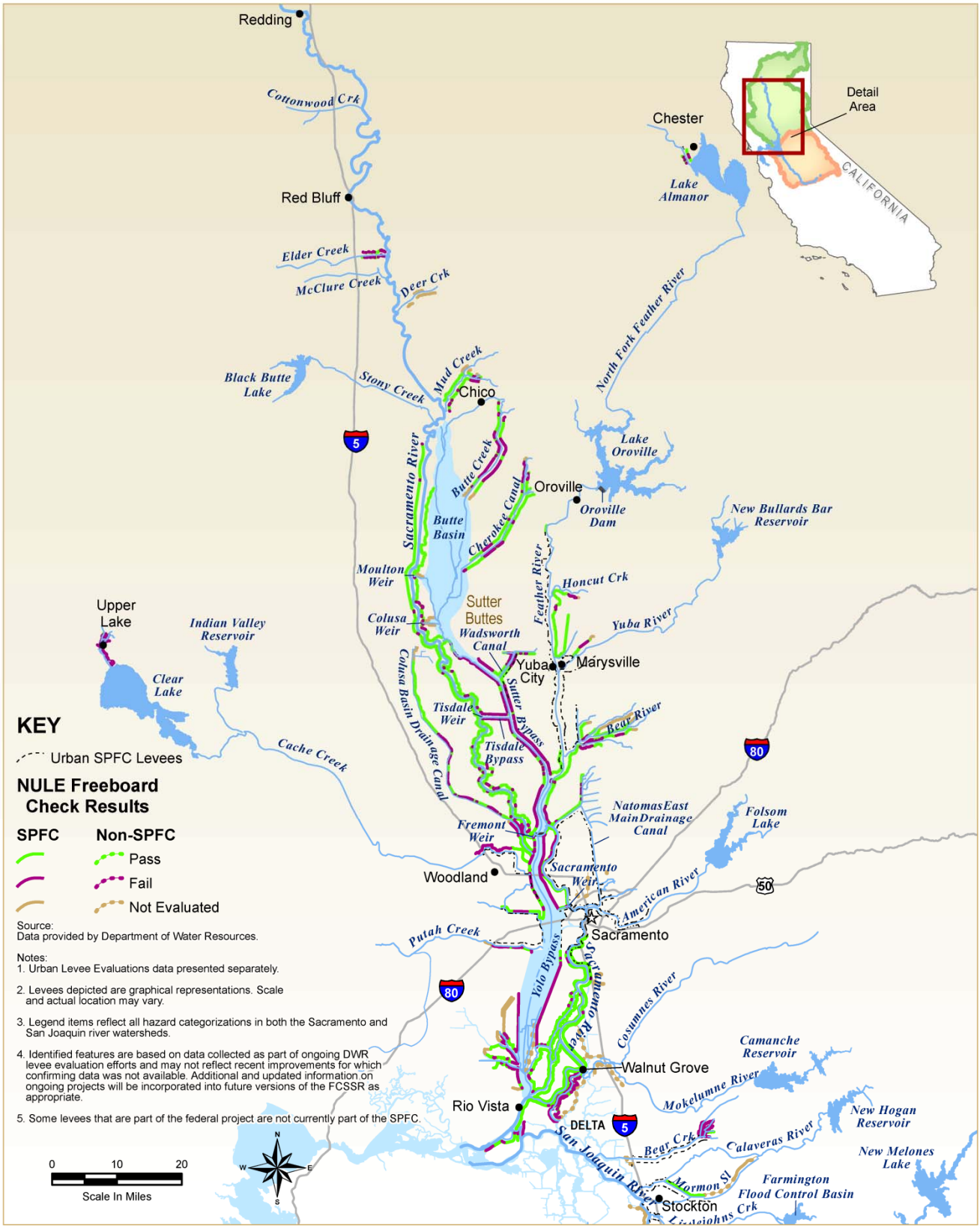

Figure A-7. NULE Freeboard Check Results in Sacramento River Watershed

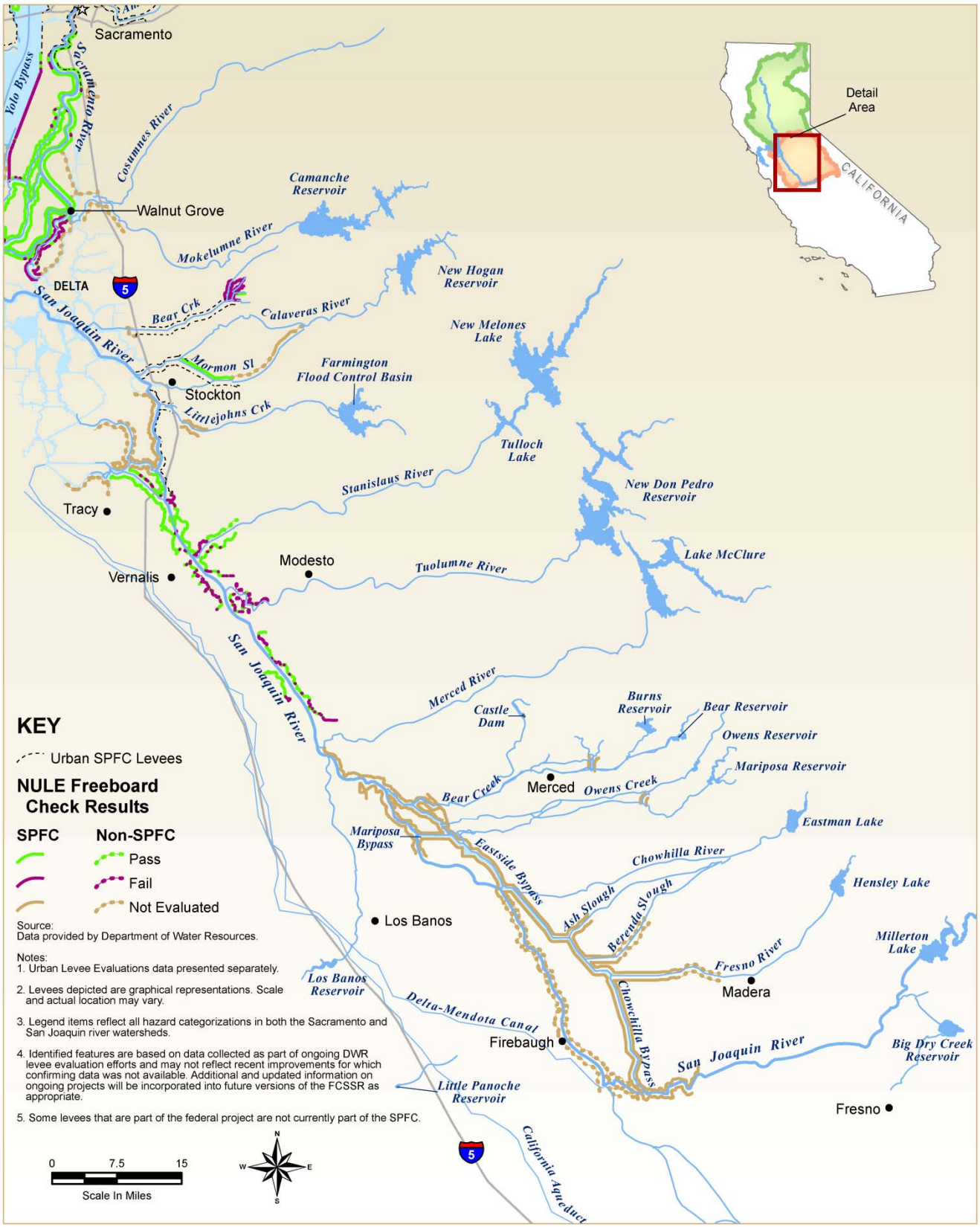

Figure A-8. NULE Freeboard Check Results in San Joaquin River Watershed

Summary of Recent Remedial Actions/Improvements

DWR's Levee Evaluations Program collected and cataloged recent levee raises, levee widening, and levee reconstructions. Figures A-9 and A-10 show locations of these documented reconstructions and improvements for the Sacramento River and San Joaquin River watersheds, respectively.

Summary of Ongoing and Planned Remedial Actions/Improvements

Several of the Early Implementation Program and USACE/Board projects discussed in Section A-1 include levee reconstructions and improvements that address inadequate levee geometry.

Ongoing Actions to Improve Future Evaluations

DWR continues to collect levee information using traditional and innovative methods, including LiDAR and bathymetric surveys (see Section A-1).

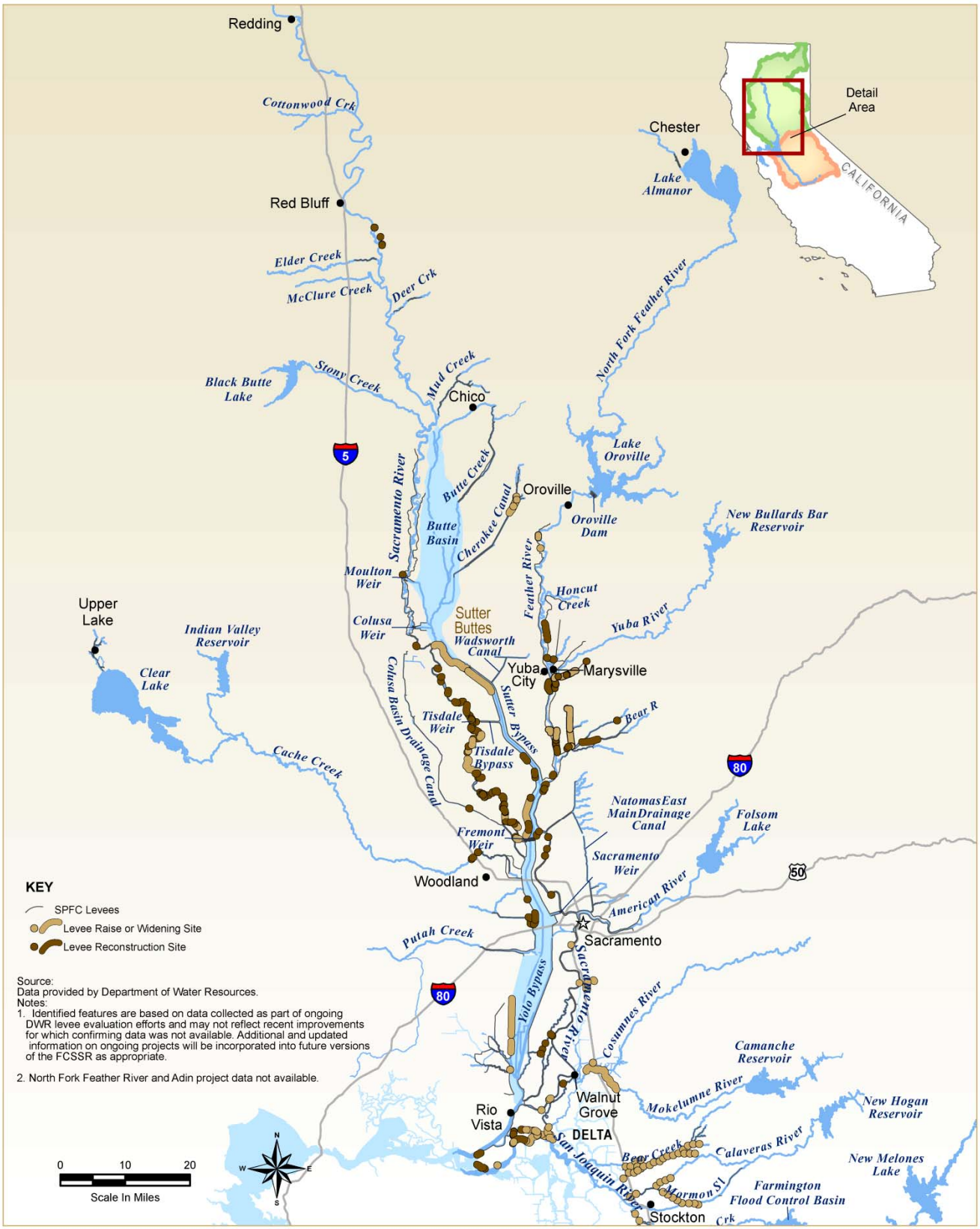

Figure A-9. Levee Raises, Levee Widenings, and Levee Reconstructions in Sacramento River Watershed

Figure A-10. Levee Raises, Levee Widenings, and Levee Reconstructions in San Joaquin River Watershed

A-3 Seepage

This section includes DWR annual inspection results for seepage, and locations of historical seepage occurrences documented by the ULE and NULE projects. Recent, current, and ongoing remedial actions/improvements including locations of seepage remediation projects documented by the ULE and NULE projects, and seepage-related levee reconstructions and improvements planned and conducted by DWR, are described. A description of ongoing actions to improve future evaluations is also included.

Results of Inspections

DWR visually inspects SPFC levees for seepage/sand boils at least twice a year, and reports results annually. Table A-13 shows the DWR inspection rating descriptions for seepage/sand boils on earthen levees.

Table A-13. Levee Inspection Rating Descriptions for Seepage/Sand Boils on Earthen Levees

Inspection Rating	Rating Descriptions
Acceptable (A)	No seepage, saturated areas, or sand boils occurring at the time of the inspection.
Unacceptable (U)	Seepage and/or sand boils were observed that could threaten the integrity of the project. Regardless of size, any sand boils observed during low water conditions could threaten project integrity when the water is high, and are considered unacceptable.

The biannual inspections that DWR conducts are performed during the spring and fall of each year, and do not necessarily coincide with the flood season. Therefore, routine DWR inspections are less likely to reveal instances of seepage because inspections are usually performed when water is below the toe of levees. Furthermore, the extent of seepage and whether the seepage condition is in a steady or changing state are difficult to determine from visual inspections. Limited knowledge of subsurface conditions also makes it difficult to identify seepage problems.

Because 2009 was a relatively dry year and there were no high-water events, no occurrences of seepage/sand boils were observed or documented in the *2009 Inspection Report of the Central Valley State-Federal Flood Protection System* (DWR, 2010b).

Historical Seepage Occurrences

The ULE and NULE projects collected and cataloged historical occurrences of levee seepage and completed or planned repairs or

improvements. Figures A-11 and A-12 show historical seepage occurrences collected by the ULE and NULE projects in the Sacramento and San Joaquin river watersheds, respectively. In the Sacramento River watershed, historical seepage occurrences were located throughout the system and were particularly prevalent along the Sutter Bypass and Sacramento River south of Sacramento. In the San Joaquin River watershed, most historical seepage occurrences were along the San Joaquin River and Eastside Bypass.

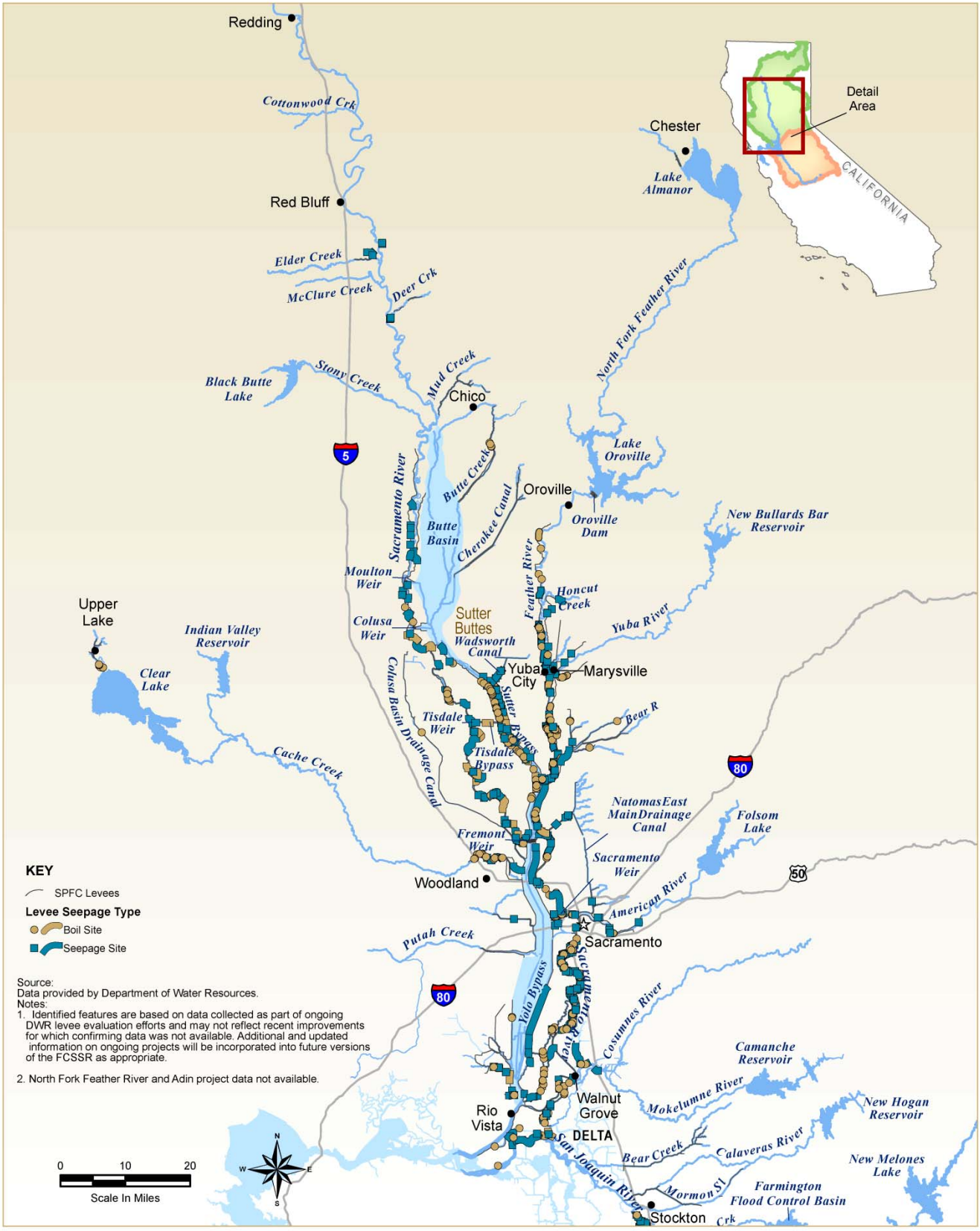

Figure A-11. Historical Seepage Occurrences in Sacramento River Watershed

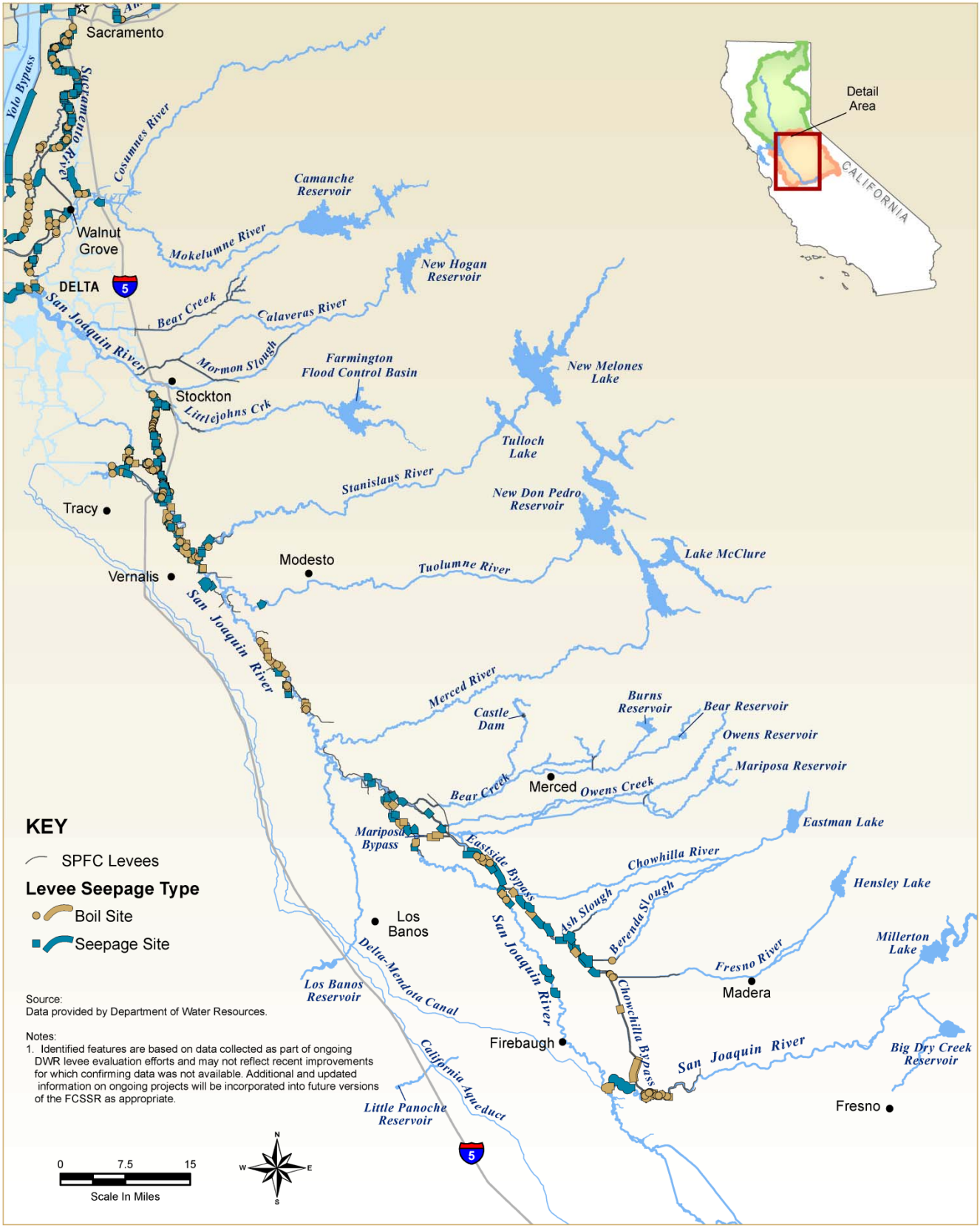

Figure A-12. Historical Seepage Occurrences in San Joaquin River Watershed

Summary of Recent Remedial Actions

Seepage remediation projects have been constructed throughout the Sacramento and San Joaquin river watersheds to address identified seepage problems. The ULE and NULE projects collected and cataloged data on the locations of a wide range of seepage remediation actions. Figures A-13 and A-14 show seepage remediation efforts in the Sacramento River and San Joaquin River watersheds, respectively. Seepage remediation has occurred throughout the Sacramento River watershed and is particularly concentrated in the Sutter Bypass, lower Feather River, west side of Natomas, American River, Sacramento River south of Sacramento, and Yolo Bypass near Woodland. In the San Joaquin River watershed, seepage remediation is the most concentrated on the lower San Joaquin River north of Stanislaus River and the upper San Joaquin River near the Chowchilla Bypass.

Summary of Ongoing and Planned Remedial Actions/Improvements

Seepage and boils are identified and monitored by maintaining agencies to initiate floodfighting and levee reconstruction and/or improvements. DWR's Levee Repairs Program is described below, and many of the Early Implementation Program and USACE/Board projects identified in Section A-1 will preserve and enhance the integrity of SPFC levees with regard to seepage.

DWR Levee Repairs Program

DWR's Levee Repairs Program repairs critically and not critically damaged levees. The projects are implemented through collaboration with the resource agencies, USACE, and local agencies. The Levee Stability Program and Public Law 84-99 Rehabilitation Assistance Program address seepage problems.

USACE's Levee Stability Program was authorized by the Water Resources Development Act of 2007. Levee Stability Program sites are selected by DWR's Levee Evaluations Program. As of December 2010, four seepage sites were recommended for remediation, but additional sites are anticipated as the Levee Evaluations Program continues.

The Flood Control and Coastal Emergency Act (Public Law 84-99) provides the federal government authority for emergency management activities. Under Public Law 84-99, USACE is authorized to undertake rehabilitation of flood control works threatened or destroyed by floods. USACE decides which sites qualify for assistance under the Public Law 84-99 program. After the 2005 – 2006 storms, 20 seepage sites were

determined to be eligible for Public Law 84-99 assistance by USACE. Since then, all of these sites have been rehabilitated.

Planned and completed seepage remediation sites from the Levee Stability Program and Public Law 84-99 program are shown in Figures A-15 and A-16 for the Sacramento River watershed and San Joaquin River watershed, respectively.

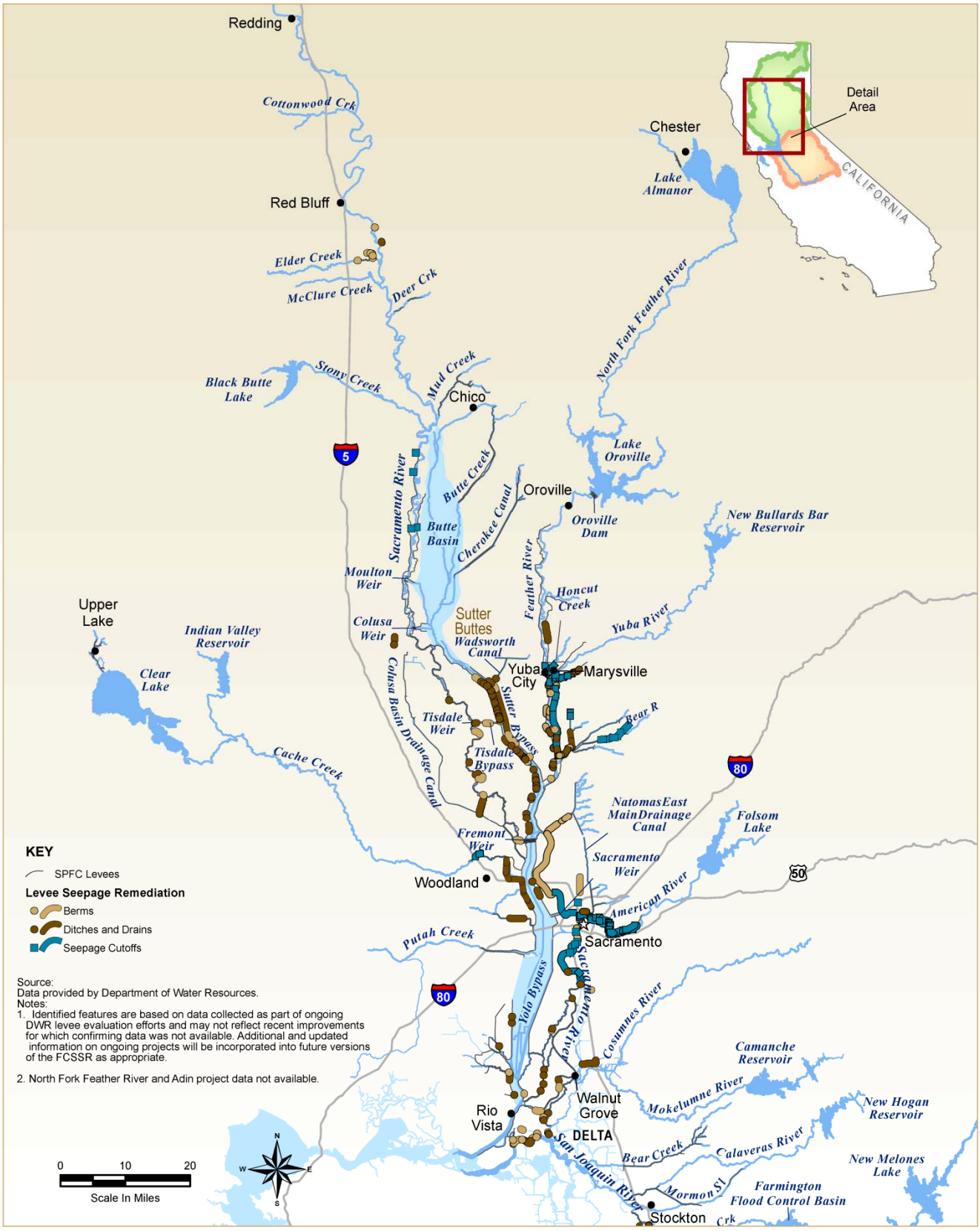

Figure A-13. Seepage Remediation in Sacramento River Watershed

Figure A-14. Seepage Remediation in San Joaquin River Watershed

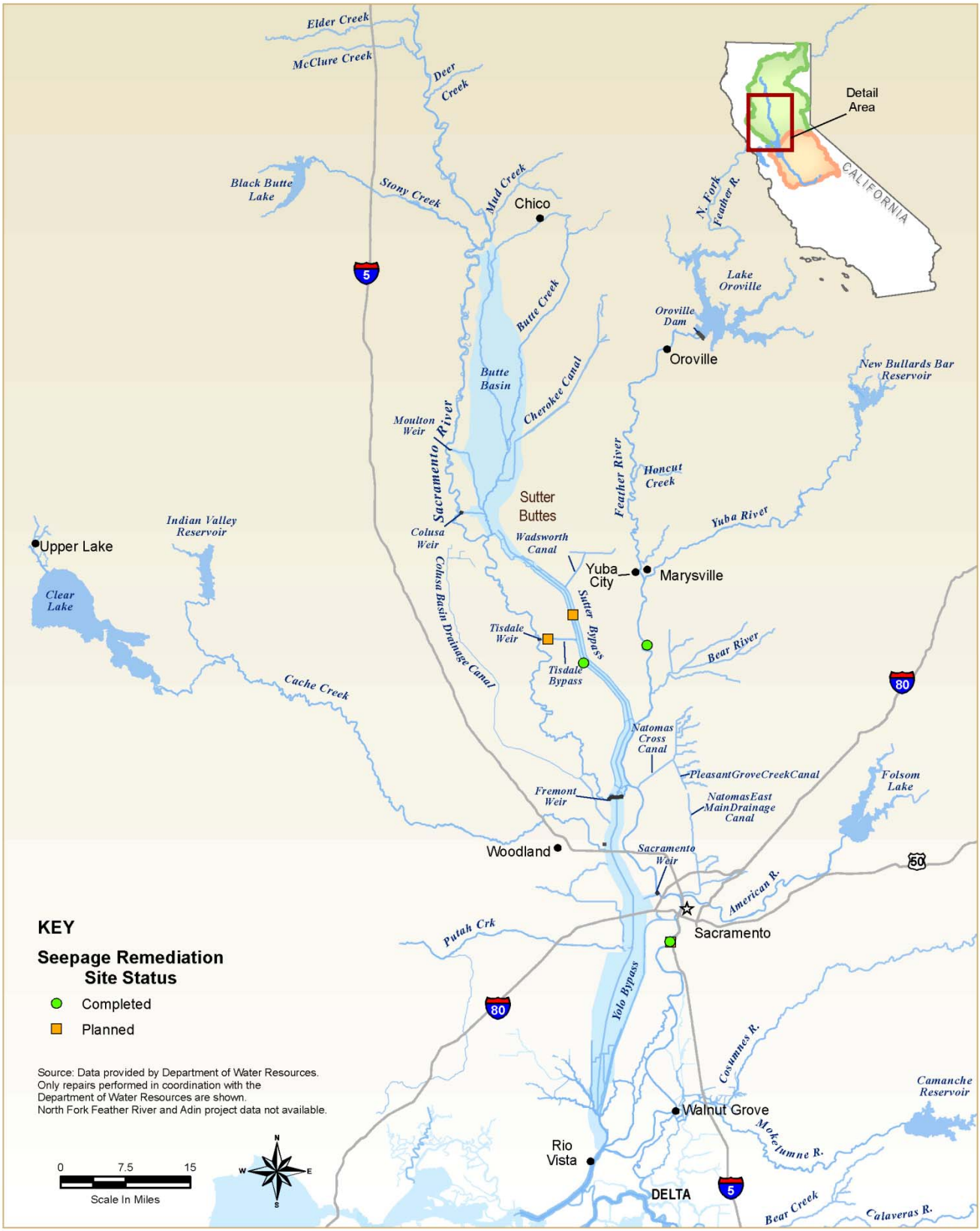

Figure A-15. Planned and Completed Seepage Remediation Sites from DWR Levee Stability Program and Public Law 84-99 Program in Sacramento River Watershed

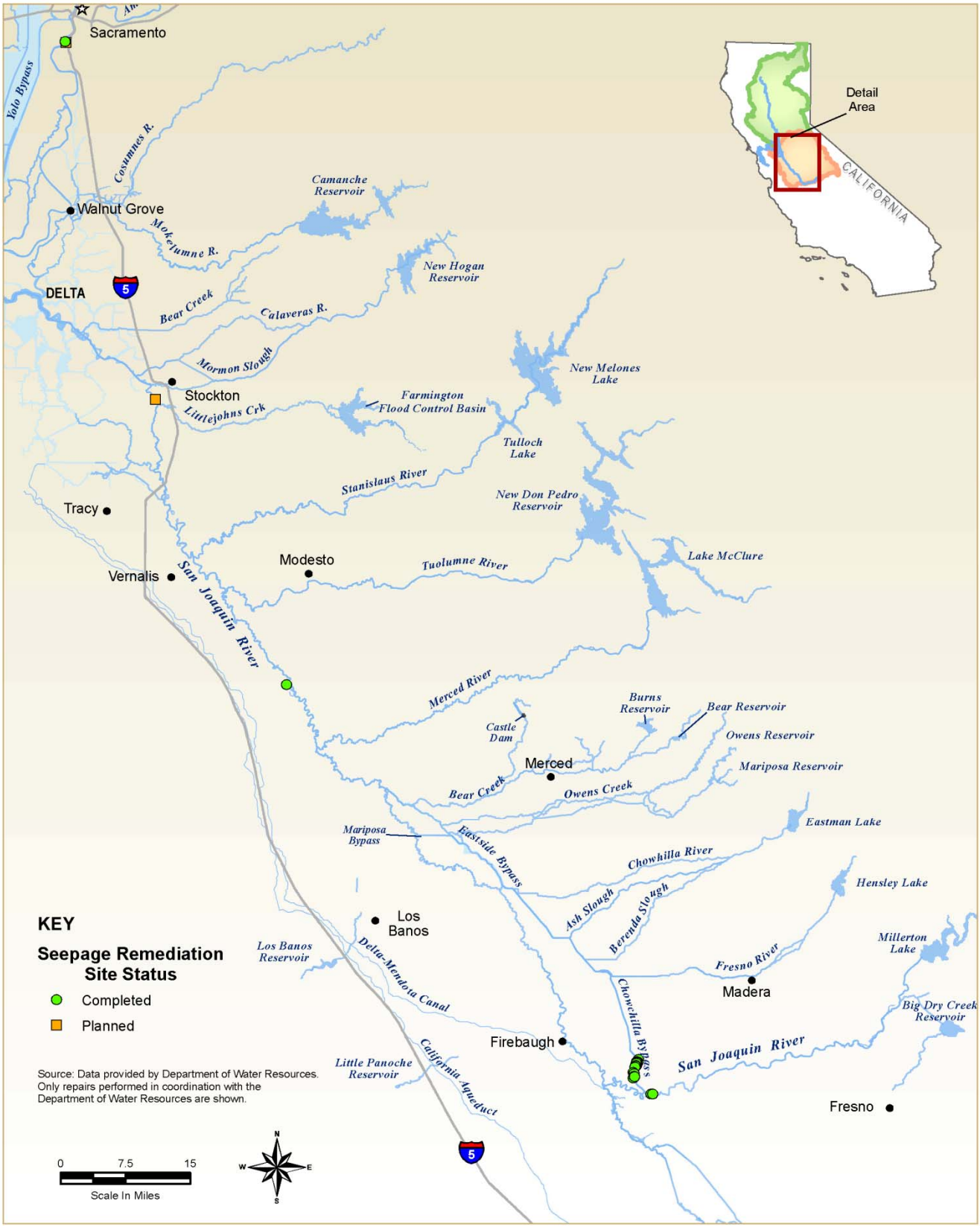

Figure A-16. Planned and Completed Seepage Remediation Sites from DWR Levee Stability Program and Public Law 84-99 Program in San Joaquin River Watershed

Ongoing Actions to Improve Future Evaluations

DWR continues to collect levee information using traditional and new innovative methods, including electromagnetic surveys. DWR is also in the early planning stages of conducting a levee monitoring pilot study that would evaluate the effectiveness and usefulness of direct, real-time measurements of seepage rates through and under levees during high-water events. The study would involve installing sealed piezometers and river stage gages at preselected critical locations within the Sacramento and San Joaquin river watersheds.

A-4 Structural Instability

This section includes results of the DWR annual inspections for slope stability and historical levee slope instability ccurrences. Recent, ongoing, and planned remedial actions and improvements, and ongoing actions to improve future evaluations for structural instability are also included.

Results of Inspections

As mentioned, DWR visually inspects SPFC levees at least twice a year, and reports results annually. Information is collected during the inspections on the performance of the levee embankment as it relates to slope stability. Table A-14 shows the DWR inspection rating descriptions for slope stability on earthen levees.

Table A-14. Levee Inspection Rating Descriptions for Slope Stability on Earthen Levees

Inspection Rating	Rating Descriptions
Acceptable (A)	No slides present.
Minimally Acceptable (M)	Minor superficial sliding that with deferred repairs will not pose an immediate threat to flood control works integrity.
Unacceptable (U)	Evidence of deep-seated sliding that threatens flood control works integrity. Repairs are required to reestablish flood control works integrity.

Visual inspections provide limited information on levee conditions related to slope stability. A typical levee inspection occurs from the crown of the levee. Thick vegetation and wide berms can obstruct an inspector's view of slides. Limited knowledge of subsurface conditions also makes it difficult to identify some slope stability problems.

Slope stability levee inspection ratings from the *2009 Inspection Report of the Central Valley State-Federal Flood Protection System* (DWR, 2010b)

are shown on Figures A-17 and A-18. Two sites with Unacceptable ratings for slope stability are located in the Delta. In the Sacramento River watershed has no Unacceptable ratings, but several sites, in various locations, have Minimally Acceptable ratings. In the San Joaquin River, Minimally Acceptable ratings are located on the lower San Joaquin River, Bear Creek, Mormon Slough, and Littlejohns Creek.

Figure A-17. 2009 Slope Stability Inspection Ratings in Sacramento River Watershed

Figure A-18. 2009 Slope Stability Inspection Ratings in San Joaquin River Watershed

Historical Levee Slope Instability Occurrences

The ULE and NULE projects collected and cataloged information on historical occurrences of levee slope instability. Figures A-19 and A-20 show historical slope instability occurrences collected from the ULE and NULE projects for the Sacramento and San Joaquin river watersheds, respectively. In the Sacramento River watershed, historical levee slope instability occurrences were located most frequently in the lower Sacramento River watershed south of the Fremont Weir. Slope instability was most prevalent on the Sacramento River south of Sacramento and in the north Delta. In the San Joaquin River watershed, historical levee slope instability occurrences were prevalent through the watershed.

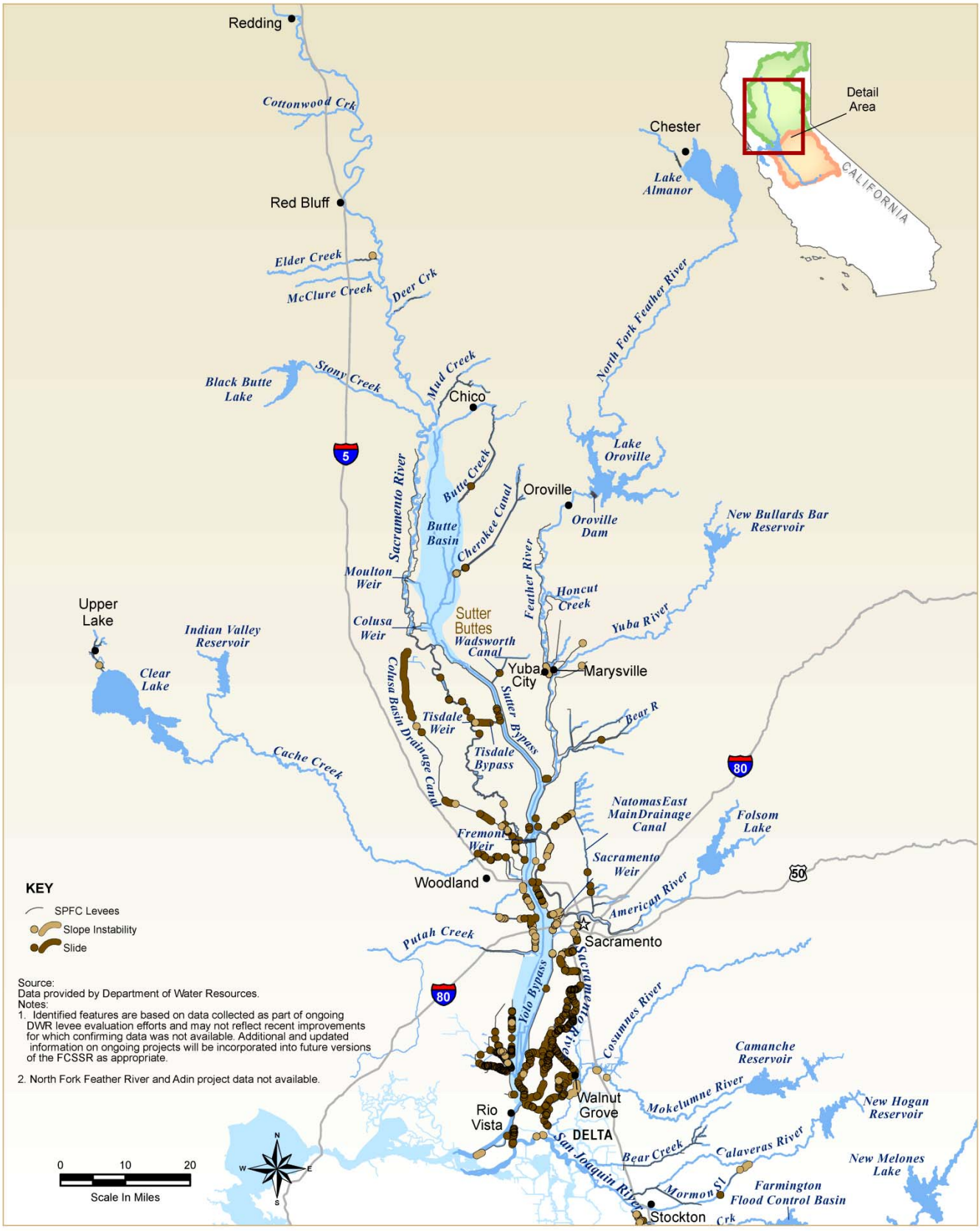

Figure A-19. Historical Slope Instability Occurrences in Sacramento River Watershed

Figure A-20. Historical Slope Instability Occurrences in San Joaquin River Watershed

Summary of Recent Remedial Actions

Stability berms, revetment, and riprap have been installed through DWR's Levee Repairs Program after slope instability was reported. Problems were generally identified from inspections or as part of levee reconstruction projects that restore levees to current design criteria. Revetments and riprap sites for the Sacramento and San Joaquin river watersheds are shown in Section A-5, Erosion.

Summary of Ongoing and Planned Remedial Actions/Improvements

Many slope stability problems are the result of inadequate levee geometry, erosion, or seepage problems. Several of the Early Implementation Program and USACE/Board projects shown in Section A-1 include levee improvements that address levee structural instability. DWR's Levee Repairs Program, described in Section A-2, also addresses structural instability.

Ongoing Actions to Improve Future Evaluations

DWR continues to collect levee information using traditional and new, innovative methods, including LiDAR, surficial geomorphic mapping, and electromagnetic surveys.

A-5 Erosion

This section includes results of DWR inspections and surveys for erosion and historical erosion occurrences. Recent, ongoing, and planned remedial actions and improvements, including revetment and riprap locations and erosion-related levee work planned and conducted by DWR, are included. Ongoing actions to improve future evaluations for erosion are also included.

Results of Inspections

Sites with erosion problems were identified through the following data sources:

- Levee Inspection Reporting (DWR, 2010b)
- San Joaquin River Flood Control System Erosion Surveys (DWR, 2010c)
- Sacramento River Bank Protection Project Erosion Surveys (USACE, 2010)

Levee Inspection Reporting

As mentioned, DWR visually inspects SPFC levees for erosion problems at least twice a year, and reports results annually. Table A-15 shows the DWR inspection rating descriptions for erosion/bank caving on earthen levees.

Table A-15. Levee Inspection Rating Descriptions for Erosion/Bank Caving on Earthen Levees

Inspection Rating	Rating Descriptions
Acceptable (A)	No active erosion or bank caving observed on the landward or on the riverward side of the levee.
Minimally Acceptable (M)	There are areas where active erosion is occurring or has occurred on or near the levee embankment, but levee integrity is not threatened.
Unacceptable (U)	Erosion or caving is occurring or has occurred that threatens the stability and integrity of the levee. The erosion or caving has progressed into the levee section or into the extended footprint of the levee foundation and has compromised the levee foundation stability.

San Joaquin River Flood Control System Waterside Erosion Surveys

In 2006, DWR began an erosion survey program for the San Joaquin River Flood Control System to assist in documenting and monitoring erosion sites. The most recent report, *2009 Supplemental Erosion Survey of the San Joaquin River Flood Control System* (DWR, 2010c), includes an inventory of levee erosion sites on the San Joaquin River Flood Control System. Surveys are conducted annually, between July and October. Land-based surveys are conducted by inspecting the waterside levee and berm from the levee crown. In navigable waterways where the view of the waterside levee is obstructed, a boat is used to conduct the survey.

Erosion sites were ranked using criteria partly based on the *2007 Field Reconnaissance Report of Bank Erosion Sites and Site Priority Ranking* (USACE, 2007), and the *Erosion Screening Process Report* (DWR, 2009a). The criteria have been partially modified to suit the type of data collected for the San Joaquin River system. An overall rating was assigned to each site based on a normalized total weighted score of erosion criteria (berm width, vegetation cover, burrow holes, levee slope, soil type, site relative to bend, radius of curvature, length of erosion, scarp height, and location of erosion). Table A-16 shows the DWR inspection rating descriptions for the surveys.

Table A-16. San Joaquin River Flood Control System Erosion Surveys Rating Descriptions for Erosion/Bank Caving on Earthen Levees

Inspection Rating	Rating Description
Minimally Acceptable (M)	A site that receives a normalized score equal to or less than the average is rated M. The site should be monitored and assessed annually for erosion activity, as it may become a serious inadequacy in the next flood event.
Unacceptable (U)	A site that receives a normalized score greater than the average is rated as U. The site may require corrective action soon, because it may become a serious inadequacy that can fail in the next flood event.

Sacramento River Bank Protection Project Erosion Surveys

Sacramento River Bank Protection Project erosion surveys are described in Section 2.1.3, Joint USACE and DWR Inspections.

DWR Levee Mile Reports incorporate data from all three inspections and present them according to the rating descriptions for erosion/bank caving on earthen levees, as shown in Table A-15. Data from the *2009 DWR Levee Mile Reports* are shown on Figures A-21 and A-22. Minimally Acceptable and Unacceptable ratings for erosion are located sporadically throughout the Sacramento River watershed. The north Delta and lower Sacramento River south of Sacramento have a relatively high concentration of erosion sites. Most of the erosion sites in the San Joaquin River watershed are along the lower San Joaquin River north of the Stanislaus River and Mormon Slough.

Limitations of Inspection Results

Visual inspections provide limited information on levee conditions related to erosion. A typical levee inspection occurs from the crown of the levee, but erosion on the slope and beyond is sometimes not visible from this vantage point. In addition, thick vegetation and wide berms can also obstruct an inspector's view of an erosion site. Erosion surveys conducted by boat can improve on these limitations, but both the levee inspections and erosion surveys are limited to what is visible above the waterline from the top of the levee.

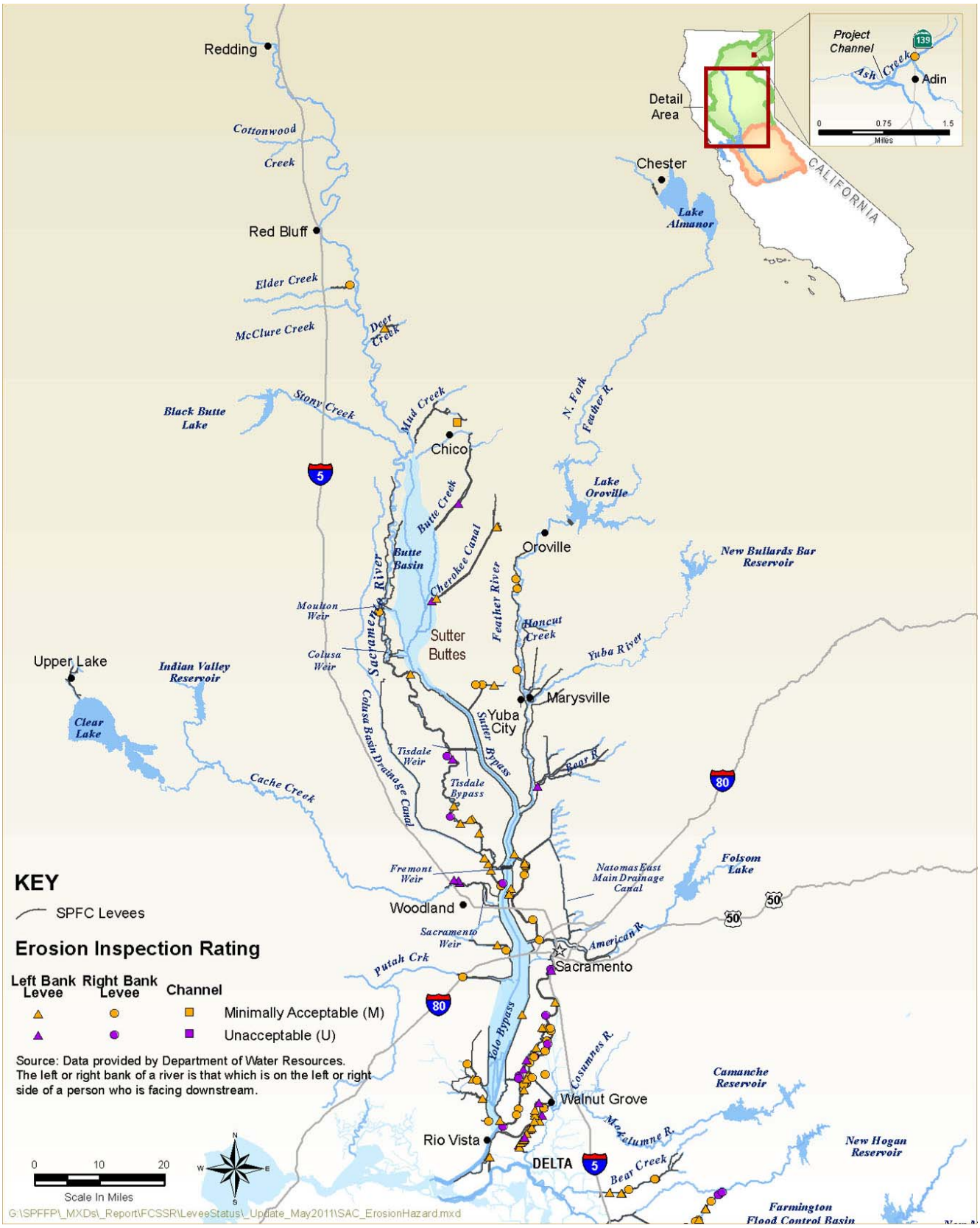

Figure A-21. 2009 Erosion Inspection Ratings in Sacramento River Watershed

Figure A-22. 2009 Erosion Inspection Ratings in San Joaquin River Watershed

Historical Erosion Occurrences

The ULE and NULE projects collected and cataloged information on historical occurrences of levee erosion and completed or planned repairs or improvements. Figures A-23 and A-24 show historical erosion occurrences for the Sacramento and San Joaquin river watersheds, respectively. Historical erosion occurrences were located throughout almost all SPFC levees of the Sacramento and San Joaquin river watersheds.

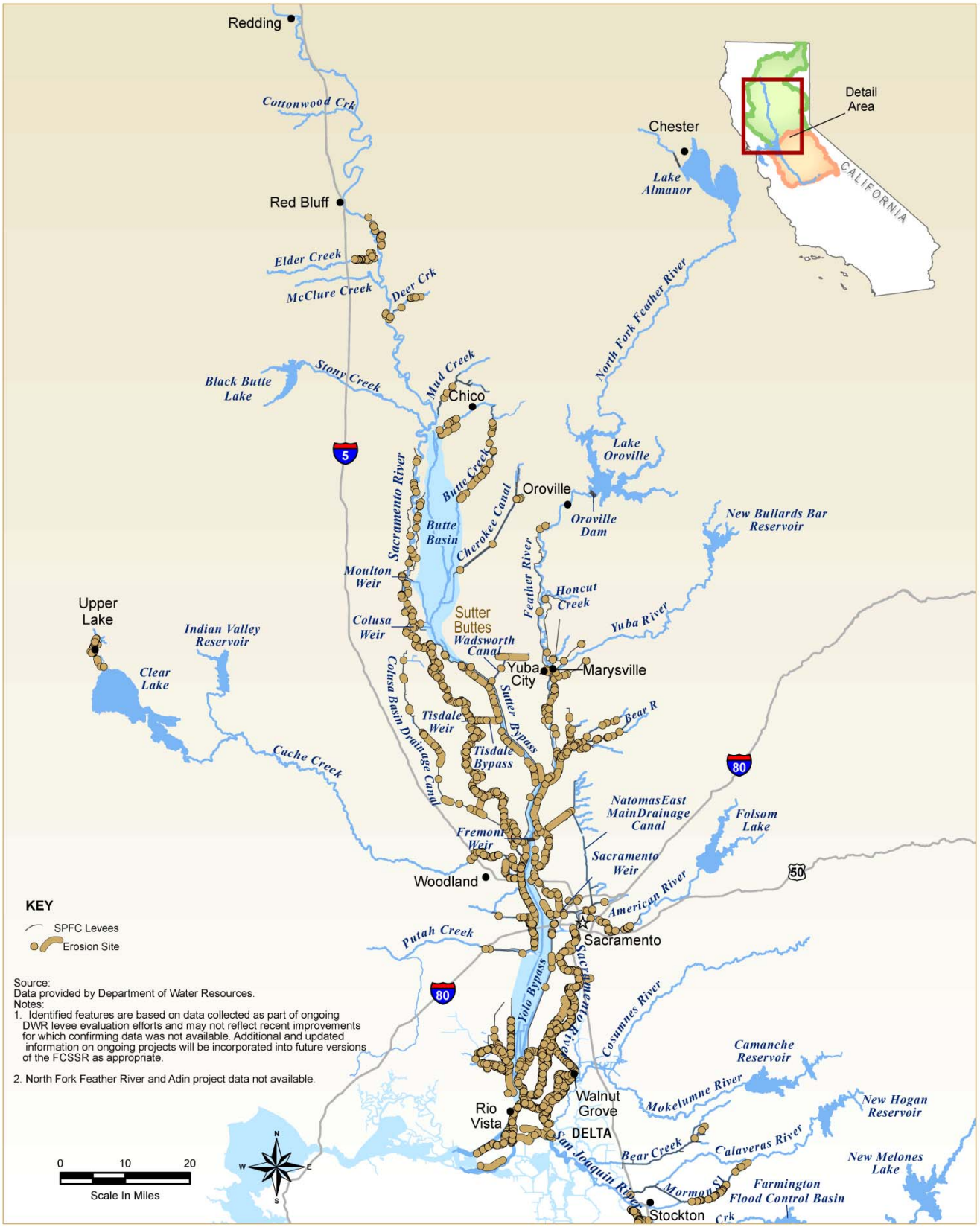

Figure A-23. Historical Erosion Occurrences in Sacramento River Watershed

Figure A-24. Historical Erosion Occurrences in San Joaquin River Watershed

Summary of Recent Remedial Actions

Revetment and riprap have been installed through DWR's Levee Repairs Program after erosion was reported from inspections to restore levees to meet current design criteria.

Information on observed revetment and riprap sites was collected and cataloged as part of the data collection efforts for the ULE and NULE projects, as described in this section. Figures A-25 and A-26 show observed revetment and riprap sites for the Sacramento and San Joaquin river watersheds, respectively. Revetment and riprap have been placed throughout the Sacramento and San Joaquin river watersheds.

Summary of Ongoing and Planned Remedial Actions/Improvements

Erosion is identified and monitored by maintaining agencies to help identify locations that require remediation. DWR's Levee Repairs Program is described below, and many of the Early Implementation Program and USACE/Board projects identified in Section A-1 will preserve the integrity of SPFC levees with regard to erosion.

DWR Levee Repairs Program

As mentioned, DWR's Levee Repairs Program addresses critically and not critically damaged levees, leveraging existing programs and authorizations. The following projects/programs address erosion problems:

- Sacramento River Bank Protection Project
- Sacramento-San Joaquin Erosion Repair Project
- Levee Stability Program
- Public Law 84-99 Rehabilitation Assistance Program

The Sacramento River Bank Protection Project is a federally authorized project with cost sharing between USACE and the Board for SPFC levees that are at risk of an erosion failure during floods and/or normal flow conditions. Waterside erosion surveys of the Sacramento River system conducted every year provide an inventory of erosion sites. As of December 2010, 83 erosion sites had been repaired and 173 were planned for repair (USACE, 2010).

The Sacramento-San Joaquin Erosion Repair Project is funded by DWR and local agencies for remediation of erosion sites across the Central Valley. The Sacramento-San Joaquin Erosion Repair Project will be used to repair erosion sites when the Sacramento River Bank Protection Project

authorization ends. As of December 2010, eight erosion sites had been completed and seven were planned for completion.

As mentioned, the Levee Stability Program is a federal program authorized by the Water Resources Development Act of 2007. Levee Stability Program sites are selected by the DWR Levee Evaluations Program. As of December 2010, two erosion sites had been recommended for repair, but additional sites are anticipated as the DWR Levee Evaluations Program continues.

As mentioned, the Flood Control and Coastal Emergency Act (Public Law 84-99) provides the federal government with authority for emergency management activities. After the 2005 – 2006 storms, 173 erosion sites were determined to be eligible for Public Law 84-99 assistance by USACE, all of which have been constructed.

Planned and completed erosion sites from the Sacramento River Bank Protection Project, Sacramento-San Joaquin Erosion Repair Project, the Levee Stability Program, and Public Law 84-99 projects are shown in Figures A-27 and A-28 for the Sacramento and San Joaquin river watersheds, respectively.

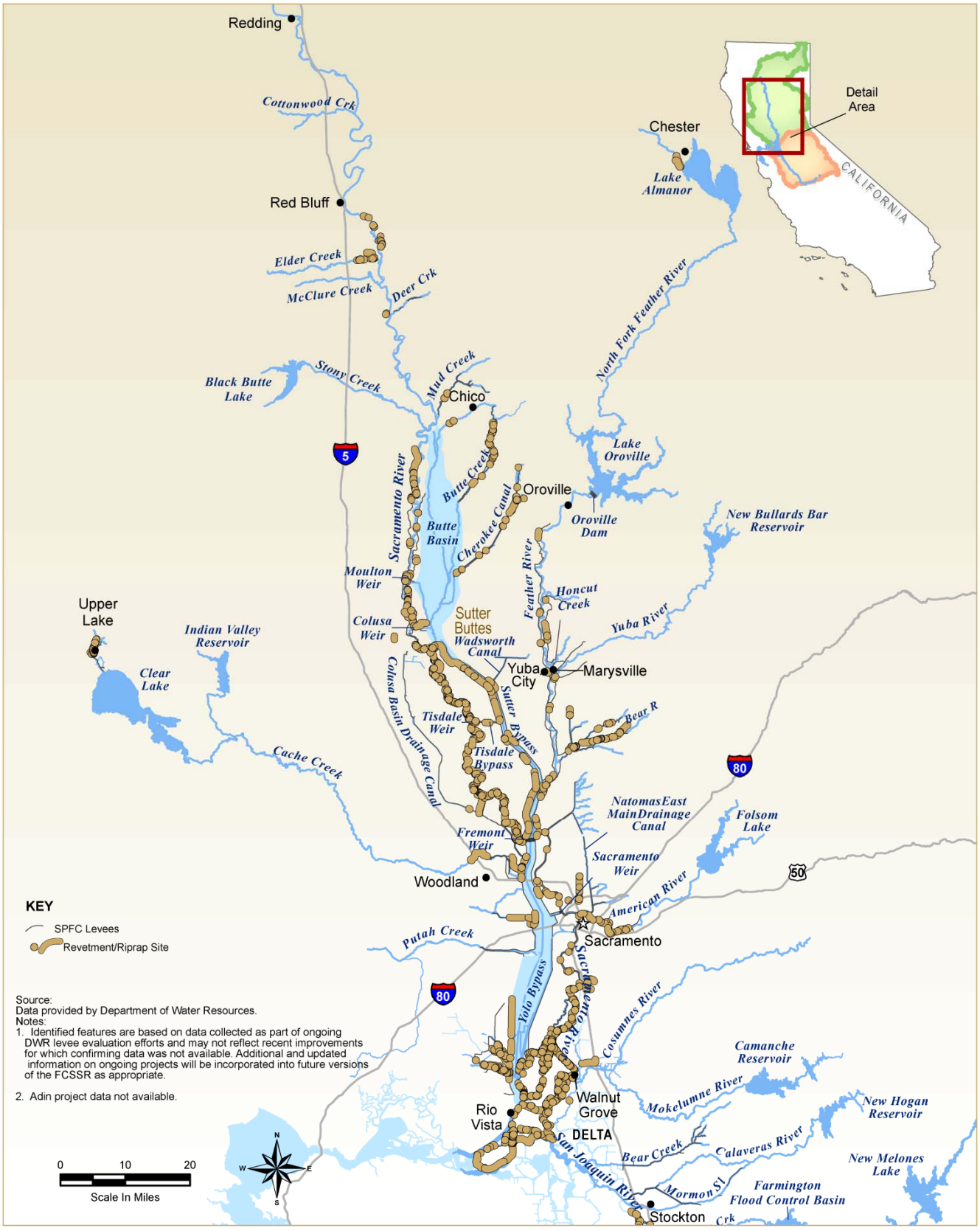

Figure A-25. Levee Revetment Sites in Sacramento River Watershed

Figure A-26. Levee Revetment Sites in San Joaquin River Watershed

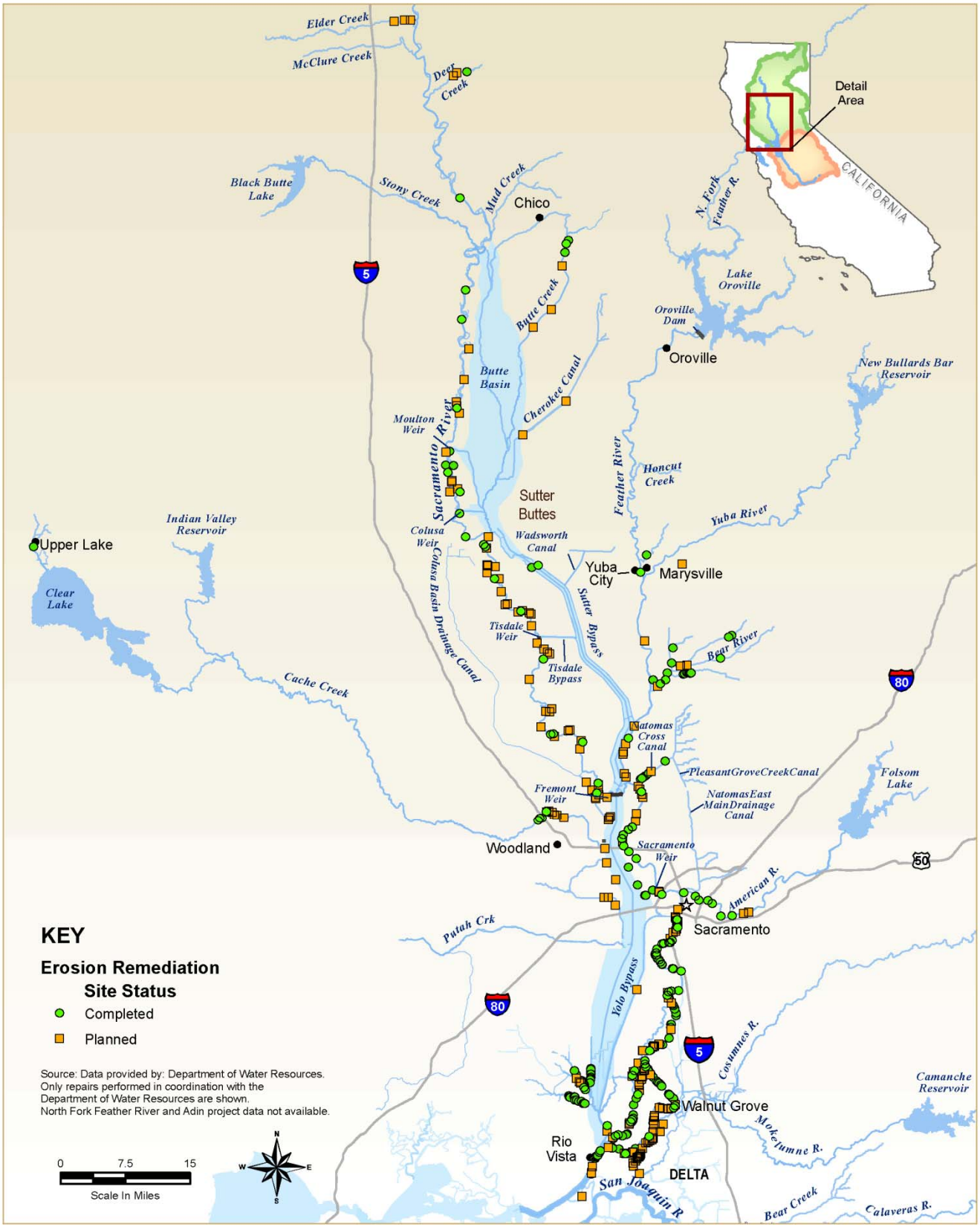

Figure A-27. Planned and Completed Erosion Repair Sites in Sacramento River Watershed

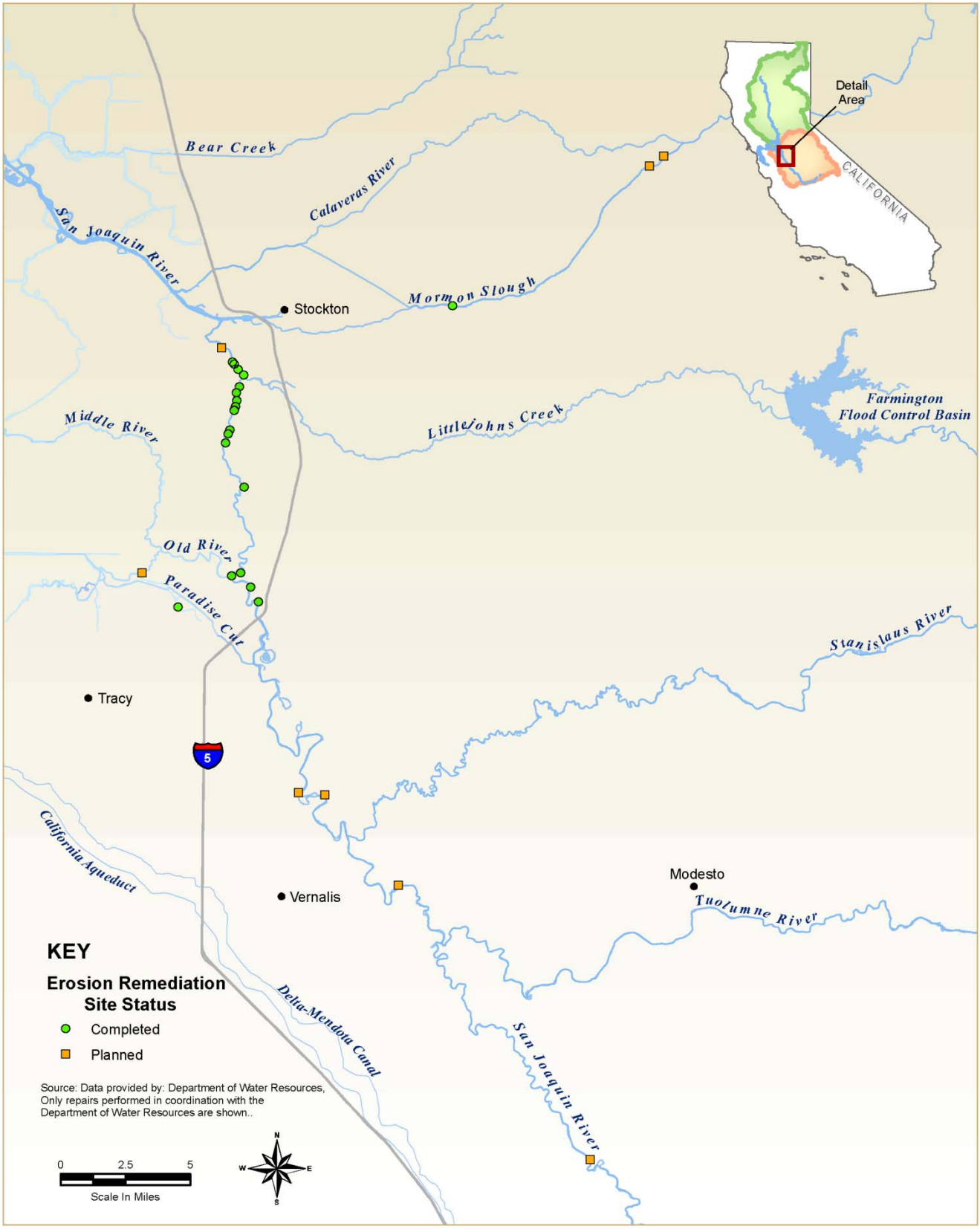

Figure A-28. Planned and Completed Erosion Repair Sites in San Joaquin River Watershed

Ongoing Actions to Improve Future Evaluations

DWR continues to collect levee information using traditional and new, innovative methods, including LiDAR, bathymetric surveys, and geomorphic mapping (see Section A-1). Bathymetric data are especially important in revealing underwater erosion of riverbanks that was previously unknown from waterside erosion surveys.

In addition, a U.S. Geological Survey Sacramento River Bank Protection Project Sedimentation Study is currently underway to evaluate sediment transport and bank stability within the Sacramento River Flood Control System. The study area extends along the Sacramento River from River Mile (RM) 46 at Freeport upstream to RM 144 at Colusa. The study consists of two phases. Phase 1 was completed in March 2009 and included collection and review of available data related to sediment transport and geomorphic trends within the study area. Phase 2 of the study will address the following objectives:

- Evaluate both long-term and flood event aggradation and degradation potential for Sacramento River system bed profiles.
- Evaluate the potential for aggradation at weirs that might affect flow distribution into bypasses.
- Assess the distribution of spawning gravels within the Sacramento River Flood Control Project today and 50 years in the future.
- Evaluate the potential reduction in riparian habitat and floodplain (potential loss of remaining overbank or “berm”) over the next 50 years.
- Assess implications of a sediment transport regime on long-term levee repair requirements for the Sacramento River Flood Control System.

Specific Phase 2 study tasks include sediment sampling, bank stability analysis, sediment transport modeling, and updates to HEC-RAS hydraulic modeling software to improve sediment transport calculation capabilities.

A-6 Settlement

This section includes locations of observed sinkhole and subsidence occurrences and a description of recent, ongoing, and planned remedial actions and improvements, and ongoing actions to improve future evaluations.

Historical Sinkhole and Subsidence Occurrences

The ULE and NULE projects collected and cataloged information on historical occurrences of levee settlement and on completed or planned levee construction or improvements. Figures A-29 and A-30 show historical sinkhole and subsidence occurrences in the Sacramento and San Joaquin river watersheds, respectively. Most of the observed subsidence occurrences in the Sacramento River watershed are located along the Colusa Basin Drainage Canal and Yolo Bypass. Sinkholes are located sporadically across the Sacramento River watershed. In the San Joaquin River watershed, observed subsidence occurrences are located on the Eastside Bypass between Chowchilla River and Owens Creek and observed sinkholes are located on the Chowchilla Bypass.

Summary of Recent Remedial Actions

DWR's Levee Repairs Program and recent other projects have remediated locations where settlement problems have been reported from inspection and evaluation activities.

Summary of Ongoing and Planned Remedial Actions/Improvements

Sinkholes and subsidence are identified and monitored by maintaining agencies to help identify locations that would require repairs or a construction project for remediation. Settlement problems are addressed through DWR's Levee Repairs Program and through other projects being implemented to address subsidence. DWR's Levee Repairs Program is described in Section A-3, and many of the Early Implementation Program and USACE/Board projects identified in Section A-1 will preserve and enhance the integrity of SPFC levees with regard to settlement.

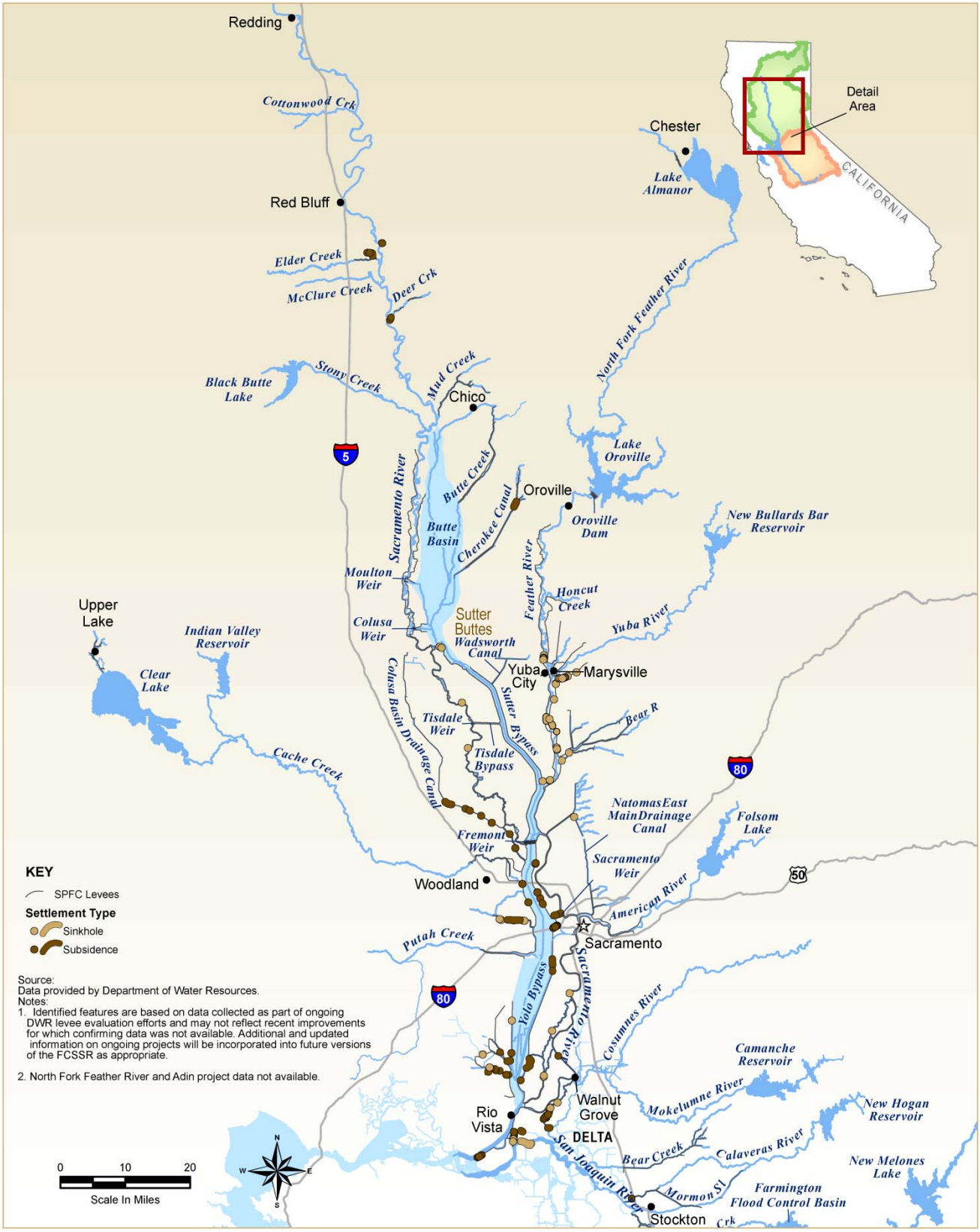

Figure A-29. Historical Sinkholes and Subsidence Distresses in Sacramento River Watershed

Figure A-30. Historical Sinkholes and Subsidence Distresses in San Joaquin River Watershed

Ongoing Actions to Improve Future Evaluations

DWR continues to collect levee information using traditional and innovative methods, including LiDAR and geomorphic mapping (see Section A-1).

A-7 Penetrations

This section includes a brief description of recent, ongoing, and planned remedial actions, and ongoing actions to improve future evaluations regarding penetrations.

Summary of Recent Remedial Actions

In 2009, six penetration failures were initially reported by either the owner or observed by the maintaining agency. DWR conducted follow-up inspections and expeditiously repaired or replaced the pipes. A description and location of these penetrations is included in Table A-17.

Table A-17. Penetrations Repaired or Replaced by DWR in 2009

Penetration Description	Location
Leak in 14-inch-diameter pipe eroded soil and created a sinkhole approximately 6 inches in diameter, located 10 feet from waterside toe of the levee.	Calaveras River
Subsidence at paved levee crown due to collapse of a 12-inch-diameter pipe, located 3 feet below levee crown.	Sacramento River
Leaky 24-inch-diameter corrugated metal pipe created a 10-foot-diameter cavity in the interior of the clayey levee. A sinkhole, 3 feet in diameter appeared on the patrol road.	Sacramento River
Corroded 12-inch-diameter drainage pipeline (located roughly 3 feet below the crown) washed out a 10-foot-diameter, 6-foot-deep hole of the landside levee slope and crown. Severe erosion at the pipe location on the waterside of the levee was evident.	San Joaquin River
Severe leak in a 6-inch-diameter irrigation pipe caused distress on the sandy levee embankment. Pipe located about 3.5 feet below the landside toe.	Sacramento River
Leaky irrigation pipe crossing the levee damaged levee waterside slope. The damage extends for a length of about 15 feet extending almost the entire waterside slope.	Putah Creek

Most penetrations through SPFC levees are maintained by entities other than DWR. Information is not available to identify the number of pipes that may have failed or have been repaired or replaced by entities other than DWR.

Summary of Ongoing and Planned Remedial Actions

DWR is continuing to inspect, identify, repair, and/or replace penetrations that could compromise the structural integrity of a levee. It is difficult to determine when remedial action is needed because internal erosion caused by penetrations often remains hidden until a surface expression occurs.

Ongoing Actions to Improve Future Evaluations

Ongoing actions to improve future evaluations of penetrations include the DWR utility crossing survey program. The goal of the program is to develop a systemwide, searchable database of all existing utility crossings. The program will develop field survey protocols and a rating system or criteria to incorporate utility crossings into current inspection ratings through a pilot project. The program will then define the frequency and schedule for completing surveys systemwide.

A-8 Levee Vegetation

This section includes the DWR *Interim Vegetation Inspection Criteria for Standard Levees* (DWR, 2007), and a description of recent, ongoing and planned remedial actions, and ongoing, actions to improve future evaluations.

DWR Interim Vegetation Inspection Criteria for Standard Levees

The DWR *Interim Vegetation Inspection Criteria for Standard Levees* (DWR, 2007) are shown on Figure A-31.

Summary of Recent Remedial Actions

Levee vegetation maintenance activities conducted by DWR and maintaining agencies include removing vegetation and downed trees that could obstruct the natural flow of water, and controlling weeds, grasses, emergent vegetation, and woody vegetation on levees. DWR's maintenance yards routinely identify and remove trees considered to have the potential to fall and undermine levees. Other specific routine maintenance activities include removing debris, spraying herbicides, mowing and burning vegetation on slopes, and dragging levee slopes.

Summary of Ongoing and Planned Remedial Actions

New levee sections being constructed as part of current Early Implementation Program and USACE/Board projects (Section A-1) will be in compliance with USACE levee vegetation criteria. DWR and the Board require maintaining agencies responsible for maintenance of SPFC levees

to be in compliance with DWR interim vegetation criteria. Progress in implementing interim vegetation requirements will be reviewed by USACE, the Board, and DWR to assess progress in complying with milestones (California Levee Roundtable, 2009). Maintaining agencies are required to develop a plan to resolve vegetation problems. Finally, DWR's maintenance yards and other maintaining agencies will continue to routinely perform annual maintenance to remediate identified problems, such as identifying and removing trees considered to have the potential to fall and undermine levees.

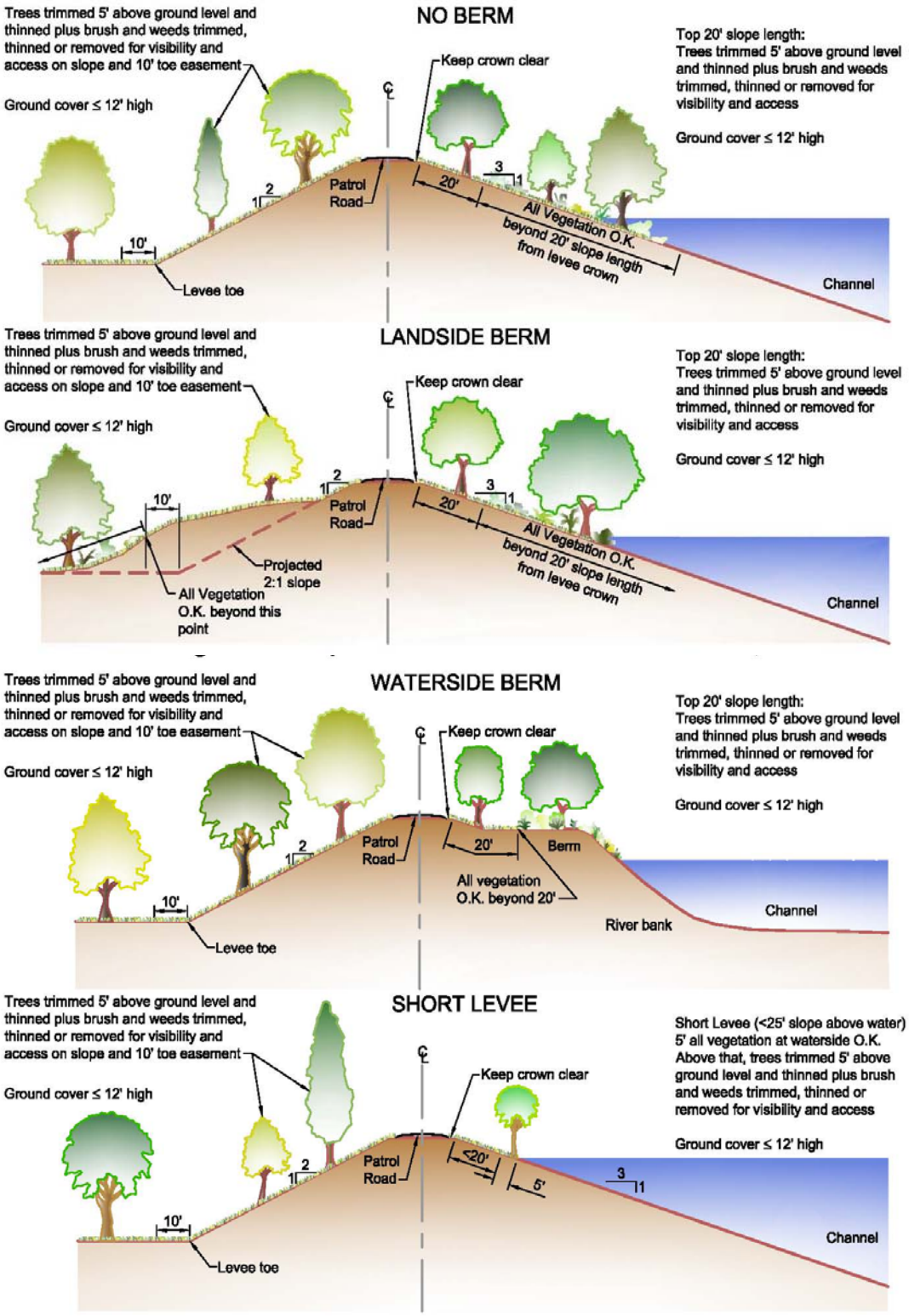

Figure A-31. DWR Interim Vegetation Inspection Criteria for Standard Levees, October 2007

Ongoing Actions to Improve Future Evaluations

Differences between USACE and DWR levee vegetation criteria are significant enough that comparison of levees with USACE criteria would likely show more SPFC levees as noncompliant with current USACE criteria. DWR and USACE continue to work to resolve these differences.

DWR may implement additional changes to its inspection program as existing USACE policies are refined over time, and as other levee management issues arise. The California Levee Vegetation Research Program is being conducted by DWR in partnership with the Sacramento Area Flood Control Agency, Board, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration, California Department of Fish and Game, and local agencies that are members of the California Central Valley Flood Control Association. The partnership conducts research that will determine the extent to which woody vegetation, such as trees, may affect the safety of levees in the Central Valley. The research is being conducted in parallel with a complementary national research program underway by USACE.

A-9 Rodent Damage

This section includes the results of DWR annual inspections for animal control, and a description of recent, ongoing, and planned remedial actions, and ongoing actions to improve future evaluations.

Results of Inspections

DWR visually inspects SPFC levees for burrowing rodent damage at least twice a year, and reports results annually. Table A-18 shows the DWR inspection rating descriptions for animal control of burrowing rodents.

Table A-18. Levee Inspection Rating Descriptions for Animal Control on Earthen Levees

Inspection Rating	Rating Descriptions
Acceptable (A)	Continuous animal burrow control program in place that includes elimination of active burrowing and filling in and compacting or grouting of existing burrows.
Minimally Acceptable (M)	The existing animal eradication and burrow repair program needs to be improved. Several animal burrows present that may lead to seepage or slope stability problems. Burrows must be filled and compacted or grouted.
Unacceptable (U)	Animal burrow control program is not effective or is nonexistent. Significant maintenance is required to fill existing burrows, and the levee will not provide reliable flood protection until this maintenance is complete.

Animal control inspection ratings from the *2009 Annual Inspection Report* (DWR, 2010b) are shown on Figures A-32 and A-33 for the Sacramento and San Joaquin river watersheds, respectively. The inspection data show that several levees were given Minimally Acceptable ratings across the Sacramento River watershed, especially along the upper Sacramento River north of Fremont weir, American River, and Feather River. In the San Joaquin River watershed, Unacceptable and Minimally Acceptable ratings are prevalent throughout the watershed.

Figure A-32. 2009 Animal Control Inspection Ratings in Sacramento River Watershed

Figure A-33. 2009 Animal Control Inspection Ratings in San Joaquin River Watershed

Summary of Recent Remedial Actions

Maintaining agencies are responsible for rodent abatement and damage repair, and implement their own rodent abatement programs. While rodent abatement practices vary among maintaining agencies, current remedial actions under DWR's Rodent Abatement Program include the following:

- Continuous monitoring of all DWR-maintained levees for rodent activity.
- Year-round application of rodent bait, as needed.
- Application of sulfur gases to some rodent runways and dens in areas frequently visited by the public and domestic animals.
- Grouting all newly discovered rodent runways and dens once a year.

Summary of Ongoing and Planned Remedial Actions

Remedial actions for rodent abatement/damage repair are currently not planned to change. Remedial actions will be implemented annually by maintaining agencies as problems are noted in inspections.

Ongoing Actions to Improve Future Evaluations

Increased communication between USACE and DWR regarding inspections is currently taking place to improve evaluation and lead to quicker and more thorough repair of rodent damage.

With the initial identification of levee reaches affected by animal burrows completed through the DWR Animal Burrow Hole Persistence Study, additional efforts could be performed to further examine the incidence of animal burrows on levees such as (1) measurement of burrow hole density and prevalent hole diameter, (2) assessment of maintenance practices to control animal population and mitigate damage to levees, (3) identification of animal species involved, and (4) correlation of animal species activity with habitat and land use.

A-10 Encroachments

This section includes a description of recent, ongoing, and planned remedial actions, and ongoing actions to improve future evaluations.

Summary of Recent Remedial Actions

The Board is responsible for reviewing applications and issuing permits for encroachments within SPFC easements. DWR inspectors perform the field

inspections of most permitted encroachments to determine that they are constructed or installed in accordance with permit conditions. DWR inspectors also document illegal (unpermitted) encroachments and inadequately maintained permitted encroachments in SPFC easements. DWR relies on maintaining agencies to help identify and remove illegal encroachments.

Assembly Bill 1165 was passed in October 2009, which gives the Board more authority for encroachment enforcement. The Board recently developed regulations to implement its new enforcement authorities. The Board has the authority to request removal of unpermitted or inadequately maintained encroachments. The Board created a new Floodway Encroachment and Enforcement Branch to permit, regulate, and enforce the Board's decisions regarding the significant number of encroachments on levees, in floodplains, and near regulated streams within the SPFC. Between May 2009 and December 2010, 50 enforcement actions in Central Valley have been initiated; 14 of those have been resolved.

Summary of Ongoing and Planned Remedial Actions

DWR will continue to inspect construction or installation of newly permitted encroachments in accordance with permit conditions. DWR will also continue to document and report new illegal encroachments and inadequately maintained encroachments to maintaining agencies and the Board for remedial actions.

Each maintaining agency is held responsible for preventing the construction of, or requiring the removal of, any illegally encroaching structures or activities on levees or within the easement at the landward toe of levees. The maintaining agency must also stop any unauthorized modifications or alterations to levees. If any person or organization deems any construction or modification necessary within a levee regulatory easement, that person or organization must apply for an encroachment permit.

Ongoing Actions to Improve Future Evaluations

As a part of ongoing efforts to improve documentation and maintenance for the SPFC, DWR, and the Board have the following efforts currently underway or planned to begin soon, that affect encroachments:

- Continue to update existing levee logs to include data from O&M manuals, existing inspection results, and historical data. This information will be placed into a database format that will function as documentation of system features and structures. All data will be field-verified and georeferenced.

- Create a georeferenced database of the historical encroachment permits and use this effort with the updated levee logs to assist in determining which encroachments are permitted, and the number and type of unpermitted encroachments.

This page left blank intentionally.

References

California Department of Water Resources (DWR). 2007. Interim Levee Vegetation Inspection Criteria.

———. 2009. Erosion Screening Process Report. April.

———. 2010a. State Plan of Flood Control (SPFC) Descriptive Document. Central Valley Flood Management Planning Program. November.

———. 2010b. 2009 Inspection Report of the Central Valley State-Federal Flood Protection System. Flood Project Integrity & Inspection Branch. January.

———. 2010c. Annual Supplemental Erosion Survey of the San Joaquin Flood Control System. April.

———. 2011a. Geotechnical Assessment Report, North NULE Study Area. April.

———. 2011b. Geotechnical Assessment Report, South NULE Study Area. May.

California Levee Roundtable. 2009. California's Central Valley Flood System Improvement Framework. February 27.

U.S. Army Corps of Engineers (USACE). 2007. 2007 - Field Reconnaissance Report of Bank Erosion Sites and Site Priority Ranking. Sacramento River Flood Control Levees, Tributaries and Distributaries. Sacramento River Bank Protection Project. December 18.

———. 2010. 2009 – Field Reconnaissance Report of Bank Erosion Sites and Site Priority Ranking. Sacramento River Flood Control Levees, Tributaries and Distributaries. Sacramento River Bank Protection Project. January 15.

U.S. Army Corps of Engineers and The Reclamation Board (USACE and Board). 1953. Memorandum of Understanding Respecting the Sacramento River Flood Control Project.

This page left blank intentionally.

Acronyms and Abbreviations

Board	Central Valley Flood Protection Board
CVFPP	Central Valley Flood Protection Plan
DWR	California Department of Water Resources
FCSSR	Flood Control System Status Report
LiDAR	Light Detection and Ranging
NULE	Non-Urban Levee Evaluations
O&M	operations and maintenance
RM	River Mile
SPFC	State Plan of Flood Control
State	State of California
ULE	Urban Levee Evaluations
USACE	U.S. Army Corps of Engineers

This page left blank intentionally.

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

CENTRAL VALLEY
FLOOD MANAGEMENT
PLANNING PROGRAM

FloodSAFE
CALIFORNIA

Flood Control System Status Report
Appendix B – Channel Status

December 2011

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

This page left blank intentionally.

Table of Contents

List of Tables

List of Figures

This page left blank intentionally.

Appendix B – Channel Status

Appendix B provides additional supporting information on channel conditions. These data include estimated channel conveyance capacity for the Sacramento and San Joaquin rivers and their major tributaries. Sections B-2, Channel Vegetation, and B-3, Channel Sedimentation, correspond to subsections in Section 5 of the Flood Control System Status Report (FCSSR) main document. Additional inspection and/or evaluation data, recent, ongoing, and planned remedial actions, and ongoing actions to improve future evaluations are described for channel conveyance capacity, channel vegetation, and channel sedimentation.

B-1 Channel Conveyance

This section summarizes estimated channel conveyance capacities along the Sacramento and San Joaquin rivers and their major tributaries. Also included is information on recent, ongoing, and planned remediation actions and ongoing actions to improve future evaluations.

Channel Capacity Status Tabular Results

Tables B-1 and B-2 present a tabulation of estimated channel capacities for the Sacramento and San Joaquin river watersheds, respectively. For each channel reach in the Sacramento River watershed, design capacities from Senate Document No. 23, design capacities from USACE operations and maintenance (O&M) manuals, and design capacities from 1957 revised profile drawings are provided where available (USACE, 1957). The 1957 revised profile drawings are the basis for State operations. Any differences between the 1957 revised profile drawings capacity and O&M manual capacity are noted. For each channel reach in the San Joaquin River watershed, design capacities from the O&M manual and design capacities from the U.S. Army Corps of Engineers (USACE) Design Memorandum No. 1 (USACE, 1955) are provided where available. The USACE Design Memorandum No. 1 includes design capacities corresponding to 1955 profile drawings, which serve as the basis for State operations. Differences between USACE Design Memorandum No. 1 capacity and O&M manual capacity are noted.

Estimated current channel capacities and their data source are also included. As mentioned, existing capacities were estimated using information from the *SPFC Existing Channel Capacity Assessment Technical Memorandum* (CVFED, 2009) and supplemented with project-

specific modeling results. Channel capacity conditions were estimated by comparing estimated current capacity with the design channel capacity reported in the USACE O&M manuals, USACE 1957 revised profile drawings, or USACE Design Memorandum No. 1 (1955).

Table B-1. Sacramento River Watershed Channel Capacity Status

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (basis of State operations)	Difference Between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Red Bluff to Chico Landing										
Sacramento River										
Deer Creek to Chico Landing	No data	No data	260,000 cfs	Not specified	Not specified	N/A	No data	No data	Estimated flow at Chico Landing is 260,000 cfs (Senate Document No. 23)	None
Tributaries to Sacramento River										
Elder Creek	6	0	Not specified	17,000	17,000	No	9,000 – 17,000	Potential inadequacy; additional evaluation required	DWR Channel Evaluation Program Modeling by DWR Northern Region Office	None
Deer Creek	7.4	0	Not specified	21,000	21,000	No	11,000 – 21,000	Potential inadequacy; additional evaluation required	DWR Channel Evaluation Program Modeling by DWR Northern Region Office	None
Chico Landing to Colusa Weir										
Sacramento River										
Chico Landing to head of east levee	175	166	160,000	160,000	160,000	No	195,000	No obvious inadequacy	*Determination of Channel Capacity of the Sacramento River* (USGS, 1976) and EIR for Butte Basin Overflow Area, (Reclamation Board, 1986)	None
East levee head (Parrott Grant Line) to Princeton-Afton Road	166	153	160,000	160,000	160,000	No	159,000	Potential inadequacy; additional evaluation required	Ayers modeling for USACE and Princeton Pump Plant	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Princeton-Afton Road to Moulton Weir	153	148.25	160,000	160,000	160,000	No	110,000 – 184,000	Potential inadequacy; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis – 184,000 cfs DWR Channel Evaluation Program – 110,000 cfs	150,000 cfs design capacity authorized with Butte Basin Bypass if it was constructed.
Moulton Weir to Colusa Weir	148.25	138	145,000	110,000	135,000	Yes	126,000	Potential inadequacy; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	None
Tributaries to Sacramento River										
Mud Creek and Big Chico Creek										
Mud Creek – end of levees to Sycamore Creek	8.22	6.82	Not specified	5,500	No data	N/A	No data	No data	N/A	None
Mud Creek – Sycamore Creek to SPRR	6.82	4.32	15,000	15,000	15,000	No	No data	No data	N/A	None
Mud Creek – SPRR to Big Chico Creek	4.32	0.00	13,000	13,000	13,000 – 15,000	No	No data	No data	N/A	None
Tributaries to Mud Creek										
Sycamore Bypass	12.4	11.0	8,500	8,500	8,500	No	>8,500	No obvious inadequacy	DWR Channel Evaluation Program Modeling by Flood Maintenance Office	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Sycamore Creek										
Sycamore Bypass to North Sycamore Creek	11.0	9.4	10,000	10,000	10,000	No	>10,000	No obvious inadequacy	DWR Channel Evaluation Program Modeling by Flood Maintenance Office	Significant scouring of the channel bed has occurred since project was completed and appears to be migrating upstream into the bypass channel.
North Sycamore Creek to Sheep Hollow	9.4	8.6	10,000	10,000	10,000	No	>8,000	Potential inadequacy; additional evaluation required	DWR Channel Evaluation Program Modeling by Flood Maintenance Office	Recently completed sediment removal at Cohasset Bridge restored localized restriction but much conveyance in the reach remains below design capacity.
Sheep Hollow to Mud Creek	8.6	6.8	11,000	11,000	11,000	No	5,000	Potential inadequacy; additional evaluation required	DWR Channel Evaluation Program Sycamore Creek Sediment Removal Project	None
Lindo Channel	10.3	2.75	Not specified	6,000	6,000	No	<4,000-6,000	Potential inadequacy; additional evaluation required	DWR Channel Evaluation Program Modeling by DWR Northern Region Office	Capacity inadequacies are dispersed throughout. There is a major constriction just downstream from the Lindo Channel Control Structure and at Big Chico Creek, where capacity is limited to less than 4,000 cfs.
Big Chico Creek – Mud Creek to Sacramento River	2.75	0	15,000	15,000	15,000	No	No data	No data	N/A	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Distributaries from Sacramento River										
Overflow to Butte Basin	175	166	100,000 cfs	100,000 cfs from Senate Document No. 23		N/A	150,000	No obvious inadequacy	*Determination of Channel Capacity of the Sacramento River* (USGS, 1976) and EIR for Butte Basin Overflow Area (Reclamation Board, 1986)	None
Moulton Weir [3]	158.5	158.5	15,000	25,000	25,000	No	34,000	No obvious inadequacy	*Two-Dimensional Hydraulic Modeling of Riparian Habitat Restoration from Colusa to Princeton* (Nature Conservancy, 2007)	None
Colusa Weir [3]	146.2	146.2	80,000	70,000	70,000	No	75,300	No obvious inadequacy	*Two-Dimensional Hydraulic Modeling of Riparian Habitat Restoration from Colusa to Princeton* (Nature Conservancy, 2007)	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]	Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
Colusa Weir to Fremont Weir									
Sacramento River									
Colusa Weir to Colusa Bridge	138.0	135.0	65,000	48,000	65,000	Yes	50,000	Potential inadequacy; additional evaluation required	Project-specific modeling from MBK for Natomas 408 Impact Analysis	None
Colusa Bridge to Butte Slough	135.0	130.0	47,000	48,000	65,000	Yes	50,000	Potential inadequacy; additional evaluation required	Project-specific modeling from MBK for Natomas 408 Impact Analysis	None
Butte Slough to Meridian Road	130.0	126.0	47,000	48,000	66,000	Yes	67,000	No obvious inadequacy	Project-specific modeling from MBK for Natomas 408 Impact Analysis	None
Meridian Road to Tisdale Weir	126.0	119.5	72,000	48,000	66,000	Yes	47,000	Potential inadequacy; additional evaluation required	Estimate from adjacent project-specific modeling from MBK for Natomas 408 Impact Analysis	None
Tisdale Weir to Wilkins Slough	119.5	118	33,500	30,000	30,000	No	29,000	Potential inadequacy; additional evaluation required	Project-specific modeling from MBK for Natomas 408 Impact Analysis	None
Wilkins Slough to Knights Landing	118.0	90.0	33,500	30,000	30,000	No	29,000	Potential inadequacy; additional evaluation required	Project-specific modeling from MBK for Natomas 408 Impact Analysis	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Knights Landing to Fremont Weir	90.0	85.0	33,500	30,000	30,000	No	29,000	Potential inadequacy; additional evaluation required	Project-specific modeling from MBK for Natomas 408 Impact Analysis	None
Tributaries to Sacramento River										
Butte Slough Outfall	138.2	138.2	7,000	3,500	1,000	N/A	Not applicable	Not applicable	N/A	This facility is subject to backwater control.
Knights Landing Outfall	90.2	90.2	Not specified	Not applicable	Not applicable	N/A	Not applicable	Not applicable	N/A	This facility is designed to protect the Colusa Basin from backwater from the Sacramento River – thus, capacity is not relevant.
Distributaries from Sacramento River										
Tisdale Weir and Bypass	119.2	119.2	38,500	38,000	38,000	No	15,000 – 32,000	Potential inadequacy; additional evaluation required	DWR Channel Evaluation Program 2006 sediment removal project	Backwater from Sutter Bypass limits the capacity of the weir and bypass during large floods. See Note 4.
Fremont Weir [3]	85.2	82.2	343,000	343,000	343,000	No	No data	Not applicable		Weir flow needs to be analyzed. See Note 4.
Sutter Bypass										
Butte Slough to Wadsworth Canal	93.2	83.0	178,000	178,000	150,000	Yes	111,000 – 150,000	Potential inadequacy; additional evaluation required	Project-specific modeling from MBK for Natomas 408 Impact Analysis – 111,000 cfs DWR Channel Evaluation Program – 150,000 cfs	DWR Channel Evaluation Program started at 1957 profile elevation, running profile irrespective of upstream levee profile.
Wadsworth Canal to Tisdale Bypass	83.0	77.8	178,000	178,000	155,000	Yes	125,000	Potential inadequacy; additional evaluation required	Project-specific modeling from MBK for Natomas 408 Impact Analysis	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Tisdale Bypass to Feather River	77.8	67.0	216,500	216,500	180,000	Yes	142,000 – 180,000	Potential inadequacy; additional evaluation required	Project-specific modeling from MBK for Natomas 408 Impact Analysis – 142,000 cfs DWR Channel Evaluation Program - 180,000 cfs.	In 1997, flood reverse flow occurred for a few hours due to backwater from the Sutter Bypass.
Feather River to Verona	67.0	59.0	416,500	416,500	380,000	Yes	400,000	No obvious inadequacy	Project-specific modeling from MBK Natomas 408 Impact Analysis	Model separates flow at the training levee and splits the flow in the channel.
Tributaries to Sutter Bypass										
Butte Creek										
Little Chico Creek Diversion Channel to Midway	15.32	8.2	12,000 (see comments)	27,000	27,000	No	27,000 to 44,222	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) - 44,222 cfs *Butte Creek Watershed Floodplain Management Plan* (Butte Creek Watershed Conservancy, 2005) - 27,000 cfs	Design flows from Senate Document 23 apply to reach SPRR to US Highway 99. Little Chico Diversion channel not specified in Senate Document 23. *SPFC Existing Channel Capacity Assessment TM* indicates uncertain estimated capacity.
Midway to 1.6 miles downstream from Aguas Frias Road	8.2	0	Not specified	22,000	22,000	No	22,000 – 44,222	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) - 44,222 cfs *Butte Creek Watershed Floodplain Management Plan* (Butte Creek Watershed Conservancy, 2005) - 22,000 cfs	*SPFC Existing Channel Capacity Assessment TM* indicates uncertain estimated capacity.

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Cherokee Canal										
Dry Creek to Gold Run Creek at Nelson Road	21.72	20.22	Not specified	8,100	8,100	No	No data	No data	N/A	None
Gold Run Creek at Nelson Road to Cottonwood Creek at Western Canal	20.22	15.82	Not specified	8,500	8,500	No	3,600 – 4,500	Potential inadequacy; additional evaluation required	DWR Channel Evaluation Program	4,050 cfs from Cottonwood Creek to Old Nelson-Shippe Road; 3,600 cfs from Old Nelson Shippe Road to Old SNNR; and 4,500 cfs from Old SNRR Road to Nelson Road.
Cottonwood Creek at Western Canal to RD 833 canal entrance at Afton Road	15.82	7.92	Not specified	11,500	12,500	Yes	No data	No data	N/A	None
RD 833 canal entrance at Afton Road to Lower Butte Basin about 1 mile downstream from Colusa-Gridley Road	7.92	0	Not specified	12,500	12,500	No	No data	No data	N/A	None
Wadsworth Canal	5	0.5	No data	1,500	1,500	No	No data	No data	N/A	None
Feather River										
Honcut Creek to end of project	50.9	44.3	180,000	210,000	210,000	No	180,000	Potential inadequacy; additional evaluation required	MBK – Feather Setback Levee – TRLIA	Future design flows may change as a result of the Forecast-Coordinated Operation of Lake Oroville and Bullards Bar Reservoir Project.
Jack Slough to Honcut Creek	44.3	27.4	180,000	210,000	210,000	No	180,000	Potential inadequacy; additional evaluation required	MBK – Feather Setback Levee – TRLIA	Future design flows may change as a result of the Forecast-Coordinated Operation of Lake Oroville and Bullards Bar Reservoir Project.

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Mouth of Yuba River to Bear River	27.4	12.0	277,000	300,000	300,000	No	350,000	No obvious inadequacy	MBK – Feather Setback Levee - TRLIA	None
Bear River to (Sutter (Yolo) Bypass	12.0	7.6	295,000	320,000	320,000	No	390,000	No obvious inadequacy	MBK – Feather Setback Levee - TRLIA	None
Tributaries to Feather River										
Honcut Creek										
Honcut Creek-Feather River to WPRR	4.5	0.0	Not specified	5,000	25,000	Yes	9,000	Potential inadequacy; additional evaluation required	Wood Rogers HEC-RAS model	Levees within this reach are designed to protect upstream flows from Honcut Creek and backwater from Feather River (when the river is at design capacity of 210,000 cfs).
Honcut Creek – WPRR to end of project	5.25	4.5	Not specified	5,000	5,000	No	0 – 9,000	No obvious inadequacy	Wood Rogers HEC-RAS model	None
Yuba River										
Yuba River – Feather River to Simpson Lane	1.6	0.5	120,000	120,000	120,000	No	121,000 – 170,000	No obvious inadequacy	MBK – Feather-Yuba River Coordinated Operating Studies – 170,000 cfs DWR Channel Evaluation Program – 121,000 cfs	Capacity is affected by backwater from Feather River.
Yuba River – Simpson Lane to end of project	5 (7.5)	1.6	120,000	120,000	120,000	No	170,000	No obvious inadequacy	MBK – Feather-Yuba River Coordinated Operating Studies	None
Bear River										
Feather River to WPRR	3.5	0.0	30,000	30,000	30,000	No	60,000	No obvious inadequacy	MBK – Feather River Setback Levee – TRLIA	Capacity improved by Feather River Setback Levee Project.
WPRR to Dry Creek	4.5	3.5	Not specified	40,000	37,000	Yes	60,000	No obvious inadequacy	MBK – Feather River Setback Levee – TRLIA	Capacity improved by Feather River Setback Levee Project.

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Dry Creek to end of project	13.0	4.5	Not specified	30,000	30,000	No	60,000	No obvious inadequacy	MBK – Feather River Setback Levee – TRLIA	Capacity improved by Feather River Setback Levee Project
Tributaries to Bear River										
WPRR Interceptor – upstream from North Dry Creek	6.3	2.3	Not specified	10,000	5,000	Yes	No data	No data	N/A	None
WPRR Interceptor Channel - Dry Creek to Bear River	2.3	0.0	Not specified	10,000	10,000	No	N/A	Backwater controlled; additional evaluation required	N/A	Capacity is affected by backwater from Bear River.
North Dry Creek	1.50	0.00	Not specified	No data	5,000	No data	No data	No data	N/A	None
South Dry Creek	1.5	0.8	Not specified	7,000	9,000	No data	No data	No data	N/A	None
Yankee Slough	4.2	0.0	Not specified	2,500	2,500	No	2,000	Potential inadequacy; additional evaluation required	Wood Rogers HEC-RAS Model	None
Fremont Weir to American River										
Sacramento River										
Fremont Weir to Sacramento Weir	80.3	63.9	107,000	107,000	107,000	No	76,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM (CVFED, 2009)*	Levees on left bank have been raised by SAFCA and therefore have adequate freeboard.
Sacramento Weir to American River	63.4	51.7	18,000	110,000	18,000	Yes	80,000 – 107,000	No obvious inadequacy	DWR Channel Evaluation Program	The hydraulics of this reach is complex and varies according to operation of the Sacramento Weir. See Note 4.

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Tributaries to Sacramento River										
Natomas Cross Canal	4.7	0.1	Not specified	800	22,000	Yes	N/A	Backwater controlled; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	Operates under backwater control during high-water events.
Tributaries to Natomas Cross Canal										
East Side Canal (Coon Creek Intercepter)										
Natomas Cross Canal to Auburn Ravine	1.7	0.1	Not specified	16,000	16,000	No	6,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) – 6,000 cfs MBK modeling for Natomas 408 Impact Analysis – backwater control designation	Backwater control – flows vary accordingly.
Auburn Ravine to Markham Ravine	2.7	1.7	Not specified	12,000	12,000	No	8,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) – 8,000 cfs MBK modeling for Natomas 408 Impact Analysis – backwater control designation	Backwater control – flows vary accordingly.
Markham Ravine to Coon Creek	4.7	2.7	Not specified	5,000	5,000	No	6,000	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)– 6,000 cfs MBK modeling for Natomas 408 Impact Analysis – backwater control designation	Backwater control – flows vary accordingly.

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Pleasant Grove Creek Canal										
Sankey Road to Pleasant Grove Creek	10.0	8.0	Not specified	900	800	Yes	No data	Backwater controlled; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis – backwater control designation	Backwater control – flows vary accordingly.
Pleasant Grove Creek to Pierce-Roberts Drain	8.0	7.0	Not specified	2,700	2,300	Yes	2,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) – 2,000 cfs MBK modeling for Natomas 408 Impact Analysis – backwater control designation	Backwater control – potential inadequacy applies to east bank, SAFCA proposed project will raise levees on west bank to provide adequate freeboard.
Pierce-Roberts Drain to Natomas Cross Canal	7.00	5.00	Not specified	7,000	6,000	Yes	3,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)– 2,000 cfs MBK modeling for Natomas 408 Impact Analysis – backwater control designation	Backwater control – potential inadequacy applies to east bank, SAFCA proposed project will raise levees on west bank to provide adequate freeboard.
American River										
State Fairgrounds to Carmichael Bluffs	5.25	14.50	128,000	115,000 (see comments)	115,000 (with 5 feet of freeboard) 152,000 (with 3 feet of freeboard)	No	115,000 (current) 160,000 (with 3-feet of freeboard after improvements)	No obvious inadequacy	New capacity from SAFCA; former capacities are from 1957 profile and USACE American River Common Features Project	1957 profile capacity and O&M design flood was set as 115,000 cfs in accordance with local desire to match existing height of the left-bank levee. 1957 profile design capacity was 152,000 cfs based on 3 feet of freeboard and 115,000 cfs with freeboard of 5 feet. Capacity, after improvements, will be 160,000 cfs.

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Sacramento River to State Fair Grounds	0.0	5.25	128,000	180,000	N/A	N/A	115,000 cfs (current) 160,000 (with 3-feet of freeboard after improvements)	No obvious inadequacy	USACE American River Common Features Project	None
Tributaries to American River										
Natomas East Main Drainage Canal (Steelhead Creek)										
Dry Creek To Sankey Road	12.7	4.00	Not specified	1,100	1,500	Yes	Greater than 1,500 cfs	No obvious Inadequacy	SAFCA	SAFCA levee raising and pump station project did not alter existing capacity.
Arcade Creek to Dry Creek	4.02	1.25	Not specified	12,900	16,300	Yes	19,000 cfs	No obvious Inadequacy	SAFCA	SAFCA levee raising project did not alter existing capacity.
American River to Arcade Creek	1.25	0.0	Not specified	16,000	16,000	No	Backwater Control – flows vary accordingly	Backwater controlled; additional evaluation required	SAFCA	Backwater control – flows vary accordingly.
Tributaries to Natomas East Main Drainage Canal										
Dry Creek (previously, Linda Creek)	1.3	0	Not specified	15,000	15,000	No	18,000 cfs	No obvious Inadequacy	Ensign & Buckley via MBK	SAFCA levee raising project increased capacity.
Arcade Creek	2.0	0	Not specified	3,300	3,300	No	6,900 cfs	No obvious Inadequacy	MBK	SAFCA levee raising project increased capacity.
Distributaries from Sacramento River										
Sacramento Weir and Bypass [3]	45.3	45.3	112,000	112,000	112,000	No	132,000 – 133,000	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Yolo Bypass										
Fremont Weir to Knights Landing Ridge Cut	57.2	54.2	343,000	343,000	343,000	No	290,000	Potential inadequacy; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	None
Knights Landing Ridge Cut to Cache Creek	54.2	51.8	362,000	362,000	362,000	No	276,000	Potential inadequacy; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	None
Cache Creek to Sacramento Bypass	51.8	45.3	377,000	377,000	377,000	No	201,000	Potential inadequacy; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	None
Sacramento Bypass to Putah Creek	45.3	39.5	480,000	480,000	480,000	No	334,000	Potential inadequacy; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	None
Putah Creek to RM 29	39.5	29.0	490,000	490,000	490,000	No	322,000	Potential inadequacy; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	None
RM 29 to Miner Slough	29.0	18.5	500,000	490,000	500,000	Yes	No data	No data	N/A	The Comprehensive Study UNET model does not provide reliable results in this reach. Additional model development will be required.
Miner Slough to Sacramento River	18.5	14.1	500,000	490,000	500,000	Yes	N/A	Backwater controlled; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	Backwater control – flows vary accordingly.

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Tributaries to Yolo Bypass										
Knights Landing Ridge Cut	2.6	0	16,000	20,000	20,000	No	16,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Colusa Basin Drainage Canal	36.5	0.00	Not specified	20000	20000	No	No data	No data	N/A	None
Cache Creek	12.9	4.50	20,000	30,000	30,000	No	27,000 – >30,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) – 27,000 cfs DWR Channel Evaluation Program – >30,000 cfs	Recent DWR analysis indicates additional study required due to subsidence of the levees and channel.
Cache Creek Weir and Settling Basin	4.5	0	20,000	30,000	30,000	No	0 – 30,000	Not applicable	DWR Channel Evaluation Program	Recent modeling shows weir submerged in high flows.
Tributaries to Cache Creek										
Middle Creek										
Upstream of Clover Creek Diversion	1.0	0	Not specified	12,500	Not applicable	N/A	No data	No data	N/A	None
Clover Creek Diversion to Clover Creek	2.25	1.0	Not specified	21,500	Not applicable	N/A	No data	No data	N/A	None
Clover Creek to Scott Creek	3.13	2.25	Not specified	19,000	Not applicable	N/A	No data	No data	N/A	None
Scott Creek to Clear Lake	4.18	3.13	Not specified	27,000	Not applicable	N/A	No data	No data	N/A	None
Tributaries to Middle Creek										
Scott Creek	1.38	0	Not specified	11000	Not applicable	N/A	No data	No data	N/A	None
Clover Creek	0.5	0	Not specified	500	Not applicable	N/A	No data	No data	N/A	None
Clover Creek Diversion	1.04	.35	Not specified	8,000	Not applicable	N/A	No data	No data	N/A	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Tributaries to Clover Creek Diversion										
Alley Creek to Clover Creek Diversion Facilities	1.2	1.0	Not specified	8,500	Not applicable	N/A	No data	No data	N/A	None
Clover Creek	.2	0	Not specified	5,000	Not applicable	N/A	No data	No data	N/A	None
Alley Creek	1.53	1.2	Not specified	2,800	Not applicable	N/A	No data	No data	N/A	None
Tributaries to Yolo Bypass										
Willow Slough	7.60	0	Not specified	6,000	6,000	No	No data	No data	N/A	None
Putah Creek	9.7	0	25,000	40,000	62,000	Yes	45,000	Potential inadequacy; additional evaluation required	DWR Channel Evaluation Program	None
Miner Slough	1.68	0	10,000	10,000	10,000	No	N/A	Backwater controlled; additional evaluation required	DWR Channel Evaluation Program	Reach subject to backwater control and flows vary.
Lindsey Slough	5.66	0	Not specified	43,500	30,000	Yes	Not applicable – backwater controls reach	Backwater controlled; additional evaluation required	N/A	Reach subject to backwater control and flows vary.
American River to Collinsville										
Sacramento River										
American River (West Sac levee) to Elk Slough	51.6	42.3	110,000	110,000	110,000	No	128,000	No obvious inadequacy	MBK modeling for Natomas 408 Impact Analysis	None
Elk Slough to Sutter Slough	42.1	34.3	110,000	110,000	110,000	No	120,000	No obvious inadequacy	MBK modeling for Natomas 408 Impact Analysis	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Sutter Slough to Steamboat Slough	34.1	32.5	84,500	84,500	84,500	No	91,000	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Steamboat Slough to Georgiana Slough	32.5	26.8	56,500	56,500	56,500	No	80,000	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Georgiana Slough to Steamboat Slough and Cache Slough (Yolo Bypass Junction)	26.5	14.8	35,900	35,900	35,900	No	75,000	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Steamboat Slough and Cache Slough (Yolo Bypass Junction) to 3-Mile Slough	14.5	9.8	579,000	579,000	579,000	No	750,000	No obvious inadequacy	MBK modeling for Natomas 408 Impact Analysis	None
3-Mile Slough to Collinsville	9.5	0	514,000	514,000	514,000	No	Not applicable	Backwater controlled; additional evaluation required	N/A	Tidal influence affects water surface elevation and discharge varies.
Distributaries from Sacramento River										
Steamboat Slough – Sacramento River to Sutter Slough	21.8	15.2	28,000	28,000	28,000	No	61,000	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Steamboat Slough – Sutter Slough to Sacramento River	26.3	21.8	43,500	43,500	43,500	No	53,000	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Sutter Slough – Sacramento River to Miner Slough	28.5 (6.75)	22.0 (2.40)	25,500	25,500	26,500	No	23,000	Potential inadequacy; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	None

Table B-1. Sacramento River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[2]		Design Flows from Senate Document No. 23	Design Capacity from O&M Manual (cfs)	Design Flow from 1957 Revised Profile Drawings (cfs) (Basis of State Operations)	Difference between 1957 Profile Flow and O&M Capacity (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Estimated Current Capacity	Comments
	From	To								
Sutter Slough – Miner Slough to Steamboat Slough	2.40	0.00	15,500	15,500	15,500	No	32,000	No obvious inadequacy	MBK modeling for Natomas 408 Impact Analysis	None
Georgiana Slough	10	0	20,600	20,600	20,600	No	19,000	Potential inadequacy; additional evaluation required	MBK modeling for Natomas 408 Impact Analysis	None
3-Mile Slough	3.10	0.00	65,000	65,000	65,000	No	No data	No data	N/A	None

Notes:
[1] The State operates SPFC facilities in the Sacramento Valley based on the 1957 profile rather than on design flows specified in USACE O&M manuals.
[2] River mile designations are based on the USACE and DWR Comprehensive Study river mile designations (2002).
[3] The river mile was estimated at this location.
[4] The operation of weirs and structures within the system are being handled separately and are not included in this evaluation; however, bypass capacities are estimated. Consequently, while bypasses may have sufficient capacity, this does not imply that the full operation of the weir and bypass does not have inadequacies. Additional modeling and evaluation are required.

Key:
Ayers = Ayers Associates, Engineers, Scientists, Surveyors
cfs = cubic feet per second
DWR = California Department of Water Resources
EIR = Environmental Impact Report
MBK = MBK Engineering Co.
N/A = Not available
No data = No data currently available
O&M = operations and maintenance
RD = Reclamation District
RM = river mile
SAFCA = Sacramento Area Flood Control Agency
SNRR = Sacramento Northern Railroad (now defunct)
SPFC = Existing Channel Capacity – *State Plan of Flood Control, Existing Channel Capacity Assessment, Combined Technical Memorandum*, January 2009, CVFED Team
SPRR = Southern Pacific Railroad Company
State = State of California
TM = Technical Memorandum
TRLIA = Three Rivers Levee Improvement Authority
USACE = U.S. Army Corps of Engineers
Wood Rogers = Wood Rogers, Inc.
WPRR = Western Pacific Railroad

Table B-2. San Joaquin River Watershed Channel Capacity Status

River Reach[1]	River Miles[4]		Design Capacity from O&M Manual[2] (cfs)	Design Flows from USACE Design Memo No. 1	Difference Between O&M Capacities and Design Memo No. 1 (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Current Capacity Estimate	Comments
	From	To							
Friant Dam to Chowchilla Canal Bypass									
San Joaquin River									
San Joaquin River	224.66	214.03	8,000	Not specified	N/A	4,000 – 8,000	Potential inadequacy; additional evaluation required	LSJLD – 4,000 cfs DWR Hydrologist – 8,000 cfs	Flows above 4,000 cfs cause damage per LSJLD at less than objective release from Friant Dam (8,000 cfs). Achieving the estimated capacity takes several days of sediment movement.
Chowchilla Canal Bypass to Sand Slough Control Structure									
San Joaquin River									
San Joaquin River – Mendota Dam to Chowchilla Canal Bypass	No data	166.44	2,500	Not specified	N/A	>2,500	No obvious inadequacy	LSJLD and MBK Modeling – River Islands Project	Diversion structure capacity <2,500 cfs. See Note 5.
San Joaquin River – Sand Slough to Mendota Dam	170.0	No data	4,500	Not specified	N/A	500	Potential inadequacy; additional evaluation required	LSJLD	Encroachment on the old channel has lowered this capacity to about 500 cfs.
Distributaries from San Joaquin River									
Chowchilla Bypass									
Bifurcation Structure to Fresno River	32.04	15.85	5,500	Not specified	N/A	5,500 – 8,000	No obvious inadequacy	DWR Hydrologist – 6,500 cfs LSJLD – 5,500 cfs RBF Consulting – 8,000 cfs	Estimated capacity of 6,500 cfs once levees are saturated. Flows above 5,500 cfs cause seepage problems per LSJLD.

Table B-2. San Joaquin River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[4]		Design Capacity from O&M Manual[2] (cfs)	Design Flows from Corps Design Memo No. 1	Difference between O&M capacities and Design Memo No. 1 (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Current Capacity Estimate	Comments
	From	To							
Eastside Bypass									
Fresno River to Berenda Slough	15.85	13.59	10,000	Not specified	N/A	10,000 – 12,000	No obvious inadequacy	LSJLD – 12,000 cfs DWR Hydrologist – 10,000 cfs RBF Consulting – 12,000 cfs *SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) – 12,000 cfs	Flows above 10,000 cfs cause seepage problems per LSJLD.
Berenda Slough to Ash Slough	13.59	10.48	12,000	Not specified	N/A	12,000 – 19,000	Potential inadequacy; additional evaluation required	DWR Hydrologist - 15,000 cfs LSJLD – 12,000 cfs RBF Consulting – 19,000 cfs	Estimated maximum capacity of 15,000 cfs. Flows above 10,000 cfs cause seepage problems per LSJLD.
Ash Slough to Sand Slough	10.48	0	17,000	Not specified	N/A	13,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Tributaries to Eastside Bypass									
Fresno River	8.36	0	5,000	Not specified	N/A	3,000 – 5,000	Potential inadequacy; additional evaluation required	DWR Hydrologist – 5,000 cfs *SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) – 3,000 cfs RBF Consulting – 3,000 cfs	None
Berenda Slough	4.28	0	2,000	Not specified	N/A	2,000	No obvious inadequacy	DWR Hydrologist – 2,000 cfs *SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) – 2,000 cfs RBF Consulting – 2,000 cfs	None

Table B-2. San Joaquin River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[4]		Design Capacity from O&M Manual[2] (cfs)	Design Flows from Corps Design Memo No. 1	Difference between O&M capacities and Design Memo No. 1 (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Current Capacity Estimate	Comments
	From	To							
Ash Slough	4.52	0	5,000	Not specified	N/A	2,000 – 5,000	Potential inadequacy; additional evaluation required	N/A	None
Sand Slough Control Structure to Merced River									
San Joaquin River									
Control Structure to Mariposa Bypass	149.89	145.15	1,500	Not specified	N/A	50	Potential inadequacy; additional evaluation required	LSJLD	None
Mariposa Bypass to Bear Creek	145.15	133.8	10,000	Not specified	N/A	1,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Bear Creek to Merced River	133.8	116.66	26,000	20,000	Yes	7,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Tributaries to San Joaquin River									
Mariposa Bypass	4.23	0	8,500	Not specified	N/A	8,000	Potential inadequacy; additional evaluation required	LSJLD and *SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	Historic channel flows have exceeded 11,000 cfs when encroached into design freeboard, per LSJLD.
Eastside Bypass									
Control Structure to Mariposa Bypass	8.96	16.0	16,500	Not specified	N/A	13,000 – 15,000	Potential inadequacy; additional evaluation required	DWR Hydrologist -15,000 cfs *SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009) – 13,000 cfs	Estimated conveyance of 15,000 cfs in 2006, and 20,000 cfs in 1997 with some levee protection. Channel has conveyed 20,000 cfs when encroached into design freeboard, per LSJLD.

Table B-2. San Joaquin River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[4]		Design Capacity from O&M Manual[2] (cfs)	Design Flows from Corps Design Memo No. 1	Difference between O&M capacities and Design Memo No. 1 (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Current Capacity Estimate	Comments
	From	To							
Mariposa Bypass to Owens Creek	8.96	5.0	12,000	Not specified	N/A	12,000	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Owens Creek to Bear Creek	5.0	1.0	13,500	Not specified	N/A	10,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Bear Creek to San Joaquin River	1.0	0	18,500	Not specified	N/A	10,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Tributaries to Eastside Bypass									
Owens Creek	0.98	0	2,000	Not specified	N/A	No data	No data	N/A	None
Deadman Creek	6.66	0	9,000	Not specified	N/A	No data	No data	N/A	None
Upper Bear Creek	7.98	4.25	7,000	Not specified	N/A	8,000	No obvious inadequacy	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Bear Creek	4.25	0	14,400	Not specified	N/A	9,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	None
Merced River to Stanislaus River									
San Joaquin River									
Merced River to Tuolumne River	110.9	81.5	45,000	45,000	No	22,000 – 35,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	The capacity of this reach needs to be verified by project-specific modeling; 1997 flows exceeded capacity with only minor conveyance problems.

Table B-2. San Joaquin River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[4]		Design Capacity from O&M Manual[2] (cfs)	Design Flows from Corps Design Memo No. 1	Difference between O&M capacities and Design Memo No. 1 (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Current Capacity Estimate	Comments
	From	To							
Tuolumne River to Stanislaus River	81.5	72.6	46,000	46,000	No	25,000	Potential inadequacy; additional evaluation required	*SPFC Existing Channel Capacity Assessment TM* (CVFED, 2009)	The capacity of this reach needs to be verified by project-specific modeling; 1997 flows exceeded capacity with only minor conveyance problems.
Tributaries to San Joaquin River									
Tuolumne River	0.6	0	15,000	15,000	No	No data	No data	N/A	None
Stanislaus River	11.9	0	12,000	12,000	No	23,000	No obvious inadequacy	N/A	Needs additional analysis – capacity data are for top of levee.
Stanislaus River to Burns Cutoff									
San Joaquin River									
Stanislaus River to Paradise Cut	72.6	58.3	52,000	52,000	No	66,000	No obvious inadequacy	Project-specific modeling by MBK for River Islands Project	None
Paradise Cut to Old River	58.3	53.3	37,000	37,000	No	30,000 – 40,000	Potential inadequacy; additional evaluation required	DWR Hydrologist – 30,000 cfs Project-specific modeling from MBK - 40,000 cfs.	Paradise Weir does not pass the design flow and is also inadequate per MBK modeling.
Old River to Burns Cutoff	53.3	40.6	18,000	Not specified	N/A	15,000 – 20,000	Potential inadequacy; additional evaluation required	DWR Hydrologist – 15,000 cfs Project-specific modeling from MBK – 20,000 cfs	Tidal impacts affect capacity.

Table B-2. San Joaquin River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[4]		Design Capacity from O&M Manual[2] (cfs)	Design Flows from Corps Design Memo No. 1	Difference between O&M capacities and Design Memo No. 1 (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Current Capacity Estimate	Comments
	From	To							
Tributaries to San Joaquin River									
French Camp Slough	6.4	0	3,000	Not specified	N/A	No data	No data	N/A	None
Tributaries to French Camp Slough									
Littlejohns Creek	1	0	1,750	Not specified	N/A	No data	No data	N/A	None
Duck Creek	0.9	0	900	Not specified	N/A	No data	No data	N/A	None
Distributaries from San Joaquin River									
Paradise Cut – San Joaquin River to Old River[3]	0	7.4	15,000	15,000	N/A	17,000	No obvious inadequacy	Modeling by MBK for River Islands Project	None
Old River – downstream from Paradise Cut	5.9	8.2	30,000	Not specified	N/A	19,000 – 30,000	Potential inadequacy; additional evaluation required	DWR Hydrologist – 19,000 cfs Project-specific modeling from MBK River Islands Project - 30,000 cfs	None
Old River – San Joaquin to Middle River	No data	No data	19,000	Not specified	N/A	30,300	No obvious inadequacy	Project-specific modeling from MBK River Islands Project	None
Old River – Middle River to Paradise Cut	No data	No data	19,000	Not specified	N/A	No data	No data	N/A	None
Old River/Salmon Slough – Paradise Cut to Grant Line Canal	No data	No data	No data	Not specified	N/A	No data	No data	N/A	None

Table B-2. San Joaquin River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[4]		Design Capacity from O&M Manual[2] (cfs)	Design Flows from Corps Design Memo No. 1	Difference between O&M capacities and Design Memo No. 1 (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Current Capacity Estimate	Comments
	From	To							
Burns Cutoff to Disappointment Slough									
Tributaries to San Joaquin River									
Calaveras River	5.8	0	15,818	13,500	N/A	31,700	No obvious inadequacy	SJAFCA Final Technical Memorandum #2 – Hydraulics (HDR, 1998)	None
Tributaries to Calaveras River									
Mormon Slough	8.4	6.2	15,022	12,500	N/A	30,000	No obvious inadequacy	SJAFCA Final Technical Memorandum #2 – Hydraulics (HDR, 1998)	None
Bear Creek – Disappointment Slough to Mosher Creek	0	10	7,630	Not specified	N/A	7,630	No obvious inadequacy	SJAFCA Final Technical Memorandum #2 – Hydraulics (HDR, 1998)	None
Bear Creek – Mosher Creek to Paddy Creek	10	13.1	5,000	Not specified	N/A	5,490	No obvious inadequacy	SJAFCA Final Technical Memorandum #2 – Hydraulics (HDR, 1998)	None
Bear Creek – upstream from Paddy Creek	13.1	16.7	1,800	Not specified	N/A	3,575	No obvious inadequacy	SJAFCA Final Technical Memorandum #2 – Hydraulics (HDR, 1998)	None

Table B-2. San Joaquin River Watershed Channel Capacity Status (contd.)

River Reach[1]	River Miles[4]		Design Capacity from O&M Manual[2] (cfs)	Design Flows from Corps Design Memo No. 1	Difference between O&M capacities and Design Memo No. 1 (yes/no)	Estimated Current Channel Conveyance Capacity (cfs)	Channel Capacity Status	Data Source for Current Capacity Estimate	Comments
	From	To							
Tributaries to Bear Creek									
Paddy Creek – Bear Creek to North Paddy Creek	0	0.3	2,000	Not specified	N/A	3,593	No obvious inadequacy	SJAFCA Final Technical Memorandum #2 – Hydraulics (HDR, 1998)	None
Paddy Creek – upstream from North Paddy Creek	0.3	1.4	400	Not specified	N/A	434	No obvious inadequacy	SJAFCA Final Technical Memorandum #2 – Hydraulics (HDR, 1998)	None
Middle Paddy Creek	0	1.4	750)	Not specified	N/A	No data	No data	N/A	None
North Paddy Creek – Paddy Creek to Middle Paddy Creek	0	1.3	1,800	Not specified	N/A	2,626	No obvious inadequacy	SJAFCA Final Technical Memorandum #2 – Hydraulics (HDR, 1998)	None
North Paddy Creek – upstream from Middle Paddy Creek	0	3.9	1,200	Not specified	N/A	No data	No data	N/A	None

Notes:

[1] Sequential river reaches were not necessarily designed as a system. Therefore, the capacities in the table do not add up. In some cases, left- and right-bank levees along the same reach may have different design capacities. In these cases, the lowest capacity was used both for O&M design flow and Estimated Current Channel Conveyance Capacity.

[2] The State operates SPFC facilities in the San Joaquin Valley based on the 1955 profile rather than on design flows from the O&M manuals. The design flows from USACE Design Memorandum ranked No. 1 (1957) correspond to the 1955 profile.

[3] The river mile was estimated at this location.

[4] River mile designations are based on the USACE and DWR Comprehensive Study RM designations (2002).

[5] The operation of weirs and structures within the system are being hadnled separately and are not included in this evaluation; however, bypass capacities are estimated. Consequently, while bypasses may have sufficient capacity, this does not imply that the full operation of the weir and bypass does not have inadequacies. Additional modeling and evaluation are required.

[6] Where "DWR Hydrologist" is identified as the source of estimated capacity, data was provided by Maury Roos, retired State Hydrologist.

Key:
cfs = cubic feet per second
DWR = California Department of Water Resources
LSJLD = Lower San Joaquin Levee District
MBK = MBK Engineering Co.
N/A = Not available
No data = No data currently presented
O&M = operations and maintenance
RM = river mile
SJAFCA = San Joaquin Area Flood Control Agency
TM = Technical Memorandum
USACE = U.S. Army Corps of Engineers

Summary of Recent Remedial Actions

No recent remedial actions to address channel capacity inadequacies have been conducted other than vegetation management and sediment management activities.

Summary of Ongoing and Planned Remedial Actions

No actions have been planned other than vegetation management and sedimentation management to address channel capacity inadequacies.

Ongoing Actions to Improve Future Evaluations

California Department of Water Resources (DWR) is developing updated and new hydrologic and hydraulic models for major rivers and tributaries in the Central Valley as part of the Central Valley Floodplain Evaluation and Delineation Program. These models will provide a more current data set to identify channel conveyance capacity inadequacies throughout State Plan of Flood Control (SPFC) channels.

DWR is currently in the process of using newly acquired surface elevation data Light Detection and Ranging (LiDAR) and creating project-level hydraulic models for the Sacramento River Flood Control Project that may reveal additional hydraulic capacity issues due to sedimentation. However, DWR is not undertaking this study on the Lower San Joaquin River and Tributaries Project because it is not part of the prescribed channel maintenance per California Water Code Section 8361. Project-level channel capacity evaluations have been completed or are currently underway for the following:

- Bear River (Pleasant Grove Road to Rio Oso)
- Deer Creek
- Elder Creek
- Cherokee Canal
- Cache Creek Settling Basin
- Lindo Channel
- Sutter Bypass
- Sycamore Creek and Sycamore Bypass

Future project-level channel capacity evaluations are planned for the following:

- Feather River

- Little Chico Creek
- Chico Creek
- Butte Slough
- Willow Slough Bypass
- Putah Creek
- American River
- Bear River
- Cherokee Canal
- Colusa Back Borrow Pit
- Mud Creek
- Putah Creek
- Sacramento River
- Tisdale Bypass
- Wadsworth Canal
- Yolo Bypass
- Yuba River
- Natomas Cross Canal
- Linda and Arcade Creek
- Middle Creek

B-2 Channel Vegetation

This section describes recent, ongoing, and planned remedial actions to improve future evaluations. A map of ongoing and planned DWR vegetation management activities is also included.

Summary of Recent Remedial Actions

Routine maintenance work within the channels includes mowing, disking, and burning vegetation, removing dead and downed trees and/or debris that could obstruct flows during high-water events within the channel, and limbing up and/or removing trees. DWR performs these tasks annually to retain an acceptable level of readiness for high-water events.

Areas undergoing active vegetation management, or in which vegetation management has been initiated in the Sacramento River watershed, are shown in Figure B-1. The figure does not represent all channels that DWR is responsible for maintaining. Data were unavailable for the San Joaquin River watershed.

Summary of Ongoing and Planned Remedial Actions

Ongoing and planned remedial actions related to channel vegetation management are also shown in Figure B-1. Nonroutine vegetation management activities are specified in vegetation management plans. Channels for which DWR is currently preparing or will be preparing future vegetation management plans are listed below:

- Feather River
- Lindo Channel
- Deer Creek
- Elder Creek
- Sutter Bypass

Following the completion of project-level channel capacity evaluations, vegetation management plans will be developed, as needed.

Ongoing Actions to Improve Future Evaluations

DWR will continue to compile information on past, current, and future vegetation management actions in the Sacramento River watershed for areas that DWR is responsible for maintaining.

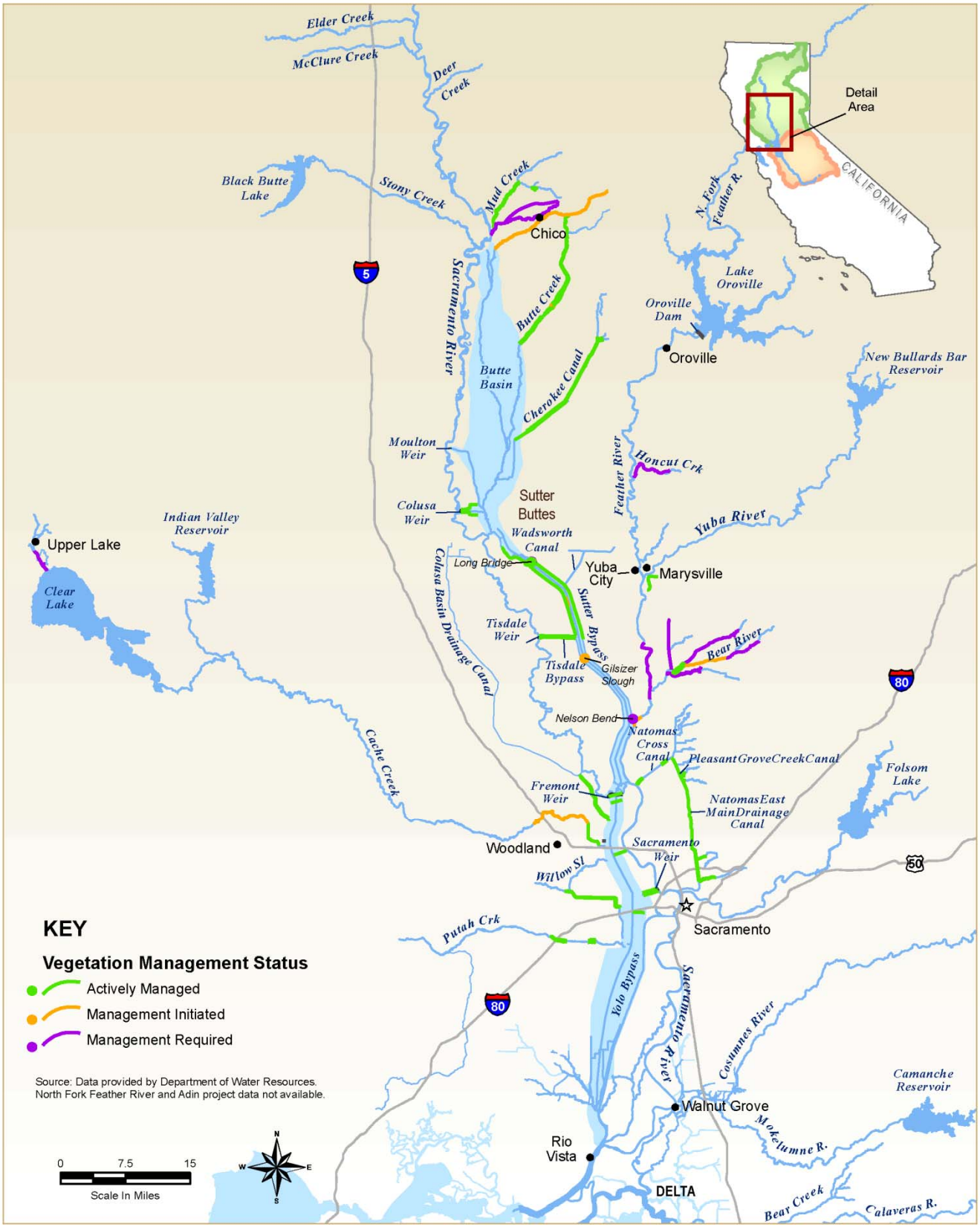

Figure B-1. Channel Vegetation Management Status in Sacramento River Watershed

B-3 Channel Sedimentation

This section describes recent, ongoing, and planned remedial actions to improve future evaluations.

Summary of Recent Remedial Actions

DWR performs sediment management for channels that it maintains within the Sacramento River Flood Control Project per California Water Code Section 8361. Sediment, debris, and rubbish have been removed in the past to retain the required conveyance capacity. Once excess sediment has accumulated in a channel such that the channel does not pass the design flow with adequate freeboard, sediment removal projects are developed.

Large-scale sediment removal projects have been implemented recently in the Sacramento River watershed. Figure B-2 shows the current status of sediment management projects in channels that DWR is responsible for maintaining in the Sacramento River watershed. Graphs embedded on Figure B-2 show annual cubic yards of sediment removed by DWR from 1983 through 2009. Data for sediment management activities in the San Joaquin River watershed are currently not available.

Summary of Ongoing and Planned Remedial Actions

DWR identifies areas of accumulated sediment based on annual visual observations of the channels. In addition, high-water staking may reveal reaches of a channel that do not convey the design capacity, as evidenced by the water surface encroaching on the freeboard. Once visual observations and high-water staking reveal a potential sediment problem, hydraulic models are prepared to evaluate the extent of the problem.

By December 2016, DWR plans to identify all additional SPFC channels within the Sacramento River watershed that are in need of sediment removal and develop channel sediment management plans to safely convey the channel's design flows without encroaching on design levels of freeboard.

As of July 2010, DWR has completed hydraulic evaluations of upper portions of the Cherokee Canal and the lower portion of Sycamore Creek to determine the water surface elevation impact of observed sediment in the channels. Based on these modeling results, sediment removal projects to restore channel conveyance capacity for portions of Cherokee Canal and Sycamore Creek are being designed and implemented. Planned sediment management studies that are currently in various stages of development by DWR within SPFC channels include Upper Bear River and Cache Creek Settling Basin.

Ongoing Actions to Improve Future Evaluations

An evaluation of channel capacity inadequacy identification, modeling and evaluation techniques, and sediment management planning and project development are underway to improve the process for managing sediment in SPFC channels in the Sacramento River watershed. After identification of channels needing maintenance, hydraulic models and evaluations will be prepared and DWR will develop and implement projects annually to address identified channel sedimentation problems. The goal is to implement these sediment management projects as part of a bigger-picture channel management strategy that incorporates possible changes or effects to the system upstream and downstream from the sedimentation problem areas.

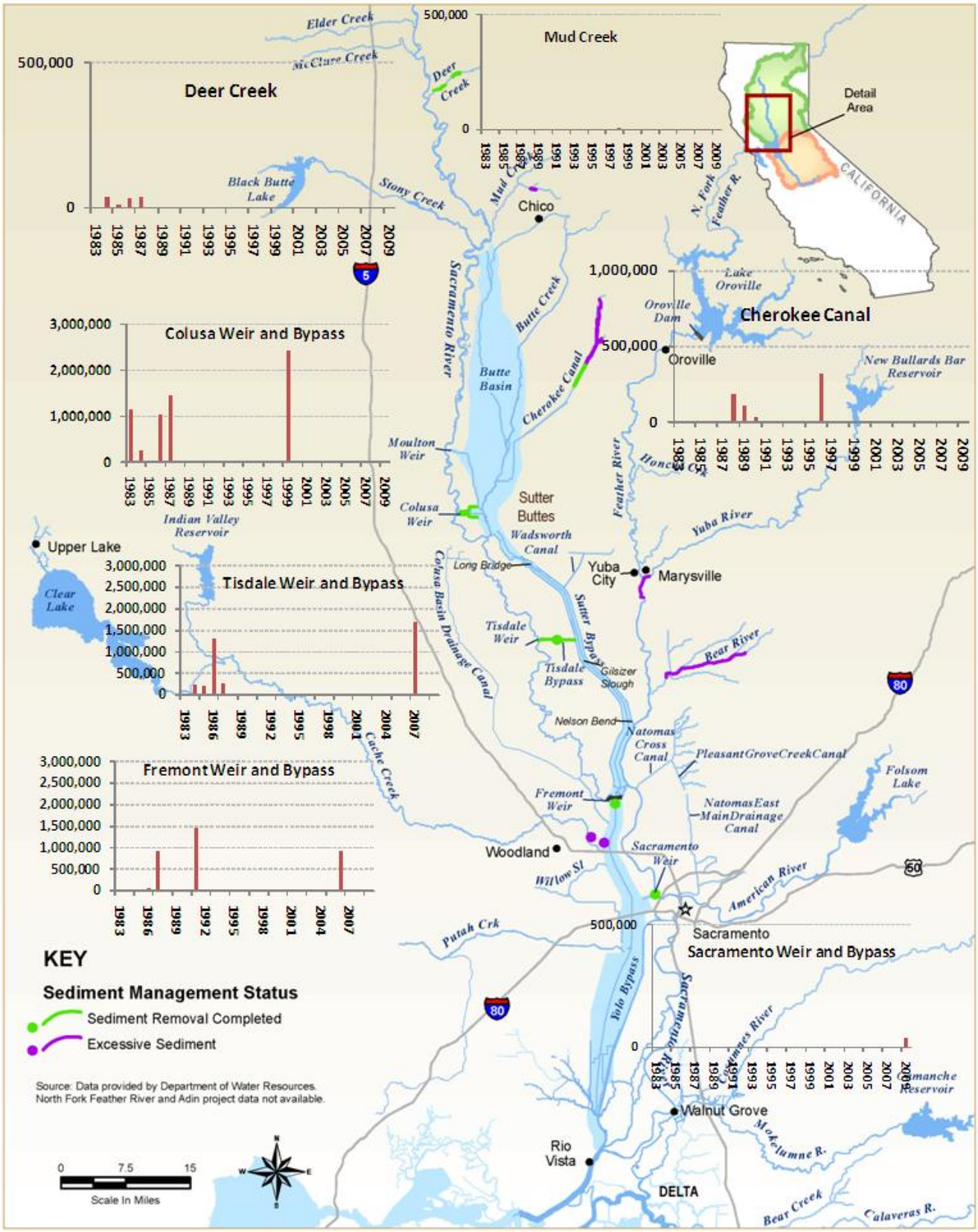

Figure B-2. Channel Sediment Management Status in Sacramento River Watershed

This page left blank intentionally.

References

Butte Creek Watershed Conservancy. 2005. Butte Creek Watershed Floodplain Management Plan. Prepared by Wood Rodgers. May.

Central Valley Floodplain Evaluation and Delineation (CVFED). 2009. State Plan of Flood Control Existing Channel Capacity Assessment Combined Technical Memorandum. January.

HDR. 1998. San Joaquin Area Flood Control Agency Final Technical Memorandum #2 – Hydraulics. February.

Nature Conservancy. 2007. Two-Dimensional Hydraulic modeling of Riparian Habitat Restoration from Colusa to Princeton. Sacramento River, RM 142.5 to 164.5. Glenn and Colusa Counties, CA. Prepared by Ayres Associates. December 3.

Reclamation Board (CVFPB). 1986. Environmental Impact Report for the Butte Basin Overflow Area. Prepared by Woodward-Clyde Consultants. Record # ES-256. December.

U.S. Army Corps of Engineers (USACE). 1955. Design Memorandum No. 1, San Joaquin River Levees, Lower San Joaquin River and Tributaries Project, California, General Design. December 23.

———.1957. Sacramento River Flood Control Project, California, Levee and Channel Profiles. March 15. Revised August 1969. Created 2006.

U.S. Geological Survey (USGS). 1976. Determination of Channel Capacity of the Sacramento River between Ordbend and Glenn, Butte and Glenn Counties, California. Prepared by R. G. Simpson. Open-File Report 76-526.

U.S. Army Corps of Engineers and California Department of Water Resources (USACE and DWR). 2002. Sacramento-San Joaquin River Basins Comprehensive Study, Technical Studies Documentation, Appendix D Hydraulic Technical Documentation. December.

This page left blank intentionally.

Acronyms and Abbreviations

DWR ..... California Department of Water Resources
FCSSR ..... Flood Control System Status Report
LiDAR ..... Light Detection and Ranging
O&M ..... operations and maintenance
SPFC ..... State Plan of Flood Control
USACE ..... U.S. Army Corps of Engineers

This page left blank intentionally.

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

CENTRAL VALLEY
FLOOD MANAGEMENT
PLANNING PROGRAM

FloodSAFE
CALIFORNIA

Flood Control System Status Report Appendix C – Flood Control Structure Status

December 2011

STATE OF CALIFORNIA
THE NATURAL RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

This page left blank intentionally.

Table of Contents

This page left blank intentionally.

Appendix C – Flood Control Structure Status

Appendix C provides supporting information on hydraulic structures, pumping plants, and bridges relative to flood management for the State Plan of Flood Control (SPFC). Sections C-1, Hydraulic Structures, C-2, Pumping Plants, and C-3, Bridges, correspond to subsections in Section 6 of the Flood Control System Status Report (FCSSR) main document. This appendix includes information on recent, ongoing, and planned remedial actions for these structures. Information about ongoing actions to improve future evaluations is also summarized.

C-1 Hydraulic Structures

This section describes recent, ongoing, and planned remedial actions for SPFC hydraulic structures. It also describes actions to improve evaluation of hydraulic structures in the future.

Summary of Recent Remedial Actions

No recent major remedial actions for SPFC hydraulic structures have been documented by the California Department of Water Resources (DWR).

Summary of Ongoing and Planned Remedial Actions

Ongoing and planned remedial actions for SPFC hydraulic structures by DWR include the following:

- **Cache Creek Settling Basin** – A 3-year study is currently underway to determine the Cache Creek Settling Basin trapping efficiency. The Cache Creek Settling Basin Weir will not be inspected until after the study is completed.

- **Willow Slough Weir and Weir No. 2**–Willow Slough Weir (Sutter Bypass East Borrow Canal) was replaced in 2011. Weir No. 2 will be replaced in 2012.

- **Knights Landing Outfall Gates** – Motor controls and communications systems are not functioning and structural materials are deteriorating. Rehabilitation of the Knights Landing Outfall Gates is anticipated to begin in 2012. The outfall gates, motor controls, and communications system will be replaced.

- **Butte Slough Outfall Gates** – A detailed inspection of the Butte Slough Outfall Gates was performed in 2008. A Capital Outlay Budget Change Proposal for Fiscal Years 2010 and 2011 is under consideration to correct the problems found.

Ongoing Actions to Improve Future Evaluations

Under the FloodSAFE California (FloodSAFE) Initiative, DWR has recently created a more robust and thorough inspection program for hydraulic structures (DWR, 2010). The Hydraulic Structures Inspection Program has been established to better track the inspections and maintenance work performed on structures maintained by DWR.

Initial actions of the program involved identifying and cataloging historical records (inspection records, record drawings, operations criteria, operations and maintenance (O&M) manuals, etc.) of all hydraulic structures, and updating the existing inspection procedures in accordance with current U.S. Army Corps of Engineers (USACE) standards. It is expected that biannual inspections and repairs will continue to improve performance of the existing hydraulic structures.

DWR produces Annual Inspection Reports outlining prioritized repairs by June 1. Structures identified are targeted to be repaired between June and November. Before November of each year, the structures will be inspected to document the repairs completed before flood season.

C-2 Pumping Plants

This section describes recent, ongoing, and planned remedial actions for SPFC pumping plants. It also describes actions to improve evaluations of pumping plants in the future.

Summary of Recent Remedial Actions

A project was completed in November 2007 to refurbish the pump motors for each pump at the three pumping plants along the east levee of the Sutter Bypass. The refurbishments were considered in the 2009 inspection results reported in Section 6 of the FCSSR. In 2011, DWR recently completed a project to provide backup power generators and fuel tanks at each of these three pumping plants in the Sutter Bypass. The project also included a remote communications system that enabled automated pump controls from the Sutter Maintenance Yard.

Summary of Ongoing and Planned Remedial Actions

No major ongoing and planned remedial actions for SPFC pumping plants have been documented by DWR.

Ongoing Actions to Improve Future Evaluations

The Hydraulic Structures Inspection Program described above also includes inspection of pumping plants. In addition, DWR is installing new communication and data relay systems with new control systems that will enable real-time monitoring of pumping plants. This technology will allow DWR to track pump efficiencies and discover maintenance problems as they arise.

C-3 Bridges

This section describes recent, ongoing, and planned remedial actions for SPFC bridges maintained by DWR. It also describes actions to improve evaluations of bridges in the future.

Summary of Recent Remedial Actions

Recent remedial actions for SPFC bridges maintained by DWR include the following:

- The decking of several of the collecting canal and intercepting canal bridges in Sutter County have been refurbished since 2003.
- McKee Lane at Western Intercepting Canal (WI-2), maintained by DWR, has been replaced.
- The following bridges maintained by Sutter County have also been replaced in coordination with DWR:
  - Garmire Bridge at Tisdale Bypass
  - Franklin Road Bridge at Wadsworth Canal
  - South Butte Road Bridge at Wadsworth Canal
  - Butte House Road Bridge at Wadsworth Canal
  - Acacia Avenue Bridge at Western Intercepting Canal
  - Mallott Road Bridge at Western Intercepting Canal
  - East Butte Road Bridge at Eastern Intercepting Canal

- Pease Road Bridge at Eastern Intercepting Canal
- Township Road Bridge at Eastern Intercepting Canal
- Obanion Road Bridge at Collecting Canal/State Drain
- Oswald Road Bridge at West Borrow Canal
- Franklin Road Bridge at West Borrow Canal

These recent remedial actions were reflected in the 2009 inspection results reported in Section 6 of the FCSSR.

Summary of Ongoing and Planned Remedial Actions

Ongoing and planned remedial actions include the following:

- Bridge EL-1A has been designated as a bridge needing repair. The bridge decking will be replaced as soon as funding is appropriated.
- Bridge CC-4 has been designated as a bridge needing immediate repair. The bridge decking and abutments will be refurbished as soon as funding is appropriated.

Ongoing Actions to Improve Future Evaluations

Under the FloodSAFE Initiative, DWR has recently created a more robust and thorough inspection program for DWR-maintained bridges to better track the inspections and maintenance work performed on bridges by DWR (DWR, 2009).

Similar to the Hydraulic Structures Inspection Program, DWR produces an *Annual Bridge Inspection Report* (DWR, 2009) outlining a prioritized list of needed repairs in June. Bridges identified on the list are targeted for repair between June and November, and inspections are performed before November on bridges to document repairs.

References

California Department of Water Resources (DWR). 2009. Annual Bridge Inspection Report. Flood Maintenance Office (FMO). December 10.

———.2010. Annual Hydraulic Structure Inspection Report. Flood Maintenance Office (FMO). April 7.

This page left blank intentionally.

Acronyms and Abbreviations

DWR ..... California Department of Water Resources
FCSSR..... *Flood Control System Status Report*
FloodSAFE..... FloodSAFE California
O&M..... operations and maintenance
SPFC ..... State Plan of Flood Control
USACE..... U.S. Army Corps of Engineers

This page left blank intentionally.

DWR
Division of Flood Management
Central Valley Flood Planning Office

Email: CVFMP@water.ca.gov

State of California
The Natural Resources Agency
Department of Water Resources