

# California's Flood Future

## Recommendations for Managing the State's Flood Risk

FINAL November 2013

*California's Flood Future* is provided to help inform local, State, and Federal decisions about policies and financial investments to improve public safety, foster environmental stewardship, and support economic stability



PUBLIC SAFETY

ENVIRONMENTAL STEWARDSHIP

ECONOMIC STABILITY



US Army Corps  
of Engineers

# STATEWIDE FLOOD MANAGEMENT PLANNING PROGRAM

---



**FINAL**

## **California's Flood Future: Recommendations for Managing the State's Flood Risk**

**November 2013**

*Photographs in this text are courtesy of the following agencies:*

*Alluvial Fan Taskforce Factsheet, California Department of Conservation, Daniel Carlson, Dr. George Pararas-Carayannis (<http://drgeorgepc.com>), Department of Water Resources, Humboldt County Resource Conservation District, Los Angeles County Department of Public Works, Monterey Peninsula Water Management District, Nancy Thornburg, Orange County Public Works, Red Clover/ McReynolds Creek Restoration Project, Riverside County Flood Control District, San Diego County, Tulare County Library, and University of California at Berkeley*

# Table of Contents

Acronyms and Abbreviations.....	ix
Executive Summary (Highlights).....	xi
1.0 Introduction .....	1-1
1.1 California’s Flood Risk.....	1-1
1.1.1 Evolution of Flood Management in California .....	1-1
1.1.2 California’s Current Flood Risk.....	1-9
1.2 California’s Flood Future Report .....	1-9
1.2.1 Purpose of Report.....	1-11
1.2.2 Report Organization .....	1-12
2.0 Understanding the Situation – California is at Risk .....	2-1
2.1 California is Exposed to Many Types of Flooding .....	2-1
2.2 Flood Management Cannot Be Accomplished in Isolation.....	2-6
2.3 Potential Flood Management Actions.....	2-7
2.3.1 Nonstructural Approaches.....	2-7
2.3.2 Natural Floodplain Function Restoration.....	2-9
2.3.3 Structural Approaches.....	2-10
2.3.4 Flood Emergency Management.....	2-12
2.3.5 Crosscutting Approaches .....	2-13
2.4 Flood Risk is Complex.....	2-14
2.4.1 Flood Risk Basics .....	2-14
2.4.2 Competing and Conflicting Terminology.....	2-16
2.4.3 Residual Flood Risk .....	2-17
2.5 Flood Recovery Costs Are High.....	2-18
2.6 Local Agencies Speak Out.....	2-20
3.0 The Problem – Lives and Property are at Risk .....	3-1
3.1 California is at Risk for Catastrophic Flooding .....	3-1
3.2 One in Five Californians Lives in a Floodplain.....	3-3
3.3 \$575 Billion in Structures are at Risk.....	3-5
3.4 California’s Agricultural Economy is at Risk .....	3-7
3.5 Critical Facilities are at Risk .....	3-10
3.6 Environmental Stewardship Suffers from Competing Regulations and Processes .....	3-12
3.7 Future Uncertainties Could Impact Flood Exposure.....	3-15
3.7.1 How Population and Land Use Changes Impact the Flood Hazard Exposure Analysis .....	3-15
3.7.2 How Climate Change Impacts the Flood Hazard Exposure Analysis.....	3-15

Table of Contents

- 3.8 Existing Flood Infrastructure Does Not Meet Current or Future Needs.....3-18
- 3.9 Flood Management in California is Fragmented .....3-22
- 3.10 Most California Regions Lack Adequate Flood Risk Information .....3-26
  - 3.10.1 Inconsistent Risk Assessment Methods.....3-26
  - 3.10.2 Data are not Available to Characterize Risk across the State .....3-28
- 3.11 Flood Risk is not Adequately Understood.....3-30
  - 3.11.1 Common Misunderstanding of Level of Risk Reduction and Residual Risk .....3-30
  - 3.11.2 Land Use Decisions can put People and Property at Risk .....3-30
- 3.12 Funding for Flood Management is Limited and Increasingly Unreliable.....3-31
  - 3.12.1 Existing Local, State, and Federal Funding.....3-31
  - 3.12.2 Recent California Legislation and Bonds.....3-34
  - 3.12.3 Funding Demand .....3-36
  - 3.12.4 Funding Challenges.....3-45
- 3.13 Other High-Level Challenges Facing Flood Management .....3-47
  - 3.13.1 Sacramento-San Joaquin River Delta .....3-47
  - 3.13.2 USACE Public Law 84-99 .....3-49
  - 3.13.3 Federal Credit for Non-Federal In-kind Contributions.....3-49
  - 3.13.4 Budgeting for Flood Management.....3-50
  - 3.13.5 NFIP Modernization .....3-52
- 4.0 The Solution ..... 4-1
  - 4.1 An Integrated Water Management Approach..... 4-1
  - 4.2 IWM Definition ..... 4-2
    - 4.2.1 Benefits of IWM ..... 4-2
    - 4.2.2 Interaction with Existing Programs..... 4-3
  - 4.3 We Must Take Action Now..... 4-4
- 5.0 Recommendations for Managing California Flood Risk ..... 5-1
- 6.0 The Path Forward ..... 6-1
  - 6.1 Approach to Implementing the Recommendations ..... 6-2
  - 6.2 Recommendations Lead to Results ..... 6-4
  - 6.3 Next Steps..... 6-4
- 7.0 References ..... 7-1

## Attachments

- Attachment A: References
- Attachment B: Glossary of Terms
- Attachment C: History of Flood Management in California
- Attachment D: Summary of Exposure and Infrastructure Inventory by County (Mapbook)
- Attachment E: Existing Conditions of Flood Management in California (Information Gathering Findings)
- Attachment F: Flood Hazard Exposure Analysis
- Attachment G Risk Information Inventory
- Attachment H: Practicing Flood Management Using an Integrated Water Management Approach
- Attachment I: Finance Strategies
- Attachment J: Recommendations to Improve Flood Management in California

## List of Tables

Table 1-1.	Selected Historical California Flood Events and Flood Management Actions Taken in Response .....	1-4
Table 3-1.	Population Exposed to Flooding by Hydrologic Region .....	3-3
Table 3-2.	Value of Structures and their Contents Exposed to Flooding by Hydrologic Region .....	3-6
Table 3-3.	Crops Exposed to Flood Hazard by Hydrologic Region.....	3-9
Table 3-4.	Number of Critical Facilities Exposed within 500-Year Floodplains by California Hydrologic Region .....	3-10
Table 3-5.	Native American Tribal Land and DoD Facilities Exposed within 500-year Floodplains by Hydrologic Region .....	3-12
Table 3-6.	State and Federal Sensitive Species Exposed to Flood Hazard by Hydrologic Region .....	3-13
Table 3-7.	Summary of Ongoing and Potential Flood Projects .....	3-19
Table 3-8.	Primary Agencies with Flood Management Responsibilities .....	3-24
Table 3-9.	Comparison of FEMA and USACE Risk Assessment Approaches.....	3-27
Table 3-10.	Local Planned Projects by Hydrologic Region .....	3-37
Table 3-11.	CVFPP Investment Approach Cost Estimates by Element .....	3-38
Table 3-12.	USACE Planned Projects by Hydrologic Region .....	3-39
Table 3-13.	Estimated Cost of Known Projects/Improvements .....	3-41
Table 5-1.	Matrix of Recommendations versus SFMP Findings.....	5-3

## List of Figures

Figure 1-1.	Examples of Historic Flooding in California .....	1-3
Figure 1-2.	History of Funding for Flood Management in California .....	1-7
Figure 1-3.	Various Documents Developed under the Statewide Flood Planning Management Program .....	1-14
Figure 2-1.	Types of Flooding in California.....	2-3
Figure 2-2.	Role of Agencies in Flood, Water, and Ecosystem Management .....	2-7
Figure 2-3.	Flood Risk Definition.....	2-15
Figure 2-4.	SFMP Participating Flood Management Agencies.....	2-23
Figure 3-1.	Population Exposed to Flooding within 500-year Floodplains in California by Hydrologic Region .....	3-4
Figure 3-2.	Counties with Largest Population Exposed within 500-year Floodplains.....	3-5
Figure 3-3.	Counties with Highest Percentage of Population Exposed within 500-year Floodplains .....	3-5
Figure 3-4.	Structure Values Exposed to Flooding in California by Hydrologic Region .....	3-6
Figure 3-5.	Percentage of Structures Exposed within 500-year Floodplains.....	3-7
Figure 3-6.	Crop Values Exposed to Flooding within 500-Year Floodplains by Hydrologic Region .....	3-8
Figure 3-7.	Percentage of Crops Exposed within 500-year Floodplains .....	3-9
Figure 3-8.	Critical Facilities within 500-Year Floodplains by Hydrologic Region .....	3-11
Figure 3-9.	State and Federal Threatened, Endangered, Listed, and Rare (“Sensitive”) Plant and Animal Species within 500-Year Floodplains by Hydrologic Region.....	3-14
Figure 3-10.	Sea Level Rise Projections Based on Air Temperatures from 12 Future Climate Scenarios.....	3-17
Figure 3-11.	Projected San Francisco Bay Flood Inundation under a 150-cm Sea Level Rise Scenario .....	3-18
Figure 3-12.	Major Flood Infrastructure .....	3-20
Figure 3-13.	Summary of Ongoing and Potential Local Projects by Hydrologic Region .....	3-21
Figure 3-14.	Number of Agencies with Flood Management Responsibilities by Hydrologic Region .....	3-23
Figure 3-15.	USACE Risk Studies .....	3-29
Figure 3-16.	Average Annual Expenditures on Flood Management in California, 2000-2010 .....	3-31
Figure 3-17.	Total Annual Expenditures on Flood Management in California, 2000-2010 .....	3-32
Figure 3-18.	Total Annual Capital Expenditures on Flood Management by Entity in California, 2000-2010.....	3-33

Figure 3-19. Total Annual O&M Expenditures on Flood Management by Entity in California, 2000-2010 .....	3-33
Figure 3-20. General Obligation Water Bond History, 1970-2010 .....	3-36
Figure 3-21. Demand for Flood Management Funding in California .....	3-44
Figure 3-22. Funding Expenditures for Water Supply, Wastewater, and Flood Management .....	3-45
Figure 5-1. Organization of Recommendations .....	5-1

# Table of Contents

This page intentionally left blank.

# Acronyms and Abbreviations

AB	Assembly Bill
ARRA	American Recovery and Reinvestment Act
B/C	benefit-to-cost
BDCP	Bay Delta Conservation Plan
BMP	best management practice
CalEMA	California Emergency Management Agency
CALFED	Collaboration among State and Federal Agencies to Improve California's Water Supply
CDEC	California Data Exchange Center
CEAC	County Engineers Association of California
cfs	cubic feet per second
CIP	Capital Improvement Plan
CLD	California Levee Database
cm	centimeters
CNRA	California Natural Resources Agency
CRS	Community Rating System
CSMW	Coastal Sediment Management Workgroup
CVFPP	Central Valley Flood Protection Plan
CW	Civil Works
CWP	California Water Plan
Delta	Sacramento – San Joaquin River Delta
DMMO	Dredged Material Management Office
DoD	Department of Defense
DSC	Delta Stewardship Council
DSOD	Division of Safety of Dams
DWR	California Department of Water Resources
EAD	expected annual damage
EM	Engineer Manual
ER	Engineer Regulation
FCSA	feasibility cost-sharing agreement
FEMA	Federal Emergency Management Agency
FERIS	Flood Emergency Response Information System
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
Flood Future Report	<i>Flood Future: Recommendations for Managing California's Flood Risk Report</i>
FloodER	Flood Emergency Response

## Acronyms and Abbreviations

FPMS	Flood Plain Management Services
FY	fiscal year
GIS	Geographic Information System
HEC-2	Hydrologic Engineering Center River Hydraulics
HEC-RAS	Hydrologic Engineering Center-River Analysis System
HMP	Hazard Mitigation Plan
HUC	Hydrologic Unit Code
ICT	Incident Command Team
IID	Imperial Irrigation District
IRWM	Integrated Regional Water Management
IWM	Integrated Water Management
IWRM	Integrated Water Resource Management
LHMP	Local Hazard Mitigation Plan
MOU	memorandum of understanding
NED	National Economic Development
NFIP	National Flood Insurance Program
O&M	operation and maintenance
OMB	Office of Management and Budget
OMRR&R	operation, maintenance, repair, rehabilitation, and replacement
PL	Public Law
PPA	project partnership agreement
PRC	Public Resources Code
RD	reclamation district
RFMP	Regional Flood Management Planning
SB	Senate Bill
SFHA	Special Flood Hazard Areas
SFMP	Statewide Flood Management Planning
SHMP	State Hazard Mitigation Plan
SPFC	State Plan of Flood Control
SSIA	State Systemwide Investment Approach
U.S.C.	United States Code
USACE	United States Army Corps of Engineers
WDL	Water Data Library
WRDA	Water Resources Development Act



US Army Corps  
of Engineers ®

The complete report, *California's Flood Future: Recommendations for Managing the State's Flood Risk*, including technical attachments and other supporting information is available for review at:

<http://www.water.ca.gov/SFMP>