

CHAPTER 3

ALTERNATIVES

This chapter summarizes information on the flood control alternatives and measures considered during the course of the Corps reevaluation of the ARWI. In accordance with the planning principles and guidelines applicable to Federal water resources projects, the alternative which maximizes national economic development benefits (NED Plan) has been designated.

The Corps, local sponsors, and other interested organizations and individuals identified a variety of measures to increase flood protection in the American River basin. These measures are listed below and compared in table 3-1. Those retained for more detailed evaluation are shown in bold type.

Increase Outlet Efficiency of Folsom Dam and Reservoir

- Normalized use of auxiliary spillway
- **Lower main spillway**
- Conjunctive use of river outlets and main spillway
- **Enlarged river outlets**
- **New river outlets**
- Use of existing diversion tunnel
- **New tunnel outlets**
- Early flood releases prior to storms based on weather forecasts

Increase Flood Releases from Folsom Reservoir

- **Levee modifications**
- Setback levees
- Flood control bypass south of Sacramento

Increase Flood Storage in the American River Basin

- **Flood detention dam at Auburn**
- Existing upstream reservoirs
- Multiple small detention reservoirs
- Offstream storage on Deer Creek
- **Increased Folsom flood storage space**
- **Raised Folsom Dam and Spillway**

SEIS 3-1

TABLE 3-1

Initial Screening of Flood Protection Measures

Measure	Frequency of Storm Controlled to Obj. Release (years)	Construction Cost (\$ million)	Flood Control Benefits (B) vs. Costs (C)	Relative Impacts		Potential for Combining with Other Measures	Status
				Environmental	Socioeconomic		
Increase Folsom Dam and Reservoir Outlet Efficiency							
1. Improved operational response time	85	< 1	B > C	low	none	high	retained
2. Normalized use of auxiliary spillway	100	20	B > C	low	none	low	dropped
3. Lower main spillway	110	60	B > C	low	none	high	retained
4. Conjunctive use of existing river outlets and main spillway	100	5	B > C	low	none	low	dropped
5. Enlarge river outlets	105	40	B > C	low	none	high	retained
6. New river outlets	105	40	B > C	low	none	high	retained
7. Existing diversion tunnel	105	70	B > C	high	high	high	dropped
8. New tunnel outlets: 3 tunnels	110	140	B > C	medium	medium	high	retained
5 tunnels	110	200					
9. Early releases	85	N/A	N/A	low	none	low	dropped
Increase Folsom Dam Flood Releases							
1. Levee modifications: 130,000 cfs	110	260	B < C	medium	low	high	retained
145,000 cfs	120	350		medium	low	high	retained
180,000 cfs	155	500		medium	low	high	retained
235,000 cfs	190	815		high	high	high	dropped
2. Setback levees	155	6,700	B < C	very low	high	low	dropped
3. Flood control bypass south of Sacramento	200	2,100	B < C	high	high	low	dropped
Increase System Flood Storage							
1. Flood detention dam	250	729	B > C	high	low	low	retained
2. Existing upstream storage: 50 percent	85	830	B < C	medium	high	low	dropped
100 percent	85	975		medium	high	low	dropped
3. Multiple small detention dams	105	900	B < C	high	low	low	dropped
4. Offstream storage - Deer Creek	200	1,600	B < C	high	high	low	dropped
5. Modify Folsom flood space: 475,000-670,000 ac-ft	100	120	B > C	low	moderate	high	retained
535,000-835,000 ac-ft	100	170		moderate	high	high	retained
6. Raise Folsom Dam & Spillway: 17 foot	130	460	B < C	medium	medium	low	dropped
30 foot	180	660					
7. Credit surcharge	95	20	B > C	low	low	high	retained
8. Excavate Folsom lakebed	130	1,400	B < C	medium	low	low	dropped
Non-Traditional (Nonstructural)							
Flood proofing, evacuation, restriction, and warning	N/A	high	low	low	high	medium	dropped

A description of each measure and why it was deleted or retained for formulation into a flood control alternative is included in chapter IV in the Main Report.

NONSTRUCTURAL MEASURES

Most structural flood damage reduction measures are directed at the source of flooding. Their purpose is to change the direction of floodflows, decrease the area of inundation, alter the timing of floodflows, or store floodflows. In contrast, most nonstructural measures are directed at flood damage reduction of individual property, through the use of land use restrictions and other actions. Nonstructural measures fall into these broad categories:

- Flood Proofing - Flood proofing includes temporary or permanent closure of structures, raising existing structures, and constructing small walls or levees around structures.
- Flood Plain Evacuation - Flood plain evacuation involves either moving the structure and its contents to a flood-free site or removing only the contents and demolishing the structure or using it for some other purpose.
- Development Restrictions - Development restrictions include zoning, subdivision regulations, and modification of building and housing codes to require that all future development is compatible with the flood threat.
- Flood Warning - Flood warning consists of flood forecasting; warning the population; evacuation before, during, and after a flood; and postflood reoccupation and recovery.

These procedures are currently in force by a coordinated plan involving Federal, State, and community governments.

PLANS CONSIDERED IN DETAIL

A variety of potential flood control measures were evaluated, and a number of action alternatives along with the No-Action Alternative were developed for detailed evaluation. These alternatives are outlined in the following section and summarized in table 3-2. Environmental effects for each alternative are summarized following each alternative outline.

Table 3-2

Summary Comparison of Initial Alternatives and Candidate Plans

Item	No Action	Initial Plans							Candidate Plans		
		Equivalent Storage	Equivalent Protection	Maximum Objective Release	Moderate Objective Release	Minimum Objective Release	Increase Folsom Flood Space	1991 ARWI Feasibility Report NED	Folsom Modification	Folsom Stepped Release ²	Detention Dam
Flood protection (chance of flooding)	1 in 100	1 in 270	1 in 200	1 in 300	1 in 240	1 in 200	1 in 160	1 in 435	1 in 180	1 in 235	< 1 in 500
Probability of passing 200-year storm (%)	16	82	65	83	70	62	50	95	54	68	97
Features											
Folsom Dam & Reservoir											
Flood control space (ac-ft) ¹	400,000/ 670,000	400,000	400,000	475,000/ 810,000	475,000/ 725,000	475,000/ 670,000	475,000/ 655,000	400,000	475,000/ 720,000	400,000/ 670,000	400,000
Objective release (cfs)	115,000	115,000	115,000	180,000	145,000	130,000	115,000	115,000	115,000	145/180,000	115,000
Lower Folsom spillway 15 feet	No	No	No	Yes	Yes	Yes	Yes	No	Yes	Yes	No
Outlets (no. of gates & capacity, cfs)	8 & 30,000	8 & 30,000	8 & 30,000	12 & 100,000	12 & 100,000	12 & 100,000	12 & 100,000	8 & 30,000	8 at 70,000	8 & 70,000	8 & 30,000
Lower American River											
American River design capacity (stage, ft)											
Probable nonfailure point	44.5	44.5	44.5	51	49	47	44.5	44.5	46.5	51	46.5
Probable failure point	47.5	47.5	47.5	52	50	48	47.5	47.5	47.5	52	47.5
Stabilize/modify levees (mi)	0	0	0	29	28	25	0	0	24	29	24
Raise/modify bridges	0	0	0	3	3	1	0	0	0	3	0
Downstream American River											
Modify Sacramento Weir & Bypass (ft)	0	0	0	2,700	1,000	600	0	0	0	1,000	0
Stabilize/modify levees (mi)	0	0	0	76	52	43	0	0	0	52	0
Natomas - east bank Sacramento River											
Stabilize/modify levees (mi)	0	12	12	12	12	12	12	12	12	12	12
Upstream storage											
Storage space (ac-ft)	0	545,000	380,000	0	0	0	0	894,000	0	0	894,000
Dam height (ft)	0	435	399	0	0	0	0	508	0	0	508
Flood operation gates	0	20	20	0	0	0	0	20	0	0	20
Raise/modify bridges	0	2	2	0	0	0	0	2	0	0	2

¹Single number is constant flood space; 400/670, for example, is variable space between 400,000 and 670,000 acre-feet.

²Part of Initial Array of Alternatives and Candidate Plans.

- **No-Action Alternative**

- ▶ The operational modifications (revised flood control release schedule, revised reservoir storage schedule, and a release schedule for spring refill) to Folsom Reservoir implemented by SAFCA and the U.S. Bureau of Reclamation would continue
- ▶ The Natomas levee project would be completed
- ▶ The West Sacramento Project would be completed
- ▶ The Folsom spillway gate would be repaired
- ▶ Bank protection along the lower American River would be implemented
- ▶ Features of the Folsom Flood Management Plan would be implemented
- ▶ The objective release from Folsom Dam would be maintained at 115,000 cfs

Chapter 6, Environmental Consequences, No-Action Alternative presents the no-action condition. Chapter 10 describes the likely socioeconomic and environmental effects and required mitigation for changing the flood control operation at Folsom Dam from a fixed 400,000 acre-feet of storage to the permanent operation of 400,000/670,000 acre-feet.

- **Increase Folsom Flood Space Alternative**

- ▶ Incorporate the variable space storage operation initiated under the No-Action Alternative and increase the minimum flood storage maintained in Folsom during the flood season from 400,000 acre-feet to 475,000 acre-feet and decrease the maximum storage from 670,000 acre-feet to 655,000 acre-feet
- ▶ Lower Folsom Dam main spillway 15 feet and replace the five main spillway gates
- ▶ Enlarge the eight river outlets through the main dam
- ▶ Construct four river outlets
- ▶ Modify Folsom Dam and dikes to permit increased surcharge storage and replace three auxiliary spillway gates
- ▶ Modify emergency spillway diagram
- ▶ Strengthen the east levee of the Sacramento River from the Natomas Cross Canal to American River
- ▶ Maintain the objective release from Folsom Dam at 115,000 cfs

Environmental effects from implementation of this alternative would be similar to those described for the Folsom Modification Alternative, but would be somewhat less severe because objective releases from Folsom Reservoir would remain at 115,000 cfs.

- **Folsom Modification Alternative**

- ▶ Incorporate the variable space storage operation initiated under the No-Action Alternative and increase the minimum flood storage maintained in Folsom during the flood season from 400,000 acre-feet to 475,000 acre-feet and the maximum storage from 670,000 acre-feet to 720,000 acre-feet

Alternatives

- ▶ Lower Folsom Dam main spillway 15 feet and replace the five main spillway gates
- ▶ Enlarge the eight river outlets through the main dam
- ▶ Modify Folsom Dam and dikes to permit increased surcharge storage and replace three auxiliary spillway gates
- ▶ Modify emergency spillway diagram
- ▶ Strengthen the east levee of the Sacramento River from the Natomas Cross Canal to American River
- ▶ Maintain the objective release from Folsom Dam at 115,000 cfs
- ▶ Construct 24 miles of slurry wall in lower American River levees.

Environmental effects from implementation of this alternative are discussed in chapter 7, Environmental Consequences, Folsom Modification Plan.

● **Folsom Stepped Release Alternative**

- ▶ Adopt the 1993 Diagram and revise the Folsom Reservoir Control Manual accordingly (continue using the 400,000 to 670,000 acre-feet of variable space storage operation)
- ▶ Lower Folsom Dam main spillway 15 feet and replace the main spillway gates
- ▶ Enlarge the eight river outlets through the main dam
- ▶ Modify Folsom Dam and dikes to permit increased surcharge storage, replace three auxiliary spillway gates, and modify emergency spillway diagram
- ▶ Implement levee and related channel modifications along lower American River
- ▶ Increase the objective release from Folsom Dam to a maximum of 180,000 cfs depending on Folsom Reservoir storage and inflow
- ▶ Construct 25.6 miles of slurry wall in lower American River levees.
- ▶ Lengthen Sacramento Weir and widen Sacramento Bypass
- ▶ Raise and strengthen levees in the Yolo Bypass
- ▶ Strengthen east levee of the Sacramento River from the Natomas Cross Canal to the American River
- ▶ Construct a recreation trail along the lower American River near Richards Boulevard and new park facilities near Highway 160 (Gateway Park)
- ▶ Restore 144 acres of degraded habitat along the lower American River near Woodlake Avenue and near the Urrutia Gravel Mining operation.

Environmental effects from this alternative are presented in chapter 8, Environmental Consequences, Stepped Release Plan.

● **1991 ARWI Feasibility Report NED Alternative**

- ▶ Construct a flood detention dam with a maximum capacity of 894,000 acre-feet near Auburn
- ▶ Relocate Highway 49 and reinforce Ponderosa Way Bridge

- ▶ Strengthen the east levee of the Sacramento River from Natomas Cross Canal to the American River
- ▶ Eliminate the variable space storage operation initiated under the No-Action Alternative and revert Folsom Reservoir to a fixed space storage operation (400,000 acre-feet)
- ▶ Maintain the objective release from Folsom Dam at 115,000 cfs

Environmental effects from this alternative would be similar to those associated with the Detention Dam discussed below. Construction of a slurry wall is not part of the 1991 ARWI Feasibility Report NED plan.

- **Detention Dam**

- ▶ Construct a flood detention dam with a maximum capacity of 894,000 acre-feet near Auburn
- ▶ Relocate Highway 49 and reinforce Ponderosa Way Bridge
- ▶ Strengthen the east levee of the Sacramento River from Natomas Cross Canal to the American River
- ▶ Eliminate the variable space storage operation initiated under the No-Action Alternative and revert Folsom Reservoir to a fixed space storage operation (400,000 acre-feet)
- ▶ Maintain the objective release from Folsom Dam at 115,000 cfs
- ▶ Construct 24 miles of slurry wall in lower American River levees.

Environmental effects from this alternative are presented in chapter 9, Environmental Consequences, Detention Dam Plan. In summary, the plan formulation process has identified the Detention Dam Plan as the NED plan. This final SEIS/EIR concludes that the Detention Dam Plan is in compliance with the guidance promulgated pursuant to Section 404(b)(1) of the Clean Water Act.

- **Maximum Objective Release Alternative**

- ▶ Incorporate the variable space storage operation initiated under the No-Action Alternative and increase the minimum flood storage maintained in Folsom during the flood season from 400,000 acre-feet to 475,000 acre-feet and the maximum storage space from 670,000 acre-feet to 810,000 acre-feet
- ▶ Lower Folsom Dam spillway 15 feet and install five new main spillway gates
- ▶ Enlarge the eight existing outlets through the main dam and construct four new river outlets
- ▶ Modify Folsom Dam so as to permit increased surcharge storage, replace three auxiliary spillway gates, and modify emergency spillway diagram
- ▶ Implement levee and related channel modification along lower American River
- ▶ Increase Folsom Dam objective release to 180,000 cfs
- ▶ Lengthen Sacramento Weir and widen Sacramento Bypass

Alternatives

- ▶ Raise and strengthen levees in the Yolo Bypass
- ▶ Strengthen east levee of the Sacramento River along the western flank of Natomas
- ▶ Construct a recreation trail along the lower American River near Richards Boulevard and new park facilities near Highway 160 (Gateway Park)
- ▶ Restore 144 acres of degraded habitat along the lower American River near Woodlake Avenue and near the Urrutia Gravel Mining operation.

Modifications to the dam outlets (spillway and flood control sluices) would have minor adverse effects on natural resources at the dam. Some adverse effects to air quality and adverse noise increases would result. These would be mitigated with proper vehicle maintenance and sound barriers.

Improvements and enlargements of the levee system along the lower American River would affect wildlife habitat, including riparian and scrub-shrub. Widening the Sacramento Bypass would require acquisition of agricultural land and grassland habitat. The improvements to levees in the Yolo Bypass would affect habitat, including agricultural fields, grassland, emergent marsh, and riparian habitat cover types. Mitigation for these losses would include planting riparian habitat along the lower American River. Habitat improvements would be made in the Sacramento Bypass to compensate for losses in the Yolo Bypass. Grassland acres that were disturbed for levee improvements would be reseeded with native vegetation.

Increasing the level of reoperation of Folsom from 400,000/670,000 acre-feet to 475,000/810,000 acre-feet is not expected to have large impacts on resources. By seasonally drawing down the reservoir to provide at least 475,000 acre-feet of space from mid-November to mid-March, the reservoir would be about 12 feet lower than the without-project condition under most situations. Increasing the drawdown would have some minor effects on delivery of local water supply and on hydropower production, but since the drawdown would be during winter, there would be few adverse effects to recreation. Increasing the storage capacity would also result in a reduction in the total water supply capacity of the CVP by about 14,000 acre-feet per year. This maximum drawdown would not change from the without-project condition. Therefore, few additional adverse effects would be expected to fisheries and vegetation in the lower American River.

● Moderate Objective Release Alternative

- ▶ Incorporate the variable space storage operation initiated under the No-Action Alternative and increase the minimum storage maintained in Folsom during the flood season from 400,000 acre-feet to 475,000 acre-feet and the maximum from 670,000 to 725,000 acre-feet
- ▶ Lower Folsom Dam main spillway 15 feet, enlarge eight existing river outlets, and construct four new river outlets through the auxiliary spillway
- ▶ Modify Folsom Dam so as to permit increased surcharge storage, replace three auxiliary spillway gates, and modify emergency spillway diagram

- ▶ Implement levee and related channel modifications along lower American River
- ▶ Increase the objective release from Folsom Dam to 145,000 cfs
- ▶ Lengthen Sacramento Weir and widen Sacramento Bypass
- ▶ Raise and strengthen levees in the Yolo Bypass
- ▶ Strengthen the east levee of the Sacramento River from Natomas Cross Canal to the American River
- ▶ Construct a recreation trail along the lower American River near Richards Boulevard and new park facilities near Highway 160 (Gateway Park)
- ▶ Restore 144 acres of degraded habitat along the lower American River near Woodlake Avenue and near the Urrutia Gravel Mining operation.

Major environmental effects of the plan and potential features to mitigate them would be similar to those for the Maximum Objective Release Alternative. This moderate-release plan would reduce effects in the lower American River to riparian scrub-shrub. Widening the Sacramento Bypass and modifying levees in the Yolo Bypass would affect emergent marsh and riparian systems. Mitigation would include planting riparian habitat along the lower American River and riparian and wetland habitat in the Sacramento Bypass. The increased seasonal storage capacity in Folsom Reservoir would result in a reduction in the water supply capacity of the CVP by an estimated 13,000 acre-feet per year. Hydropower generation and recreation use at the lake would also be slightly reduced.

● **Minimum Objective Release Alternative**

- ▶ Incorporate the variable space storage operation initiated under the No-Action Alternative and increase the minimum flood storage maintained in Folsom during the flood season from 400,000 acre-feet to 475,000 acre-feet (475,000 acre-feet to 670,000 acre-feet)
- ▶ Lower Folsom Dam main spillway 15 feet, enlarge eight existing river outlets, and construct four new river outlets through the auxiliary spillway
- ▶ Modify Folsom Dam so as to permit increased surcharge storage, replace three auxiliary spillway gates, and modify emergency spillway diagram
- ▶ Implement levee and related channel modifications along lower American River
- ▶ Increase Folsom Dam objective release to 130,000 cfs
- ▶ Lengthen Sacramento Weir and widen Sacramento Bypass
- ▶ Raise and strengthen levees in the Yolo Bypass
- ▶ Strengthen the east levee of the Sacramento River from Natomas Cross Canal to the American River
- ▶ Construct a recreation trail along the lower American River near Richards Boulevard and new park facilities near Highway 160 (Gateway Park)
- ▶ Restore 144 acres of degraded habitat along the lower American River near Woodlake Avenue and near the Urrutia Gravel Mining operation.

Alternatives

Environmental effects of the plan and measures included to mitigate the effects would be similar to the previous two plans. The relatively higher amount of seasonal storage could begin to affect water temperatures released to the lower American River. Potential adverse effects to fisheries in the lower American River would be compensated by modifying the temperature shutters at Folsom Dam to control temperatures of releases. The increased seasonal storage capacity in Folsom Reservoir would result in an annual reduction in the water supply capacity of the CVP of about 12,000 acre-feet. Hydropower generation and recreation use at the lake would also be slightly reduced.

- **Equivalent Storage Alternative**

- ▶ Construct a flood detention dam near Auburn with a maximum capacity of 545,000 acre-feet
- ▶ Relocate Highway 49 and reinforce Ponderosa Way Bridge
- ▶ Strengthen the east levee of the Sacramento River from Natomas Cross Canal to the American River
- ▶ Eliminate the variable space storage operation initiated under the No-Action Alternative and revert Folsom Reservoir to a fixed space storage operation (400,000 acre-feet)

The plan would result in effects in the American River canyon due to construction and operation of the detention dam. Vegetation would be lost as a result of construction of the dam and replacement of Highway 49. Operation of the detention dam would result in the loss of upland vegetation over the project life as a result of vegetation mortality.

Wildlife in the canyon would be affected when their habitat is inundated. The more mobile animals would be able to flee from the rising floodwaters, but more sedentary animals or animals in hibernation could be lost. Although some animals would be lost following each flood, repopulation would take place over the next several years. The operation of the detention dam would also periodically affect habitat of the threatened valley elderberry longhorn beetle.

Mitigation for the loss of approximately 1,228 acres of vegetation (and associated wildlife habitat values) would involve acquiring and preserving about 2,600 acres of land. These figures include 100 acres for mitigating lost habitat for the beetle.

- **Equivalent Protection Alternative**

- ▶ Construct a flood detention dam near Auburn with a maximum capacity of 380,000 acre-feet
- ▶ Relocate Highway 49 and reinforce Ponderosa Way Bridge
- ▶ Strengthen the east levee of the Sacramento River from Natomas Cross Canal to the American River

- ▶ Eliminate the variable space storage operation initiated under the No-Action Alternative and revert Folsom Reservoir to a fixed space storage operation (400,000 acre-feet)

The plan would result in impacts in the American River canyon due to construction and operation of the detention dam similar to those of the equivalent storage plan. The smaller footprint of the dam and smaller detention storage area would reduce mitigation needs. Mitigation would consist of purchasing and preserving land, including mitigating lost habitat for the threatened valley elderberry longhorn beetle.

The plans described above were modified and became the candidate plans proposed for implementation. Following is a more detailed description of the No-Action Alternative and the Folsom Modification, Stepped Release, and Detention Dam Plans. The environmental impacts of these alternatives are discussed in chapters 7, 8, and 9. These alternatives are representative of the two smaller flood detention dams and other increased objective release plans; consequently, these plans have not been included in the following discussion.

NO-ACTION ALTERNATIVE

Under this alternative, in the absence of congressional action on a long-term improvement project for the American River, SAFCA and Reclamation would take whatever steps are necessary to ensure that their agreement on interim reoperation of Folsom Dam and Reservoir is indefinitely extended. Therefore, under this plan, the flood operations of Folsom Dam and Reservoir would be conducted in accordance with the flood control diagram referenced in the SAFCA-Reclamation interim reoperation agreement (1993 Diagram). This diagram has three essential elements: (1) a flood control release schedule designed to permit simultaneous use of the existing five main spillway bays and eight river outlets until the objective release is reached; (2) a reservoir storage schedule which provides for a minimum winter season flood control allocation of 400,000 acre-feet of empty space and a maximum of 670,000 acre-feet of empty space, depending on the space available in three upstream reservoirs (Union Valley, Hell Hole, and French Meadows); and (3) a release schedule for the spring refill. Each of these elements is explained below. To protect the environmental and recreational resources in the lower American River, the Interim Reoperation implementing agreement further obligates Reclamation to ensure that Folsom Reservoir releases during the spring refill period are at least equal to the lesser of (1) the releases that would have been made if Folsom had continued to be operated in accordance with the 1986 Diagram or (2) the releases designated by Judge Hodge in deciding the matter of Environmental Defense Fund et al. versus East Bay Municipal Utility District (Hodge Decision).

The 1993 Diagram requires that water stored in the designated flood control space be released as rapidly as possible. The maximum specified release is 115,000 cfs. However, during relatively small flood events, the outflow would be limited to the maximum inflow.

Alternatives

Any change in outflows is limited to 30,000 cfs per 2-hour period when inflows are increasing and 10,000 cfs per 2-hour period when inflows are decreasing. When the spillway gates and river outlets are operating simultaneously (between elevation 423.6 feet and 447 feet), the gates on the river outlets would be set in a 60 percent open position to avoid damage to the spillway and outlet conduits by cavitation.

Reclamation would be required to reduce the water conservation pool in Folsom Reservoir to no more than 575,000 acre-feet full (400,000 acre-feet empty) at the outset of each flood season if the three upstream reservoirs have 200,000 acre-feet or more empty space at that time. This target must be met by November 17 and maintained thereafter unless, based on a daily evaluation, the storage space upstream falls below 200,000 acre-feet. At that point, the Folsom Reservoir pool must be reduced in accordance with the storage schedule. For example, a decline to 175,000 acre-feet of empty space upstream requires a reduction in storage in Folsom Reservoir to 550,000 acre-feet, while a decline to 130,000 acre-feet of empty space upstream requires a reduction in storage in Folsom Reservoir to 475,000 acre-feet. For purposes of calculating the total amount of creditable empty space in the upstream reservoirs, French Meadows would be deemed to have a maximum of 45,000 acre-feet of creditable storage, Hell Hole 80,000 acre-feet, and Union Valley 75,000 acre-feet. Empty space in excess of these amounts at each reservoir would not be creditable.

FOLSOM MODIFICATION PLAN

This plan would increase protection to most of Sacramento and Natomas by reducing the possibility of flooding to a 1 in 180 chance of occurring in any year by increasing the variable space allocated to flood control under the 1993 Diagram from 400,000/670,000 acre-feet to 475,000/720,000 acre-feet, implementing structural modifications to Folsom Dam, and strengthening the American River levees and a portion of the Sacramento River east levee. These measures are described below. This alternative is a modification of the Increase Folsom Flood Space Alternative discussed in the Main Report.

Folsom Storage

Under the Folsom Modification Plan, a new flood control diagram would be developed increasing the space allocated to flood control from 400,000/670,000 acre-feet to 475,000/720,000 acre-feet, depending on storage available in the upstream reservoirs.

Folsom Dam Modifications

To ensure efficient use of the space dedicated to flood storage in the reservoir, the Folsom Modification Plan also includes provisions for structurally modifying Folsom Dam.

These modifications include lowering the Folsom Dam main spillway by 15 feet, enlarging the eight river outlets through the main dam, and implementing the improvements necessary to create additional surcharge storage in the reservoir. These modifications would permit Folsom operators to make larger releases earlier in a flood event, thereby preserving as much flood control storage space as possible in the reservoir.

American River Levee Improvements

To increase the reliability of the American River with the 115,000 cfs objective release, a 24-mile-long slurry wall would be constructed in the Federal and non-Federal levees along both sides of the lower American River.

Sacramento River Levee Improvements

This plan includes approximately 12 miles of minor improvements to strengthen the east levee of the Sacramento River along the western flank of Natomas downstream from the mouth of the Natomas Cross Canal.

STEPPED RELEASE PLAN

This plan would increase the flood protection to Sacramento by reducing the probability of flooding due to levee failure to 1 in 235 in any year by incorporating permanent reoperation of Folsom Reservoir (based on the 1993 Diagram) into the existing flood control system, modifying Folsom Dam to ensure efficient use of this storage space, and increasing the capacity of the downstream levee system. These improvements are described below.

Folsom Storage

Under this plan, the Secretary of the Army would adopt the 1993 Diagram for Folsom Reservoir.

Folsom Dam Modifications

This plan would include the same Folsom Dam modifications previously described in connection with the Folsom Modification Plan. These include lowering the main spillway 15 feet and replacing the five main spillway gates, enlarging the eight river outlets, and strengthening portions of the dam and dikes and enlarging the auxiliary spillway gates to permit increased surcharge storage.

Alternatives

Downstream Improvements

The Stepped Release would include improvements to accommodate increased objective releases from Folsom Dam up to a maximum of 180,000 cfs. The magnitude of these releases would depend on inflow and water storage in the reservoir. For floods greater than about a 20-year event but less than about a 175-year, the objective release would be 145,000 cfs. For floods greater than a 175-year event but less than about the 220-year, the objective release would be 180,000 cfs. The improvements required to accommodate these higher releases would include raising and strengthening portions of the existing American River levee system, raising Howe Avenue and Guy West bridges and modifying the Union Pacific Railroad trestle, and modifying interior drainage facilities and other infrastructure in the flood plain. A 25.6-mile-long slurry wall would be constructed in the Federal and non-Federal levees along both sides of the lower American River to increase levee reliability. To avoid higher flood stages in the Sacramento River downstream from the mouth of the American River, it would be necessary to lengthen the Sacramento Weir by 1,000 feet, widen the Sacramento Bypass by 1,000 feet, and raise and strengthen levees in the Yolo Bypass to ensure that the flood risk to the lands protected by these levees is not worsened.

Sacramento River Levee Improvements

This plan would include the same improvements along the east levee of the Sacramento River previously described in connection with the Folsom Modification Plan.

Restoration Plan

The Stepped Release Plan includes a restoration plan consisting of wetland/riparian features in two areas of the American River Parkway: the Woodlake area, which extends from the mouth of the NEMDC (Natomas East Main Drainage Canal) to Cal Expo, and the Urrutia property adjacent to Discovery Park.

Woodlake Area. Restoration in the Woodlake area would include development of a slough/wetland complex on approximately 37 acres of land owned and managed by Sacramento County and conversion of 50 acres of non-oak upland habitat to riparian and wetland plant communities. Material excavated to create this restoration feature would be used to provide fill for a portion of the levee improvements called for under the Stepped Release plan.

Urrutia Property. Restoration on the Urrutia property would consist of creating wetland/riparian habitat on land adjacent to the 57-acre pond which dominates the site. This pond has been excavated over time as part of mining on the property. Restoration would involve excavation and fill along the northern edge of the pond to create a series of shallow shelves extending from the water's edge along a gently sloping berm to adjacent high ground.

These shelves would support an assemblage of emergent marsh habitat, and the sloping berm would be planted with riparian vegetation.

Recreation Plan

The Stepped Release Plan also includes a recreation plan consisting of an 8-mile-long bicycle/pedestrian trail along the south side of the American River linking Tiscornia Park near the Sacramento-American River confluence to California State University, Sacramento, and a gateway park on the north side of the river in the American River Parkway adjacent to the Highway 160 overcrossing.

DETENTION DAM PLAN

This plan would provide occupants of the American River flood plain greater flood protection by reducing the probability of flooding due to levee failure to less than a 1 in 500 chance in any year through construction of a flood detention dam near Auburn. The improvements included in this plan are described below.

Flood Detention Dam on the American River

The main feature of the Detention Dam Plan is a flood detention dam on the North Fork American River at mile 47.2 near Auburn, near the site of Reclamation's authorized multipurpose Auburn Dam Project. The dam would be a peak-flow detention dam of concrete gravity design that would not permanently store water. An overview of the Auburn area, damsite plan, outlet works tunnel intake structure, and dam and spillway profile and sections are shown on plates 17 through 19 in the Main Report.

In most years, no water would be impounded behind the dam. It is expected that some water would begin to be impounded for short periods with about a 25-year event. However, during extremely rare events (less frequent than 1 in 500 in any year), up to 894,000 acre-feet of water could be impounded for several hours. During such an event, the filling and emptying of the reservoir would take up to 28 days.

During a 400-year event, water would reach a maximum elevation of 942 feet and cover about 5,450 acres. From streambed, the dam would be about 508 feet high and detain floodwaters up to 452 feet deep. The crest of the dam would be 2,700 feet long (about 1/2 mile). The dam would be about 400 feet wide at its base, decreasing to about 25 feet at the dam crest. The foundation of the dam would extend about 50 feet below the surface of the streambed.

Alternatives

Construction of the dam would require about 6 million cubic yards of aggregate. The aggregate would include material deposited in the riverbed in 1986 from the old cofferdam and an underground amphibolite mine at the damsite.

Dam construction would require removing approximately 2 million cubic yards of material from the foundation of the dam. Any material that cannot be used in constructing the dam would be placed in the foundation keyway excavated in connection with the multipurpose project or banked at the foot of the uncompleted boat ramp paralleling Salt Creek.

Outlet capacity for the structure would be provided by 20 rectangular box sluices 5 feet by 10.5 feet. The combined releases of these sluices at gross pool during design events would be 77,000 cfs. The sluices would include operational gates.

The tunnel constructed by Reclamation for its Auburn Dam Project would continue diverting streamflows around the damsite during construction. Following completion of the detention dam, a watertight bulkhead gate would be installed to seal the entrance to the tunnel.

A spillway is provided for dam safety in the event a flood is greater than the design storm. The 540-foot-long spillway would be located in the center of the dam and have a design capacity of 810,000 cfs. Floodwater would first pass over the spillway when the water level behind the dam reached 56 feet from the top of the dam.

About 7,152 acres of land in the Auburn area would be required for construction, operation, and maintenance of the proposed dam and related facilities, including 47 acres to relocate Highway 49. The land would include 6,280 acres in Federally owned property, 8 acres in State ownership, and 817 acres currently held in private ownership. All Federally owned property would remain in Federal ownership.

The Corps would obtain a joint-use permit on 260 acres of Federal land for the dam foundation and appurtenances. Within the detention area, the non-Federal sponsor would obtain temporary easements on 99 acres for construction of the dam and permanent road easements on 52 acres for road replacements. The non-Federal sponsor and the Corps would obtain flowage easements on 5,932 acres. The non-Federal sponsors would purchase easement rights to plant and manage 1,481 acres as an adaptive management plan in the canyon and purchase and plant 2,774 acres in the Yuba River basin for fish and wildlife mitigation.

Allowance for a "dead pool" space for sediment would not be included in the dam, primarily because only small amounts of sediment would be expected to reach the facility.

Most of the sediment that would be transported to the damsite would pass through the outlet works.

Bridge Across the North Fork American River

The portion of Highway 49 relocated would be about 1.8 miles long, with a bridge about 0.6 mile long crossing the North Fork at river mile 49.1. The replacement would contain no enhancements and make no allowance for future traffic projections. The right-of-way would require about 47 acres. From about the town of Cool, the relocated route would extend northwest across the North Fork American River at about elevation 1,000 feet. The alignment would intersect High Street in Auburn.

The non-Federal sponsor is responsible for all relocations. State regulations may require route adoption studies to review plans for upgrading and realigning the highway in accordance with future traffic projections. These studies may result in the selection of a route other than the one described above. The State, if it ultimately selects a plan other than this, would have to complete separate environmental and related analyses to proceed with that plan.

Levee Improvements

As with all the plans carried forward for detailed analysis, the Detention Dam Plan includes strengthening the lower American River levee system by constructing a 24-mile-long slurry wall in the core of the Federal levee on both sides of the river and strengthening the east levee of the Sacramento River along the western flank of Natomas (12 miles) to maximize the flood protection for Natomas.

Folsom Dam Operations

The storage created under the Detention Dam Plan would return flood control operations at Folsom Dam to the 1986 Diagram of 400,000 acre-feet of fixed storage space and an objective release of 115,000 cfs.