

## Contents

Chapter 28 Flood Risk Management .....	28-1
Flood Risk Management in California .....	28-1
Background .....	28-1
Description .....	28-1
Connections to Other Resource management strategies .....	28-6
Potential Benefits of Flood Risk Management .....	28-7
Potential Costs of Flood Risk Management .....	28-8
Major Issues Facing Flood Risk Management .....	28-9
Issues Common to All Flood Risk Management Approaches .....	28-9
Structural Approach Issues .....	28-10
Land Use Management Issues .....	28-10
Disaster Preparedness, Response, and Recovery Issues .....	28-11
Recommendations to Facilitate Flood Risk Management .....	28-11
Recommendations Common to All Flood Risk Management Approaches .....	28-11
Structural Approach Recommendations .....	28-12
Land Use Management Recommendations .....	28-12
Disaster Preparedness, Response, and Recovery Recommendations .....	28-13
Selected References .....	28-13

### Box

Box 28-1 Flood Risk Management Using Land Use Management: Other Related Resource management strategies .....	28-4
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Subgroup: Improve Flood Management

## Chapter 28 Flood Risk Management

Flood Risk Management is a strategy specifically intended to enhance flood protection. It includes projects and programs that assist individuals and communities to manage floodflows and to prepare for, respond to, and recover from a flood. This strategy is a key element of integrated flood management, a process that promotes a comprehensive approach that considers land and water resources at a watershed scale within the context of integrated regional water management and aims to maximize the benefits of floodplains, minimize the loss of life and damage to property from flooding, and recognize the benefits to ecosystems from periodic flood events.

### Flood Risk Management in California

#### Background

Traditionally, flood risk management has relied on physical improvements that 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 integrated flood management, a mix of structural and non-structural methods including land use practices that minimize development in flood prone areas (e.g., floodplains, alluvial fans, and low-lying coastal areas) and enhance the ability of undeveloped floodplains and other open spaces to absorb, store, and slowly release floodwaters during small and medium-sized events. The application of integrated flood management extends the range of strategies that may be employed to include those that may be primarily focused on other water resource issues (such as water supply or water quality) but have the potential to provide ancillary flood management benefits. The strategies that may be implemented to manage flood risk within a hydrologic region or watershed will vary depending on the physical attributes of the area, the presence of undeveloped floodplains, the type of flood hazards (e.g., riverine, alluvial fan, or coastal), and the areal extent of flooding.

#### Description

Flood Risk Management includes a wide range of projects and programs, which may be generally grouped into three categories discussed below: Structural Approaches, Land Use Management, and Disaster Preparedness, Response, and Recovery.

#### ***Structural Approaches***

Structural approaches to flood risk management include: a) Dams and Reservoirs; b) Levees, Floodwalls, and Flood Embankments; c) Channelization; d) High Flow Diversions and Bypasses, e) Coordination of Flood Operations, and f) Maintenance of Facilities.

- a) **Dams and Reservoirs** provide an opportunity to collect floodflows 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 often 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. Smaller

- reservoirs throughout California typically provide some incidental flood benefits. Many of these facilities could be reoperated to increase flood management benefits.
- b) **Levees, Floodwalls and Flood Embankments** are a common form of flood protection, where an earthen or rock berm is constructed parallel to a stream (or around a lake) to provide protection from high water, typically during floods. Levees, floodwalls or flood embankments may be placed close to the stream edge, or further back (e.g., a setback levee), incorporating a portion of the floodplain. Floodwalls (or seawalls) are sometimes installed along low-lying coastal areas to protect those areas from high surf or storm surges. The Central Valley's State-federal flood control system includes approximately 1,600 miles of project levees that protect more than 500,000 people, approximately 200,000 structures, and two million acres of agricultural lands.
  - c) **Channel Modification** is an increase of the channel capacity of a river or stream, thereby improving the ability of the channel to convey floodflows. This may include lining of the streambed and/or banks with concrete, rip rap, or other materials, to enhance the channel's drainage efficiency by reducing surface roughness. Other forms of channel modification include channel deepening or excavation to increase floodflow capacity. Although effective at conveying flows more quickly, channelization results in the loss of habitat, simplifies channel morphology (as channels are often straightened) and removes the potential for infiltration of flows to the underlying groundwater (and groundwater contributions to streamflow). Channel modifications are particularly common in urban areas where the high value and limited availability of land have limited opportunities for more integrated forms of flood management. In some regions, channel modification of streams has recently been prohibited by regional water quality control boards, which limits the potential application of this type of flood management. An example of a high capacity concrete-lined channel located in an urbanized environment is the Los Angeles River system.
  - d) **High Flow Diversions and Bypasses** are structural features which divert a portion of floodflows into adjacent lands (or underground culverts) 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 do not erode the point of diversion or adjacent banks, and may require acquisition of lands, or easements to allow for occasional inundation of the lands in an above ground bypass. An example is the Yolo Bypass west 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. Another example of a bypass system that diverts excess floodflows away from the adjacent lands is the Guadalupe River flood management project in downtown San Jose.
  - e) **Coordination of Flood Operations** is an important consideration when operable facilities such as reservoirs, interacting hydraulically, fall under separate jurisdictions. The prime example is the San Joaquin River system, which incorporates nine multi-purpose reservoirs under six jurisdictions, together with several flood control reservoirs, and three major levee systems under different operating agencies. Coordination may contemplate operating under formal forecast-coordinated agreements such as the one being developed for Lake Oroville and New Bullards Bar Reservoir by DWR, Yuba County Water Agency, the US Army Corps of Engineers (USACE), and the National Weather Service. It may include agreements not involving flood forecasts, or simply participation in coordination meetings during flood emergencies. All coordination efforts

include the basic element of individual operational modifications to minimize regional impact.

- f) **Maintenance of Constructed Facilities** is a crucial element in managing floodflows. Adequate maintenance and adequate financing of maintenance are crucial to secure the long-term preservation of the intended flood management benefits of any constructed facility, whether dam, reservoir, levee, bypass, or channel improvement. Maintenance of levees is particularly critical. The potential for failure of old levees can be high, due to early-day design and construction techniques. Even modern levees can fail as a result of poor maintenance. Periodic inspection and certification of levees, floodwalls, and other structural facilities is a key activity for assuring the performance of effective maintenance.

### ***Land Use Management***

Land Use Management approaches include: a) Floodplain Function Restoration, b) Floodplain Regulation, c) Development and Redevelopment Policies, d) Housing and Building Codes, and e) Flood Insurance. Land Use Management may also include measures from other Resource management strategies (see Box 28-1).

- a) **Floodplain Function Restoration** is a technique that recognizes that periodic flooding of undeveloped lands adjacent to rivers and streams is a natural function and may be a preferred alternative to restricting floodflows to the existing channel. This may require purchase of the lands that could be subject to inundation, or the acquisition of flood easements from willing land owners. The intent of floodplain function restoration is to preserve and/or restore the natural ability of undeveloped floodplains to absorb, hold, and slowly release floodwaters. To permit seasonal inundation of undeveloped floodplains, some structural improvements (e.g., a weir) may be needed to constrain flooding within a defined area along with nonstructural measures to limit development and permitted uses within those areas subject to periodic inundation.
- b) **Floodplain Regulation** includes land use policies which guide the development of areas adjacent to streams, rivers, and coastal areas which may be subject to periodic flooding or inundation. These measures may include measures to restrict or prohibit development within floodplains. Where development is permitted, measures may require protection of buildings from potential flood damage (such as flood-proofing, described below) or measures to reduce potential impacts to other development, such as requiring that new development result in no adverse flood impacts to existing structures. It may also include acquisition of floodplain lands and low-lying coastal areas through purchase or easements and measures intended to restore the natural, beneficial functions and values of the floodplain.
- c) **Development and Redevelopment Policies** include land use practices that are designed to reduce flood risks, reduce the severity of potential floods, and expedite recovery after floods. This may include floodplain regulation (described above), stream protection ordinances, storm water management practices, open space preservation, and watershed management programs. The intent of these practices is to reduce risk to structures by requiring rigorous analysis of flood risk and/or limiting development in flood prone areas, preserving the ability of water courses, estuaries, wetlands, and open spaces to absorb precipitation and slowly release runoff, and reducing the extent of impervious surfaces. Redevelopment policies may include measures which impose conditions on

future construction that restrict the size and placement of structures, encourage reduction of impervious areas, and encourage the long-term restoration of streams and floodplains.

- d) **Housing and Building Codes** include specific measures which reduce flood damage and preserve egress routes during high water events—such as rooftop exits in areas subject to deep flooding— or require that streets serving development are elevated above anticipated water levels to ensure safe egress from flooded areas. These codes may include floodproofing, which consists of measures that render buildings and their contents less vulnerable to floods through structural changes to existing buildings and specific design features of new buildings. These modifications or features can include impervious walls without any openings and valves on sewer lines that automatically close from back pressure. Alternatively, the lowest floor could be completely open, consisting of open columns that create a covered patio or storage area.
- e) **Flood Insurance** is provided by the federal government via the National Flood Insurance Program (NFIP), which was established by Congress in 1968. The NFIP enables property owners in participating communities to purchase insurance as a protection against flood losses. Participation in the NFIP is based on an agreement between each community and the federal government. If a community adopts and enforces an approved floodplain management ordinance to reduce future flood risk to new construction in floodplains, the federal government will make flood insurance available within the community as a financial protection against flood losses. If a community participates in the voluntary Community Rating System and implements certain floodplain management activities, the flood insurance premium rates are discounted to reflect the reduced flood risks.

### **Box 28-1 Flood Risk Management Using Land Use Management: Other Related Resource management strategies**

**Agricultural Lands Stewardship** can enhance the ability of lands used for food, fiber, and animal production to absorb rainfall and runoff, limit soil erosion, reduce the magnitude of some flood events, and enhance recovery after flood events. For more information on this strategy, refer to Chapter 20.

**Land Use Planning and Management** in both urban and rural locations can affect the potential risk to lives and property on floodplains, alluvial fans, and coastal areas from flooding, and affect the intensity and duration of some flood events. For more information on this strategy, refer to Chapter 4.

**Ecosystem Restoration** can enhance the ability of open spaces to absorb rainfall and runoff and reduce the magnitude of flood events, or enhance recovery after flood events. For more information on this strategy, refer to Chapter 22.

**Forest Management**, including preservation of forest meadows, riparian vegetation along streams, and maintenance of forest canopy, may reduce soil erosion and moderate the severity and frequency of some flood events and promote recovery after flood events. For more information on this strategy, refer to Chapter 23.

**Watershed Management** can promote the retention of open space and habitat which may reduce the severity and frequency of flood events and promote recovery after flood events. For more information on this strategy, refer to Chapter 27.

### **Disaster Preparedness, Response, and Recovery**

Disaster Preparedness, Response, and Recovery for flood risk management includes: a) Information and Education, b) Disaster Preparedness, c) Emergency Response, and d) Post-flood Recovery.

- a) **Information and Education** is an important element of flood risk management. To understand potential risks, flood hazard information is a prerequisite to sound education. The development of needed technical information includes the hydrology and hydraulics of streams and rivers, delineation of the areas subject to inundation, assessment of properties at risk, and calculation of the probabilities of various levels of loss from floods. The utilization of geographic information systems (GIS) to display and analyze flood risk data has become more widespread. Once potential flood risks are known, public education is a powerful tool to modify the impact of future events. If the public understands the potential risks, they can make decisions to reduce their risk, increase their personal safety, and expedite recovery after floods. The success of these efforts depends on an appreciation of the perceptions of those at risk, as the willingness to act on flood risk information may vary among different populations. Early warning of flood events, in the form of flood forecasting and warning, involves the forecasting of river stages and the timely notification of responsible authorities so that plans for evacuation of people and property can be implemented. Factors which influence the benefits of flood warnings include: reliability of the precipitation forecast, length of forecast warning time, and magnitude of reducible damage, human perceptions of risk, and the resultant efficiency of response to a warning.
- b) **Disaster Preparedness** includes the development of plans and procedures on how to respond to a flood and the implementation of measures that can reduce future risks. Emergency response planning includes activities undertaken in advance of an emergency to develop operational capabilities and improve effective response to disasters, such as the preparation of a comprehensive response plan, training of local response personnel, designation of evacuation procedures, the conduct of exercises to assess readiness, and development of emergency response agreements that address issues of liability and responsibility. Flood preparedness may occur as an element of Hazard Mitigation Planning, which includes analyses of ways to eliminate or reduce the impact of potential hazards, such as floods, earthquakes, or wildfires. The federal Disaster Mitigation Act of 2000 requires each state to develop and maintain a State Hazard Mitigation Plan to address various potential disasters, including floods. A local hazard mitigation plan, approved by the Federal Emergency Management Agency (FEMA), is required to receive grant funds for mitigation projects from the federal Hazard Mitigation Grant Program and the federal Pre-Disaster Mitigation Grant Program.
- c) **Flood Emergency Response** is the aggregate of all those actions taken by responsible parties during a flood emergency. For floods in California, response *by law* is organized under the federal National Incident Management System and the State Standardized Emergency Management System (NIMS/SEMS) using the methods of the Incident Command System (ICS). Emergency response includes the following:
  - Establishment of *ad hoc* responding organizations on the ICS pattern
  - Procurement of personnel and materials
  - Supplying technical advisers
  - Placement of sandbags and other flood-fight materials

- Arranging for and providing emergency heavy construction
- Communication and action to control waterflow
- Preparation and broadcast of weather, river, and coastal forecasts
- Activation of flood warning systems
- Evacuation preparation and execution
- Sheltering
- After-action analysis.

Response begins with and may be confined to the affected agencies or operational areas (counties). Depending upon the intensity of the event and the resources of the responders, regional, State and federal response may be required.

- d) **Post-Flood Recovery** includes programs and actions to recover from floods. After major floods, long delays can occur in organizing recovery actions if planning is attempted on an ad hoc basis under the stress of post-disaster situations. Pre-flood planning can be beneficial in reducing post-disaster delays, minimizing costs, and facilitating recovery. Short-term programs and actions to recover from floods include those that restore utility services, public facilities, and community services; repair levees and other structural flood management facilities; drain flooded areas; provide aid to individuals, and facilitate other forms of assistance to individuals, businesses, and communities. The restoration of public facilities and services is crucial to expediting post-flood recovery as vital public services are needed to permit homes and businesses to return to functionality. In the period immediately following the flood, individual residents and business owners may require aid to protect lives and property. Various forms of assistance can also expedite recovery, which may be in the form of temporary shelter, grants or loans, pump-out programs or other forms of financial assistance. Typically, the issuance of a disaster declaration (by the governor and/or President) expands the forms of assistance that can be offered.

Recovery planning can also include development of long-term floodplain reconstruction strategies to determine whether reconstruction will be allowed in flood prone areas, what building standards should be met, and how the permit process for planned reconstruction can be streamlined. Some post-flood recovery grants and loans may be conditioned on reducing future flood risks by reducing or eliminating development in flood prone areas or minimizing future flood exposure through reconstruction techniques.

### **Connections to Other Resource management strategies**

The process of integrated flood management relies on the application of multiple strategies. In addition to this flood-specific strategy, and the land use-related strategies listed in Box 28-1, other water resource management strategies included in the Water Plan Update 2009 have the potential to provide flood management benefits and may be incorporated as an element of integrated flood management, including:

- **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.

- **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.

## **Potential Benefits of Flood Risk Management**

The primary benefits of flood risk management are derived from the potential to reduce risks to lives and property from flood events, which reduces the social and economic disruption and flood recovery costs.

Additional benefits derive from changes in the floodplain. The deposition of sediment and debris during inundation is a natural function and can improve the quality of habitat and enhance soil conditions in agricultural areas. Periodic inundation of undeveloped floodplains can provide opportunities to store and slowly release floodwaters, thus reducing floodflow peaks and their subsequent impacts during small and frequent flood events. These areas can act as sponges, soaking up floodwaters, filtering runoff and providing opportunities to recharge (depending on soil conditions) groundwater and enhance ecosystem functions that benefit fish and wildlife.

The potential benefits that would accrue to each hydrologic region depend on the potential need for additional flood protection within each region. The Regional Reports (included in Volume III) 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 and restoration of floodplain functions. 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 the potential for levee failure and increase flood protection to a 200-year level for urban and urbanizing areas in the Central Valley. When implemented, this would reduce potential damage associated with flood events in those watersheds. In addition, benefits to each region vary depending on the extent of flood protection planning by local jurisdictions within each region (such as FEMA/OES [Office of Emergency Services] Multi-Hazard Mitigation Plans), community participation in the NFIP/Community Rating System, the extent of current and projected future development within floodplains, and the willingness of local jurisdictions to enact land use policies and practices which reduce exposure to flood risks.

Interregional benefits associated with flood risk management are limited, as the conveyance of floodflows does not occur between hydrologic regions. However, the implementation of flood risk management within the Mountain Counties special interest area has the potential to provide benefits to downstream areas in the Sacramento and San Joaquin regions. Similarly, improvements in the Sacramento and San Joaquin regions would provide benefits to the Sacramento-San Joaquin Delta Region. Statewide benefits from flood risk management 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.

Other potential benefits from the implementation of flood risk management 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 and increased protection of water supply conveyance systems. Channelization of streams reduces the potential for instream recharge of groundwater.
- **Reduce Groundwater Overdraft:** The development of high-flow diversions and flood bypasses may have the greatest potential to enhance water supply and drought preparedness. Both typically result in the discharge of water into areas that retain water for long periods, which enhances the potential for groundwater recharge.
- **Water Quality:** Structural and Land Use Management approaches may enhance water quality to the extent that such approaches reduce sediment loads. Channelization of streams can eliminate the potential for assimilation and transformation of pollutants from plants and aquatic organisms.
- **Energy:** Implementation of flood risk management is unlikely to result in large energy benefits, as floodwaters are typically released after storm events and are not available to increase hydroelectric power generation. Some benefits may accrue because less energy is required to pump groundwater when levels are higher.
- **Resource Stewardship:** Implementation of floodplain function restoration and development of setback levees, incorporating a portion of the floodplain, have the potential to enhance terrestrial and aquatic habitat and provide ecosystem restoration benefits.

## Potential Costs of Flood Risk Management

The Department of Water Resources is working to identify the costs of improving flood management on a statewide basis. Included in this effort are 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 a subsequent water plan update.

The implementation of integrated flood management has the potential to reduce overall costs, as an integrated approach can leverage flood management benefits from a variety of projects and programs, including those focused on other forms of water resource management. In terms of relative magnitude, **Structural Approaches** to flood management are the most capital intensive, in terms of both initial cost and long-term outlays for maintenance of flood management facilities. **Disaster Preparedness, Response, and Recovery** can have much lower costs (than structural approaches) although these approaches require long-term funding to assure that the programs, equipment and personnel training remain effective. **Land Use Management** is the least costly flood management approach, as implementation typically involves relatively minor funding for planning and adoption, with few long-term costs (although flood insurance does require long term expenditures for program maintenance).

## Major Issues Facing Flood Risk Management

### Issues Common to All Flood Risk Management Approaches

Although flood risk management can reduce the intensity and frequency of flooding, man-made flood protection cannot completely eliminate risk of flooding, because the design capacity of structural measures can be exceeded by large storm events or individual elements of structural protection systems can be subject to failure. Thus, residual risk of flooding will remain in those areas protected by flood risk management projects and programs.

The liabilities associated with flood management and the ability to limit these liabilities poses a major challenge to the state of California. Major efforts to address these liabilities, such as the Central Valley Flood Protection Plan, are underway. The absence of a common standard, regarding what constitutes “reasonable” impacts on downstream drainage, have created variable risks to local agencies from facilities constructed long ago. The potential liability discourages agencies from constructing flood management projects that could delay needed improvements.

Global climate change will have a significant impact on the timing and magnitude of precipitation and runoff and contribute to a rise in sea levels. Increased air temperatures may reduce the extent of snow pack in mountainous areas, thereby adding to the portion of watersheds that are available to contribute to direct *winter* runoff. Decreased snow pack would also reduce spring runoff volumes. Rainfall intensity for individual storms could also increase. Sea level rise could increase the potential for high tides and storm surges to inundate low-lying coastal areas. 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 and a rise in sea level suggests that the enhancement of both structural and non-structural flood management measures may be needed.

Integrated flood management suggests the application of a wide range of strategies to achieve a comprehensive result. Integration creates challenges associated with the close coordination of activities by multiple agencies, both to achieve a coordinated result and avoid unintended consequences. IRWM is the preferred methodology to integrate flood management with other water resources programs, but coordination of actions by multiple agencies is often complex, requiring memorandums or other legal agreements that address issues of liability and responsibility. The lack of clear mechanisms to implement coordinated actions may hamper the potential for integrated action.

Currently, the extent of the need for flood management is not well documented for most portions of the state. Some local flood management plans (and multi-hazard mitigation plans prepared in response to the Stafford Act) describe local needs, but coverage of such plans is not statewide. The age, condition, and maintenance status of existing flood management facilities may not be well documented. The effect of sea level rise on lands along the coast or in low-lying inland areas (e.g., the Delta) or on the discharge of floodwaters in river channels at coastal locations may not be well documented. 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 the understanding of potential flood risks.

Implementation of flood risk management will not adversely affect drought preparedness, water quality or energy consumption. 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 require close coordination among multiple agencies.

## **Structural Approach Issues**

Existing structural flood management systems, such as levees, were designed to separate river and stream channels from adjacent land uses. The installation of these features permitted occupation and development of adjacent lands, sometimes resulting in the placement of structures and homes in close proximity to levees and streambanks, which may limit future improvements, such as expansion, reconstruction, or the creation of setback levees.

The costs of structural solutions can be substantial, competition for scarce local resources and legal requirements for approval of new funding as required by Proposition 218 may impede implementation of structural flood improvements. Population growth and development may increase runoff and increase the population and number of structures at risk, increasing demand for additional flood protection projects and programs. In some locations, federal participation could help provide additional funding, although the availability of federal funds is not assured, given competition from other regions and programs.

Maintenance of flood management facilities is chronically underfinanced in some areas. The USACE, as constructor and owner of many of these facilities, has contracted with the State or local agencies for operation and maintenance, defining maintenance as actions to “maintain, repair, and replace” the facility. The State has re-delegated much of its maintenance responsibility to local agencies. In many instances, the limited resources of these agencies have enabled them to perform only the basic recurring maintenance. In recent years, increased awareness of environmental considerations has run counter to traditional, less expensive maintenance practices. Passage of Proposition 13 in 1978 and Proposition 218 in 1996 have severely restricted the local agencies’ ability to obtain maintenance funds through taxation.

Routine maintenance of flood facilities has the potential to impact sensitive environmental resources such as riparian habitat and special status species; conversely it has the potential to provide benefits through removal of invasive species. A streamlined and effective environmental review and permitting process for maintenance projects could result in time and cost savings, while protecting sensitive environmental resources.

## **Land Use Management Issues**

FEMA’s ongoing map modernization program may result in changes in flood risk designations for some communities, which could change and in some areas expand, the areas that are subject to flood insurance requirements. The expansion of flood hazard zones can cause short-term impacts to the real estate and construction industry as well as the financial industry supporting those sectors.

Although the restoration of floodplain functions may result in flood management and habitat benefits, the integration of naturalized floodplains into structural flood management systems requires careful evaluation of geomorphologic and hydraulic factors and may require some form of management to assure the long term sustainability of these features.

Insufficient funding currently exists for local governments to prepare revised land use plans and regulations that are responsive to flood risks. Local governments generally do not have the guidance, information base, and incentives to voluntarily prepare these revised flood-sensitive land use plans and regulations, yet are facing statutory deadlines that require them. Funding is

also insufficient for the land acquisition, and operation and maintenance, needed to implement floodplain function restoration on a large scale. Future development on tribal lands needs to be factored into flood management planning.

### **Disaster Preparedness, Response, and Recovery Issues**

The Department of Water Resources currently lacks agreements with local flood control districts and other relevant jurisdictions that assign roles and responsibilities when State assistance is needed during flood events, which results in confusion about financial responsibilities. For example, State assistance was provided in several locations during the 1997 floods, but resolution of financial responsibilities afterward required nearly a year of negotiations.

California has made substantial advances in disaster preparedness and response planning, but post-disaster recovery planning is not well organized. After a catastrophic flood, major delays and costs could be incurred in the absence of organized pre-flood recovery planning at the State, regional, and local levels.

## **Recommendations to Facilitate Flood Risk Management**

### **Recommendations Common to All Flood Risk Management Approaches**

- 1) The Department of Water Resources should lead research into the potential effects of global climate change on precipitation and runoff patterns, and disseminate revised flood projections needed to plan for flood events. Flood management agencies and local governments should incorporate the potential effects of climate change into planning for future flood events.
- 2) Consistent with the governor's Executive Order S-13-08, the Ocean Protection Council, the Resources Agency, the Department of Water Resources, and the Governor's Office of Planning and Research, should (1) initiate a statewide climate change adaptation strategy, (2) request the National Academy of Science establish an expert panel to report on sea level rise impacts; (3) issue interim guidance to State agencies for how to plan on sea level rise in designated coastal and floodplain areas; and (4) initiate a report on critical existing and planned infrastructure projects vulnerable to sea level rise.
- 3) The Department of Water Resources should, with extensive stakeholder input, describe the current status of the flood management systems in the Sacramento and San Joaquin watersheds and recommend changes throughout the system for those areas currently receiving protection from the State-federal system by January 1, 2012, consistent with the California Water Code (commencing with §9600).
- 4) The Department of Water Resources should, with extensive stakeholder input, prepare a report that identifies the current status of flood protection infrastructure and flood risks statewide and identifies opportunities and needs to improve integrated flood management statewide by January 1, 2012.
- 5) The Department of Water Resources should develop incentives and provide support for the creation and maintenance of IRWM plans that address regional flood management issues by January 1, 2012.
- 6) The Department of Water Resources should develop a financing strategy to address statewide flood management needs identified in the statewide report on flood

- management risks by January 1, 2012. The strategy should address both capital costs and operation and maintenance costs.
- 7) DWR should develop a comprehensive statewide database on flood management, and make it accessible to flood management agencies and local governments. The database should include natural floodplain resources, land use and watershed boundaries, and updated flood hazard areas.
  - 8) DWR should map 200-year floodplains throughout the state, make this information available to flood management agencies and local governments, and evaluate the costs and benefits of establishing the 200-year flood as the minimum planning standard for urban and urbanizing areas statewide (Currently the 200-year standard is required only for the Central Valley.)
  - 9) The Department of Water Resources should utilize the comments and recommendations in the Flood Risk Management Strategy to inform: 1) the statewide report on opportunities and needs to improve integrated flood management; 2) the Central Valley Flood Protection Plan; and 3) Integrated regional water management planning groups on regional flood management.

### **Structural Approach Recommendations**

- 10) The Legislature should enact legislation which clarifies the liability for structural flood management facilities and defines what constitutes “reasonable” impacts on downstream drainage and property.
- 11) DWR and local flood jurisdictions should establish long-term buyback programs to acquire properties immediately adjacent to levees and other structural facilities to facilitate the eventual removal of these structures, thereby enhancing the potential for setback levees and floodplain restoration where feasible.
- 12) To facilitate cross-jurisdictional projects and programs, the Governor’s Office of Planning and Research should develop guidelines and model legal agreements (e.g., MOU or Joint Powers Authority) that clearly delineate responsibilities for construction, operation, and maintenance of flood management facilities and programs and address liability issues.
- 13) Planning for structural projects should be integrated into a comprehensive integrated flood management approach that takes a watershed perspective.
- 14) For routine maintenance of structural facilities, DWR should develop recommendations for streamlined environmental review and permitting that result in time and cost savings, while protecting and enhancing sensitive environmental resources.

### **Land Use Management Recommendations**

- 15) The Department of Water Resources should continue to work with the Federal Emergency Management Agency to expedite the review and update of flood insurance rate maps and expand ongoing efforts to enhance public understanding of potential flood risks.
- 16) Local governments should prepare revised general plans and regulations that respond to statutory mandates to address flood risks, and are updated frequently, as hydrologic projections change. As required by Water Code Section 65302, the land use element should identify and annually review floodprone areas identified by FEMA or DWR. The revised General Plans and regulations should reflect an integrated flood management

- approach and consider future development on tribal lands. DWR and OPR should provide technical assistance to local governments to revise their General Plans and land use regulations.
- 17) Local land-use agencies should not allow new critical public facilities (such as fire stations, emergency shelters, hospitals or schools) to be constructed within the 200-year floodplain. Existing critical facilities located in flood-prone areas should be noted in the Emergency Plans prepared by local agencies, with evacuation and egress routes clearly identified.
  - 18) CEQA reviews of development projects in floodplains should use the latest floodplain mapping data available, implement General Plan flood management policies, and ensure that flood risks associated with development projects are fully understood and properly mitigated. The potential impacts of “floodproofing” individual development projects to the risk of upstream and downstream flooding should be evaluated and mitigated if significant.
  - 19) DWR (as required by Water Code Section 9130) and local agencies should analyze potential flood risks, including residual flood risks to property within levee protection zones, and make this information publicly available, including residual flood risks. The public, businesses, tribal governments, and public agencies should be provided with sufficient information about potential flood risks to make informed decisions that can reduce potential impacts of flooding.
  - 20) The State should explore additional funding options for local government preparation of revised General Plans and land use regulations that address flood risks, and for floodplain function restoration projects. State funding for floodplain function restoration projects should be prioritized based on the magnitude of flood risks that would be avoided, and the magnitude of ecosystem and water resources benefits that would be created.
  - 21) Local flood management jurisdictions should promote the preservation of existing floodplains and restoration of natural floodplain functions where feasible and carefully analyze the interface between natural and naturalized floodplains and structural flood management systems, to ensure that erosion and debris deposition from these natural areas do not create undue hazards to downstream facilities and property.

### **Disaster Preparedness, Response, and Recovery Recommendations**

- 22) The Department of Water Resources should work closely with the Governor’s Office of Emergency Services and California Department of Health Services to ensure a consistent approach to disaster preparedness plans and procedures.
- 23) The Department of Water Resources should take the lead in developing guidance and recommending improved, organized approaches for post-flood recovery, at the state, regional, and local levels. Creation of a statewide California Recovery Authority should be considered.

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