CHAPTER 3.0

PROBLEMS AND OPPORTUNITIES

3.1 Flood Risk with Current Improvements

The Sacramento area is protected from American River flooding by Folsom Dam and a system of levees. Although recent and ongoing work to improve levees on the Lower American River and modifications planned for Folsom Dam will reduce the risk of flooding, the flood risk to the Sacramento Area will remain high and will fall short of the stated community flood control goal of reducing the flood risk to no greater than a 1-in-200 chance of exceedance in any year. A high level of flood damage reduction is desired for the Sacramento area because a levee system failure would lead to catastrophic flooding including the loss of human life and property.

Current estimates hold that Folsom Dam and Reservoir and the existing levee system provide protection from a flood with a 1-in-85 chance of occurring in any year. Modification to the existing levee system, known as the Common Features Project, was authorized in the Water Resources Development Act (WRDA) of 1996 and WRDA of 1999. Construction of the Common Features Project is scheduled for completion in 2003. In addition, modifications to the Folsom Dam, known as the Folsom Modification Project, were authorized in WRDA of 1999. Construction of the Folsom Modification Project is scheduled for completion in 2008. Following completion of these projects, the risk of flooding in the Sacramento area will be reduced to approximately a 1-in-160 chance in any year.

3.2 System Inadequacies

The potential for catastrophic damages attributable to flooding in Sacramento is magnified by the area's dependence on high levees. If the runoff volume is sufficient to fill Folsom Reservoir to its capacity, it would be necessary to match releases to inflow rates, which would result in overtopping of the downstream levees. When high levees fail, the population is significantly threatened by rapid flooding of the adjacent areas. Plate 3-1 shows the extent of flooding in the Sacramento area in a large flood event.

High levees essentially function as long dams. However, levees cannot be built with the same precision as dams. Levees are subjected to floodwaters that move at erosive velocities for miles along their waterside slope. In addition, the characteristic of the foundation soil and rock over many miles cannot be known as accurately for a levee as for a dam. Because a single weak spot in the system could potentially cause a breach that would result in uncontrolled, life-threatening flooding, special attention must be given to the design, construction, and operations and maintenance (O&M) of levee systems.

Levees can fail for several reasons, and predicting how and where they will fail is difficult. Levees have failed in cases when the stage (or height) of the water surface was significantly below the design flow. In other cases, floodflows have encroached into the design freeboard (or safety level) without levee breaching or significant damages.

The identification of potential locations and likelihood of levee failure is based on an analysis of the levee system as determined by a geotechnical assessment of levee stability. To identify the levee's weak points, probable nonfailure points (PNPs) and probable failure points (PFPs) were defined. The PNP is the highest water-surface elevation at which levee failure is highly unlikely. Conversely, the PFP is the lowest water-surface elevation at which levee failure is highly likely. For this analysis, the PNP and PFP are based on the results of field inspections and explorations, levee stability calculations, an assessment of levee performance during high water in February 1986 and January 1997, and the Common Features Modifications authorized in 1996 and 1999. After the Common Features Project is completed in 2003, the levees are expected to have a high degree of reliability for their design flows.

3.3 Flood Characteristics

Areas of major flooding (flood plains) were identified based on estimated river stages, levee stability conditions during high flows, and topography. Plate 3-1 shows the likely area of inundation for a major flood. Flood problems in the Natomas basin (located north of Sacramento) are being resolved; recently completed levee modifications have substantially increased flood protection to that area.

Flooding of the Sacramento area resulting from levee failure from American River flows would be widespread, encompassing approximately 86 square miles of the developed Sacramento Area. Water depth would range from 0.5 to 19.5 feet during a flood with a 1-in-500 chance of occurrence in any one year. Flooding would persist over 5−10 days. Levee failure would lead to catastrophic flooding in developed areas.

3.4 Future Without-Project Flood Risk and Damage

3.4.1 Change in Flood Risk

With the North Area Local Project and the Common Features Project in place, the flood risk to Natomas, north of Sacramento, will be reduced to approximately a 1-in-400 chance in any year. The alternatives under consideration as part of this evaluation would not significantly affect the flood protection for Natomas.

The without-project condition includes completion of the Common Features Project, the Folsom Modification Project that includes outlet modification and surcharge operation, and a reoperation plan reducing the variable flood control space from 400,000 - 670,000 acre-feet to 400,000 – 600,000 acre-feet. Table 3-1 shows the conditional probabilities of exceedance of major flooding along the Lower American River. Authorized flood control improvements will reduce the flood risk to a 1-in-140 chance in any one year) by 2008. The chance that a storm with a 50-year return period would result in flooding is approximately 2 percent, given the design of levees and uncertainties in hydrology and hydraulic evaluations. The likelihood that flooding will not occur is very high—approximately 98 percent. For larger (more rare) storms, the chance of levee failure and flooding increases.

As discussed in Chapter 2, "Affected Environment," when Folsom Dam outlets are enlarged, Folsom Dam will have the ability to make releases in advance of reservoir inflow

TABLE 3-1. Probability of Nonfailure from Specific Events [a] under Without-Project Conditions [b]

Storm		Percent Chance of Exceedance			Percent Chance of Nonexceedance		
1-in-X Chance per Year (X)	Exceedance Probability	No Advance Release	Without-Project Advance Release[c]	Upper Bounds Advance Release[d]	No Advance Release	Without-Project Advance Release[c]	Upper Bounds Advance Release[d]
50	2.0	2	1	1	98	99	99
100	1.0	21	14	12	79	86	88
200	0.5	62	52	46	38	48	54
400	0.25	91	86	82	9	14	18

[a] A particular frequency flood event (e.g., a 100-year flood) can result in various river stages within the Lower American River levees. If river stage exceeds the ability of the levees to hold back the water, levee failure and flooding of the Sacramento area will occur. Uncertainties exist regarding several parameters that determine the stage in the Lower American River. These parameters include amount of runoff and peak discharge from Folsom Dam. The biggest unknown parameter is the volume of runoff into the regulating reservoir from a particular frequency rainfall event. These uncertainties are estimated, which results in a range of river stages that may occur for any particular frequency flood event. Many different possible combinations for a particular frequency flood event are evaluated, and the percentages of the combinations that result in flooding are calculated.

[b] These conditions include Folsom Dam modifications and associated work in 2007. They do not include advance release that may be implemented through the flood management plan update.

[c] Advance release would create between 0 and 190,000 acre-feet of temporary flood space, with 100,000 acre-feet being the most likely.

[d] Advance release would create between 100,000 and 250,000 acre-feet of temporary flood space, with 140,000 acre-feet being the most likely.

based on forecast inflows that are large enough to be a flood risk. Under this operation, the water supply pool would be partially emptied in advance of the impending storm. This advance release operation would result in a further reduction in the without-project flood risk. Because an advance release operation has not been developed, and no agreements have been made to institute advance release, this study cannot forecast whether advance release will actually be instituted.

Advance release is part of the without-project condition through update of the Flood Management Plan, although the specific operational parameters are still under development. Advance release (or prerelease) has the potential to reduce flood risk. To illustrate the possible impacts of the addition of prerelease to the without-project condition flood risk, three scenarios were developed. The first scenario is that advance release would not occur, possibly because of currently unanticipated problems. For the second and third scenarios, this study provides a cursory estimate of the potential amount of additional flood space that could be created under advance release. Under the second or most likely scenario, advance release could create 100,000 acre-feet of additional flood space. This estimate is the outcome of a Risk and Uncertainty (R&U) analysis, and a worst case no additional flood space and best case, of 190,000 acre-feet additional flood condition advance release. This moderate advance release would reduce the exceedance probability to 0.0061 (a 1-in-164 chance in any given year). The third scenario provides the maximum extent of additional flood space that could be gained under the most optimum advance release condition. Under this scenario, approximately 140,000 acre-feet of additional flood space would be gained. This estimate is the outcome of an R&U analysis that assumed a worst case of 100,000 acre-feet of additional flood space and a best case of 250,000 acre-feet of additional flood storage space. This optimum advance release advance would reduce the exceedance probability to 0.0056 percent (1-in-179 chance in any given year). At present, this is considered unlikely given the current understanding of the limits of advance release operation. However, it is presented as a check on the economic feasibility of alternatives, if optimum upper bounds advance release is later to be found implementable. Table 3-1 portrays the without-project conditions for all three advance release scenarios.

3.4.2 Damages

Major flooding in an urban environment has many adverse consequences, including effects on public health and safety, monetary damages, and loss of real property. Damageable property in the Sacramento flood plain consists of commercial, industrial, residential, and public buildings valued at nearly $29 billion. Damages to buildings from levee failure during a storm with a 1-in-200 chance of occurring in any year (currently authorized projects in place, no advance release) would amount to approximately $10 billion. Damages during a storm with a 1-in-400 chance of occurring in any year would amount to approximately $12 billion.

As a result of damage to infrastructure and buildings, the adverse effects on the day-to-day business activities of Sacramento would be substantial. Many businesses would be forced to close, at least temporarily, resulting in lost revenue and wages. Rebuilding or relocating homes, businesses, and related infrastructure would require substantial natural and financial resources. Because Sacramento is California's capitol and center of government, a major flood and the resulting effects on day-to-day business would have far-reaching effects outside the area damaged by the flood.

Average annual equivalent damages are the expected value of damages for a given economic condition. They are determined by weighing the estimated damages from varying degrees of flooding with their probability of occurrence. Existing average annual equivalent flood damages are estimated at $69 million ($81 million with no advance release, $63 million with upper bounds advance release). Future average annual flood damages are estimated at approximately $73 million ($86 million with no advance release, $67 million with upper bounds advance release).

In addition to the building damage that could be suffered in the Sacramento area, transportation and power transmission disruption could adversely affect governments and businesses regionally and throughout California. A major flood could result in significant disruption and potential damage to Interstates 5 and 80, which are major north-south and east-west transportation corridors in the state. State Highways 16, 99, and 160 and U.S. Highway 50 also would be affected, as would Sacramento’s light rail system, Sacramento International Airport, Amtrak passenger service, and the Union Pacific Railroad commercial rail lines. In addition, damage to the metropolitan area’s power grid would likely disrupt the distribution of electricity.

The effect on human life from levee failure and resultant flooding would depend on the flood magnitude, number of people at risk, flood warning time, depth of flooding, time of day, and availability of evacuation routes. Because nearly 270,000 people reside in the flood plain of the American River, it would be reasonable to expect drownings during a very large flood. The number of fatalities would depend on the time of day, the warning time, and the suddenness of the levee breach. In addition to loss of life, major flooding could result in life-threatening injuries and the spread of waterborne infectious diseases.

Flooding could result in significant releases of toxic and hazardous substances from aboveground tanks and drums containing heating oil, fuel oil, liquid propane, and kerosene; agricultural chemicals such as herbicides, pesticides, solvents, and fertilizers; many commercial and industrial chemicals; and untreated wastewater. Widespread flooding also could result in groundwater contamination. In addition, flooding could likely result in the deposition of large quantities of flood-related debris, most of which would have to be collected and hauled to local landfills.

Flooding also would have effects on urban landscaping and wildlife, and special-status wildlife and plant species could be affected by inundation.

3.5 Ecosystem Restoration Problems and Opportunities

Flows in the Lower American River are regulated by Folsom Dam and other water resource developments in the basin. The combination of mining, development, flood plain constrictions (including bridges, levees, diversions, and the parkway system), dam construction, and flow modifications over the past 150 years has altered the physical processes that sustain ecosystem values, thereby contributing to significant degradation of the Lower American River ecosystem. These changes will likely continue, further reducing riparian, wildlife, and related habitat values along the lower river. There is a significant need to preserve the resources remaining and, as much as possible, restore lost resource values. The following bulleted items address some of the problems and opportunities in this ecosystem.

- High water temperatures in the Lower American River affect the spawning and other life stage behavior of fish species, including fall-run chinook salmon and Federally-threatened Central Valley steelhead, resulting in reductions of the species' natural production populations in the Lower American River. Historically, salmon and steelhead were able to migrate to upstream areas where there were cooler water temperatures in the summer and fall. Since construction of Folsom and Nimbus Dams, these species have been confined to an area with less suitable water temperatures for spawning and rearing.

- High flood plains produced by the deposit of sandy sediments from upstream hydraulic mining during the Gold Rush are disconnected from the ordinary flow of the river, except during very high flow events. Without a regular cycle of frequent inundation, which brings water to the unnaturally high terraces and shallower water tables, native plant species cannot regenerate adequately. Species favoring infrequent inundation and many nonnative, invasive species have taken advantage of the altered system and reduced the ecological integrity of the flood plain ecosystem.

- Shallow aquatic vegetation consisting of emergent and woody vegetation in combination with low-lying inundated areas has largely disappeared from the Lower American River. These areas provide valuable habitat for native fish species and are a critical link in restoring ecological integrity to the Lower American River corridor.

- Channel downcutting between the high flood plain banks results in a lack of shallow aquatic habitat—an important resource for juvenile fish rearing—along channel edges. This process also results in a lack of shallow, slow-water side channels and other off-channel aquatic habitats that are important to both fish rearing and fish spawning.

- Dredge tailings in the form of bars and deposits along the riverbanks and on the flood plain provide a poor substrate for riparian plants and less-than-optimal fish and wildlife habitat values. Upstream dams have eliminated downstream transport of sediment and slowed the development of substrate used by plants for colonization.

- Deep pools are found in several locations where the river has captured abandoned gravel mining pits. These pools provide habitat for predator fish that prey on juvenile salmon.

Many native plant communicates in the Lower American River have degraded significantly, lowering their ability to provide forage and cover needed to sustain diverse populations of animal species. Riparian forests on the Lower American River are limited to narrow, steep strips adjacent to the river, the Natomas East Main Drainage Canal (NEMDC) Bannon Slough, and the borrow channels adjacent to the levees. Most of these areas are old-generation forest.

Before construction of levees and conversion of land into agriculture and urban development, much of the higher elevations in the Lower American River flood plain had expanses of oak woodlands. Only remnants of these woodlands remain in small patches.

Most of the grasslands once covering the drier soils of the flood plain have been converted to other uses since the area was settled. Most remaining grasslands have been infested and fragmented by large stands of nonnative invasive species or have become covered with more woody species as the historical, cultural practice of burning grasslands has been eliminated from the landscape.

Shaded riverine areas with low, overhanging vegetation cool the water temperature, and downed woody material (e.g., branches and trunks of trees) provides areas for spawning salmon and steelhead to rest. As the river channel has incised over time, riparian vegetation has been left high on the terrace and clinging to steep banks, leaving it inaccessible to anadromous fish species. The steep banks prevent the low vegetation from attaching itself to soil so that it may regenerate.

The flood plain has numerous steep banks devoid of vegetation including along the river's edge at the Bushy Lake site. Terracing the steep bank allow riparian vegetation to re-establish and thereby create shaded riverine aquatic habitat that would provide important habitat for native fish species.