

## Content

Chapter [#]Floodflow Modification .....	1
Floodflow Modification in California .....	1
Background .....	1
Description .....	2
Connections to Other Resource Management Strategies.....	3
Potential Benefits of Floodflow Modification.....	3
Potential Costs of Floodflow Modification .....	4
Major Issues Facing Floodflow Modification .....	4
Recommendations to Facilitate Floodflow Modification .....	5
Selected References.....	5

**About this draft:** This is a working draft. It is incomplete. The chapter contains placeholders for some figures and tables. Much of the data is missing. Full discussion of some topics may be incomplete. This is the second of several drafts to be circulated in 2008 before the public review draft is distributed in December.

Subgroup: Improve Flood Management

## Chapter [#] Floodflow Modification

Floodflow modification is one of four strategies specifically intended to improve flood management. It includes projects and programs that detain or divert floodwaters or improve the ability of channels to accommodate floodwaters. Other flood management strategies are flood impact modification, flood susceptibility modification, and floodplain restoration (see chapters in volume 2). Additionally, other resource management strategies discussed in California Water Plan Update 2009 may provide flood management benefits.

The selective application of this suite of strategies creates an opportunity to engage in Integrated Flood Management, a process that promotes a comprehensive approach to flood management that considers land and water resources at a watershed scale within the context of Integrated Regional Water Management, which aims to maximize the benefits of floodplains and minimize the loss of life and damage to property from flooding.

### Floodflow Modification in California

#### Background

Traditionally, flood management has relied on physical improvements which divert or reduce floodwaters and avoid damage to lives and property. Often referred to as “flood control,” this concept favored physical modification of stream channels, dams and surface impoundments, levees, and other structures that altered or confined natural watercourses. More recently, the emphasis has shifted to a more integrated approach that includes both structural and non-structural methods and seeks to enhance the ability of undeveloped floodplains and open spaces to reduce the incidence of flood events and the implementation of land use practices that minimize the risk to lives and property. This multi-faceted approach to flood management relies on the integration of multiple strategies to achieve the broad goal of improving flood management.

To identify statewide flood risks and inform the State’s flood management policies and investment decisions, the Department of Water Resources has initiated the FloodSAFE California program. The goals of the FloodSAFE program are: (1) Reduce the Chance of Flooding – Reduce the frequency and size of floods that could damage California communities, homes and property, and critical public infrastructure; (2) Reduce the Consequences of Flooding – Take actions prior to flooding that will help reduce the adverse consequences of floods when they do occur and allow for quicker recovery after flooding; (3) Sustain Economic Growth – Provide continuing opportunities for prudent economic development that supports robust regional and statewide economies without creating additional flood risk; (4) Protect and Enhance Ecosystems – Improve flood management systems in ways that protect, restore and where possible enhance ecosystems and other public trust resources; and (5) Promote Sustainability – Take actions that

improve compatibility with the natural environment and reduce the expected costs to operate and maintain flood management systems into the future.

## Description

Floodflow Modification includes the following types of structural projects and programs: 1) Dams and Reservoirs; 2) Levees, floodwalls, and Flood Embankments; 3) Channel Improvements; and 4) High Flow Diversions and Bypasses.

Dams and the associated reservoirs provide an opportunity to collect flood flows and release the water downstream slowly, such that the downstream capacity of the river or channel is not exceeded. Following the storm event, the stored water is typically released, to provide storage capacity for subsequent storms. Most California reservoirs with significant storage capacity are multi-purpose projects providing water supply, flood control, and recreation benefits. Examples include Shasta Dam and Reservoir on the Sacramento River, Oroville Dam and Reservoir on the Feather River, and Folsom Dam and Reservoir on the American River, all located on the western slope of the Sierra Nevada. The smaller reservoirs throughout California typically provide some incidental flood benefits and could be re-operated to provide increased flood management benefits.

Levees, floodwalls, and flood embankments: Levees are a common form of flood protection, where an earthen berm is constructed parallel to a stream (or around a lake) to provide protection from high water, typically during floods. Levees may be placed close to the stream edge, or further back where they are called a setback levee, incorporating a portion of the floodplain. Although the use of levees for flood management is widespread, the potential for failure of old levees can be high, due to poor design and construction techniques. Even modern levees can fail as a result of poor maintenance, or overtopping (where the water surface elevation exceeds the height of the levee). The Central Valley's state-federal flood control system includes approximately 1,600 miles of project levees that protect more than 500,000 people, two million acres of agricultural land, and approximately 200,000 structures. In addition, there are approximately \_\_\_\_\_miles of local levees throughout California.

Channel improvements are modifications to a river or stream to increase the channel capacity, thereby improving the ability of the channel to convey floodflows. This typically results in channelization of the stream. The stream bed and banks may be covered with concrete, which greatly enhances the channel's drainage efficiency by reducing surface roughness. Although effective at conveying flows more quickly, channelization results in the loss of habitat and removes the potential for infiltration of flows to the underlying groundwater. Channel improvements have been particularly common in urban areas where the high value and limited availability of land have made other methods of flood management less economically viable. One example of a high capacity concrete-lined channel located in an urbanized environment is the Walnut Creek channel project in the San Francisco Bay Area.

High flow diversions and bypasses are structural features which divert a portion of floodflows into adjacent lands which provide additional through-flow capacity and/or temporarily store the flows and slowly release and infiltrate the stored water. These diversions require careful design to assure that the high flows associated with flood events don't erode the diversion or adjacent banks, and require acquisition of lands, or easements to allow for occasional inundation of the lands in the bypass. An example is the Yolo Bypass north of Sacramento, which diverts high flows from the Sacramento River into lands adjacent to the river, some of which serve as habitat and some are used seasonally for agriculture.

## Connections to Other Resource Management Strategies

As discussed above, this strategy is one of four specifically intended to improve flood management. The other three strategies (flood susceptibility modification, flood impact modification, and floodplain restoration) are addressed in other chapters. The concept of integrated flood management relies on the application of multiple strategies to achieve a comprehensive effect. In addition to these key strategies, other strategies included in the Water Plan also have the potential to provide flood management benefits and may be included as an element of integrated flood management. Potential flood management benefits from other resource management strategies include:

- **Conjunctive Management and Groundwater Storage:** Diversions of surface water for groundwater infiltration could enhance flood management by reducing flows.
- **Conveyance:** Improvements to regional water supply distribution systems could enhance the potential for floodflow conveyance.
- **Ecosystem Restoration:** Ecosystem restoration can enhance the ability of open spaces to absorb rainfall and runoff and reduce the potential for flood events, or enhance recovery after flood events.
- **Surface Storage:** Reservoirs can be designed to provide storage for floodflows, thereby reducing downstream flood peaks or volumes.
- **System Reoperation:** Reoperation of reservoirs constructed for water supply purposes could provide opportunities to preserve and/or enhance flood management capabilities, by providing for the storage of floodflows.
- **Urban Runoff Management:** Management of urban runoff for purposes of improving water quality can preserve and/or enhance flood management by designing management practices to reduce or delay flood peaks.
- **Watershed Management:** Watershed management can promote the retention of open space and habitat which can reduce the severity of flood events and promote recovery after flood events.

## Potential Benefits of Floodflow Modification

The potential benefits of floodflow modification for each hydrologic region depend on the potential need for additional structural flood protection within each region. The Regional Reports for each of the 10 hydrologic regions and 2 special interest areas describe some of the potential benefits of integrated flood management, which could include structural modifications. The Central Valley Flood Protection Plan, which includes the Sacramento and San Joaquin hydrologic regions, is intended to identify structural and non-structural improvements, including levee repairs and modifications to reduce potential for levee failure and increase flood protection to a 200-year level for urban areas in the Central Valley. When implemented, this would reduce potential damage associated with flood events in those watersheds.

Inter-regional benefits associated with floodflow modification are limited, as the conveyance of floodflows does not occur between hydrologic regions. However, the implementation of floodflow modification within the Mountain Counties special interest area has the potential to provide benefit to downstream areas in the Sacramento and San Joaquin regions. Similarly, improvements in the Sacramento and San Joaquin regions would provide benefit to the Sacramento-San Joaquin Delta Region. Statewide benefits from Floodflow modification would accrue from improvements to the State and Federal Flood Control System. Improvements to that system could reduce the State's liability for future flood events.

Global climate change may have a significant impact on the timing and magnitude of precipitation and runoff. Increased air temperatures may reduce the extent of snowpack in mountainous areas, thereby increasing the portion of watersheds that are available to contribute to direct winter runoff. Decreased snowpack would also reduce spring runoff volumes. Rainfall intensity for individual storms could also increase. These changes could change the magnitude and frequency of flood events, although specific effects may be difficult to reliably predict. However, the potential for increased flood frequencies and flood magnitudes suggests that the enhancement of both structural and non-structural flood management measures may be warranted.

Other potential benefits from the implementation of floodflow modification include:

- **Water Supply and Drought Preparedness:** Detention of floodwaters could provide benefits to the extent that structural improvements result in additional water storage or groundwater infiltration.
- **Reduce Groundwater Overdraft:** The development of high-flow diversions and flood bypasses may have the greatest potential to enhance water supply and drought preparedness, and both typically result in the discharge of water into areas that retain water for long periods, which enhance the potential for groundwater recharge.
- **Water Quality:** Structural improvements may enhance water quality, to the extent that such improvements reduce sediment loads, although channelization of streams can eliminate the potential for assimilation of pollutants from plants and aquatic organisms.
- **Energy:** Implementation of floodflow modification is unlikely to result in energy benefits, as floodwaters are typically released after storm events and are not available to increase hydroelectric power generation. Also, if groundwater levels are higher, less energy will be required to pump it out.
- **Resource Stewardship:** Implementation of setback levees, incorporating a portion of the floodplain has the potential to enhance terrestrial and aquatic habitat and provide ecosystem restoration benefits.

## **Potential Costs of Floodflow Modification**

The Department of Water Resources is currently working to identify the costs of improving flood management on a statewide basis. Included in this effort is the Central Valley Flood Protection Plan, a Statewide Flood Management Planning Project, and support for enhanced regional flood management through Integrated Regional Water Management (IRWM) plans. Collectively, these efforts will identify flood risks, propose feasible flood management improvements and quantify the cost of implementing the identified improvements. Some preliminary information may be available to inform Update 2009 of the Water Plan, but the bulk of this information may not be available until the subsequent Update of the Water Plan.

## **Major Issues Facing Floodflow Modification**

Implementation of floodflow modification will not adversely affect drought preparedness, water quality or energy consumption. As an element of Integrated Flood Management, this strategy will enhance flood management. Promotion of this strategy as an element of integrated regional water management creates challenges, as the implementation of multi-purpose projects, or use of dams and reservoirs for both flood management and water supply typically requires close coordination between multiple agencies.

The costs of floodflow modification can be substantial and competition for scarce local resources may impede implementation of structural flood improvements. Population growth and development pressures may increase the population at risk, increasing demand for additional flood protection.

As climate change is anticipated to increase the magnitude of future flood events, climate change will create new challenges to existing water supply reservoirs, which may enhance flood management. Although more severe flood events may occur, current models of global climate change have not been localized to individual watersheds, thus specific floodwater volumes are not known for most locations, making planning for structural or other channel improvements problematic. As the intensity of storms may increase, expanded emphasis on integrated flood management may be the best approach to address potential risks.

Currently, the extent of flood management across the state needs are not well documented, although some local flood management plans (and multi-hazard mitigation plans prepared in response to the Stafford Act) may describe local needs, but coverage of such plans is not statewide. Many regions lack current hydrologic information or hydraulic models that are needed to assess potential flood risks, suggesting that the state may need to consider investments in data collection and analysis to address data gaps and improve understanding of potential flood risks.

## **Recommendations to Facilitate Floodflow Modification**

Consistent with the recommendations of the FloodSAFE Strategic Plan:

- The Department of Water Resources should develop a comprehensive Central Valley Flood Protection Plan (as described in SB5) with extensive stakeholder input by January 1, 2012.
- The Department of Water Resources should identify opportunities and needs to improve integrated flood management statewide and develop a financing strategy by January 1, 2012.
- The Department of Water Resources should develop a strategy to provide incentives and support for the creation and maintenance of IRWM plans that address regional flood management issues by January 1, 2012.

## **Selected References**

- (ASFM 2003) Association of State Floodplain Managers, No Adverse Impact: A Toolkit for Common Sense Floodplain Management, 2003
- (ASFM 2007) Association of State Floodplain Managers, National Flood Program and Policies in Review, 2007
- (DWR 1980) California Department of Water Resources, California Flood Management: An Evaluation of Flood Damage Prevention Programs, Bulletin 199, Sacramento, California, September 1980.
- (DWR 2006) California Department of Water Resources, Progress on Incorporating Climate Change into Management of California Water Resources, Technical Memorandum Report, July, 2006
- (DWR 2008) Draft FloodSAFE Strategic Plan, March 2008
- (OES 2007) Governor's Office of Emergency Management, State of California Multi-Hazard Mitigation Plan
- (FEMA 1986) Federal Emergency Management Agency, A Unified National Program for Floodplain Management, FEMA Publication 100, March, 1986

(WMP 2004) World Meteorological Programme, Associated Programme on Flood Management, Integrated Flood Management, 2004

(WMP 2007) World Meteorological Programme, Associated Programme on Flood Management, Formulating a Basin Flood Management Plan, March, 2007

Working Draft