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Shasta Lake Water Resources Investigation

Feasibility Report

U.S. Department of the Interior
Bureau of Reclamation
Mid-Pacific Region

November 2011

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Feasibility Report

Shasta Lake Water Resources Investigation, California

Prepared by:

United States Department of the Interior
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Executive Summary

The purpose of this Shasta Lake Water Resources Investigation (SLWRI) Draft Feasibility Report is to document the U.S. Department of Interior, Bureau of Reclamation (Reclamation) and cooperating agencies' evaluation of the potential enlargement of Shasta Dam and Reservoir to (1) improve anadromous fish survival in the upper Sacramento River, (2) increase water supply reliability in the Central Valley of California, and (3) address related water resource problems, needs, and opportunities.

This report presents the results of planning, engineering, environmental, social, economic, and financial studies and potential benefits and effects of alternative plans, and is a companion document to the Preliminary Draft Environmental Impact Statement (EIS), published under separate cover. When the Feasibility Report and EIS are finalized, the Secretary of the Interior will use both documents and supporting information to provide a recommendation to Congress. If a plan is recommended, this recommendation will be documented in a Record of Decision (ROD) and used by the U.S. Congress, along with the Final Feasibility Report and Final Environmental Impact Statement (FEIS), to determine the type and extent of Federal interest in enlarging Shasta Dam and Reservoir.

The SLWRI is a feasibility study being conducted by Reclamation, in coordination with cooperating agencies, other resource agencies, stakeholders, and the public. The SLWRI is being conducted consistent with the 1983 U.S. Water Resources Council *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G), National Environmental Policy Act (NEPA), and other pertinent Federal, State of California (State), and local laws and policies.

Background

Reclamation completed constructing Shasta Dam and Reservoir in 1945. Reclamation operates Shasta Dam and Reservoir, in conjunction with other facilities, to provide flood damage reduction and irrigation and municipal and

industrial (M&I) water supply, maintain navigation flows, protect fish in the Sacramento River and the Sacramento-San Joaquin Delta (Delta), and generate hydropower. The Central Valley Project Improvement Act (CVPIA), enacted in 1992, added "fish and wildlife mitigation, protection, and restoration" as a priority equal to water supply, and added "fish and wildlife enhancement" as a priority equal to hydropower generation. Major modifications to Shasta Dam include construction of a temperature control device (TCD) in 1997 for improved management of water temperatures in the upper Sacramento River.

Shasta Dam and Reservoir were constructed as an integral element of the Central Valley Project (CVP), with Shasta Reservoir storing about 55 percent of the total annual water supply delivered by the CVP. The 602-foot-tall Shasta Dam (533 feet above the streambed) and 4.55-million-acre-foot (MAF) Shasta Reservoir are located on the upper Sacramento River in Northern California, north of the City of Redding (see Figure ES-1) within the Whiskeytown-Shasta-Trinity National Recreation Area (NRA). Shasta Lake supports extensive water-oriented recreation. Recreation within these lands is managed by U.S. Forest Service (USFS).

Figure ES-1. Location of Shasta Dam and Reservoir

In 2000, as a result of increasing demands for water supplies and growing concerns over declines in ecosystem resources in the Central Valley of California, Reclamation reinitiated a feasibility investigation to evaluate the

potential for enlarging Shasta Dam and Reservoir. The SLWRI is being conducted under the authority of Public Law 96-375, which was reaffirmed under Public Law 108-361, also known as the CALFED Bay-Delta Authorization Act.

Major existing projects that influence and could be influenced by modifications to Shasta Dam and Reservoir include the CVP and the State of California's State Water Project (SWP). In addition, several programs in the Central Valley significantly influence the SLWRI, including the CVPIA and CALFED Bay-Delta Program (CALFED). Other programs and projects currently in the planning phase could influence the SLWRI in the future. Prominent examples include the Delta Plan and the Bay Delta Conservation Plan (BDCP). These projects and programs have not been included in the evaluation of the alternative plans for the SLWRI because there has not been a specific decision to implement them at this time.

Study Area

Shasta Dam and Reservoir are located on the upper Sacramento River in Northern California, about 9 miles northwest of the City of Redding; the dam and entire reservoir are within Shasta County. The SLWRI includes both a primary and extended study area because of the potential influence of the proposed modification of Shasta Dam and Reservoir, and subsequent system operations and water deliveries over a large geographic area.

As shown in Figure ES-2, the primary study area encompasses Shasta Dam and Lake; lower reaches of three primary tributaries flowing into Shasta Lake (Sacramento, McCloud, and Pit rivers) and all smaller tributaries flowing into the lake; Trinity and Lewiston reservoirs; and the Sacramento River downstream from Shasta Dam to about the Red Bluff Diversion Dam (RBDD) facilities, including tributaries at their confluence. The RBDD facilities are directly adjacent to the Red Bluff Pumping Plant (RBPP), which is currently under construction. The extended study area encompasses the Sacramento River downstream from the RBDD facilities, including portions of the lower American and Feather river basins, the Delta, parts of the lower San Joaquin River basin; and CVP and SWP facilities and water service areas (shown in Figure ES-3).

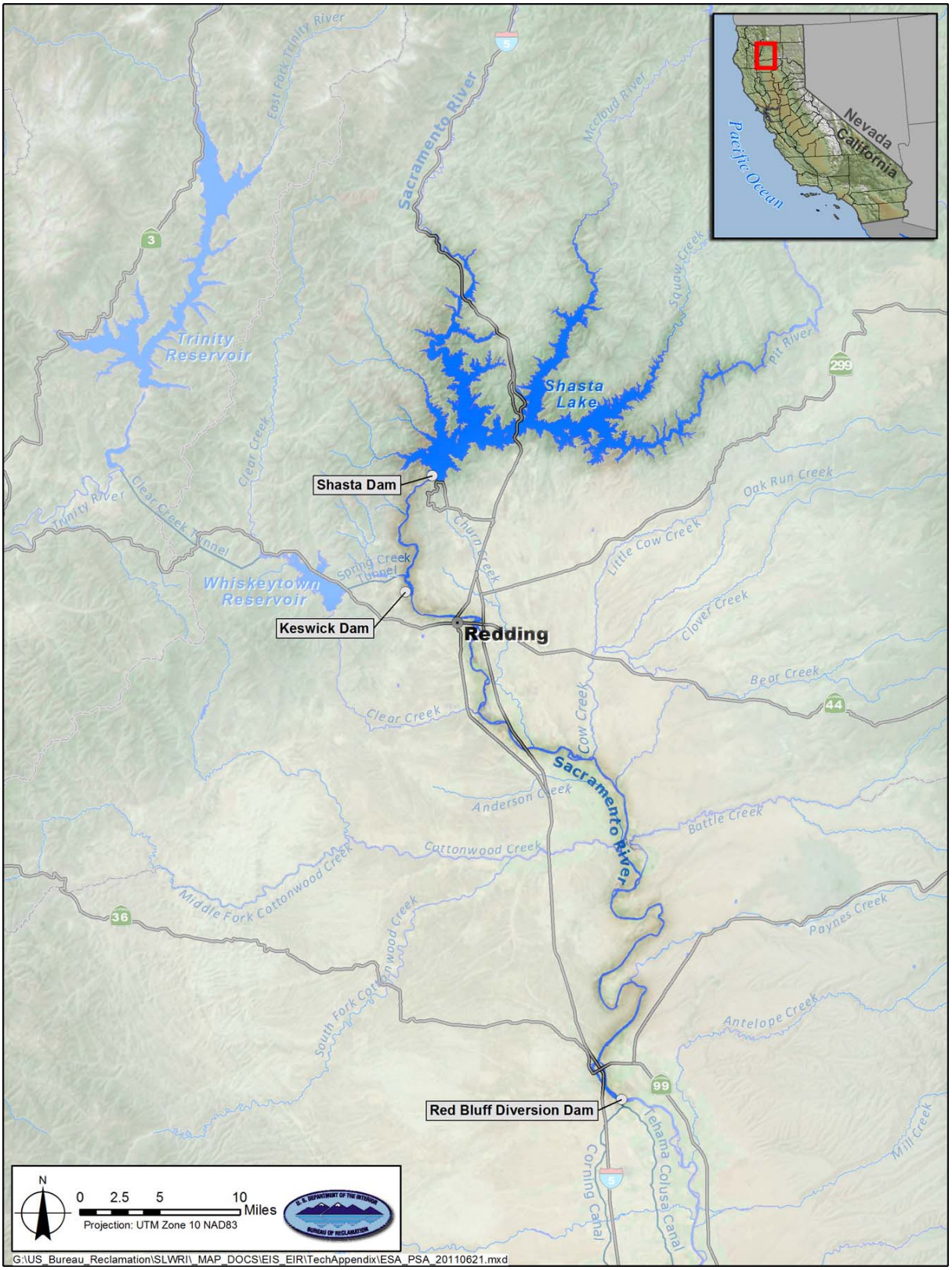


Figure ES-2. Shasta Lake Water Resources Investigation Primary Study Area

Figure ES-3. Central Valley Project and State Water Project Water Service Areas

Problems, Needs, and Opportunities

Major identified water and related resources problems, needs, and opportunities in the primary study area include anadromous fish survival, water supply reliability, and other resources needs, as described below.

Anadromous Fish Survival

A number of environmental factors have led to considerable declines in the populations of Chinook salmon and steelhead in the Sacramento River. One of the most significant factors contributing to the declines is unsuitable water temperature in the upper Sacramento River, especially in dry and critically dry years. Releases of cold water stored behind Shasta Dam can improve water temperatures in the Sacramento River for anadromous fish during critical periods.

The 2009 National Marine Fisheries Service (NMFS) *Public Draft Recovery Plan* concludes that prolonged droughts depleting the cold-water storage in Shasta Reservoir could extirpate the entire Sacramento River winter-run Chinook salmon population. Under current conditions, even 2 consecutive years of drought could reduce Shasta Reservoir cold-water storage to levels insufficient to support the Sacramento River winter-run Chinook spawning and incubation season. Various actions ranging from minimum instream flow requirements to structural changes at Shasta Dam have been undertaken to address this problem. Despite these steps, there is still a need for additional, effective actions to address anadromous fish survival in the Sacramento River, particularly upstream from the RBDD facilities.

Water Supply Reliability

Demands for water in California exceed available supplies. Reclamation's 2008 *Water Supply and Yield Study* describes dramatic increases in statewide population, land use changes, regulatory requirements, and limitations on storage and conveyance facilities, resulting in unmet water demands and subsequent increases in competition for water supplies among urban, agricultural, and environmental uses. The 2009 California Department of Water Resources (DWR) *California Water Plan Update* concludes that California is facing one of the most significant water crises in its history: drought impacts are growing, ecosystems are declining, water quality is diminishing, and climate change is affecting statewide hydrology. Challenges are greatest during drought years when water supplies are less available.

As the population of California grows, and the demand for adequate water supplies becomes more acute, the ability to maintain a healthy and viable industrial and agricultural economy while protecting aquatic species will be increasingly difficult. Compounding these issues, potential effects of climate change such as changes in precipitation patterns, decreases in snowfall, and earlier snowmelt may further increase the demands on available water supplies in the future. As owner and operator of the CVP, one of the largest water

storage and conveyance systems in the world, Reclamation has identified the need to increase the reliability of CVP water deliveries to its water contractors, particularly during dry and critically dry water years. Similar needs and challenges are faced by the SWP and other water projects throughout the State. The SLWRI is being conducted as one of many efforts to improve the reliability of California's water supply.

Other Resources

Other identified problems, needs, and opportunities include the need for restoring ecosystem resources in the Shasta Lake area and downstream along the Sacramento River; the need for additional flood management along the upper Sacramento River; the need for new energy generation, especially from renewable sources such as hydropower; the need for additional recreation opportunities in the north Sacramento Valley; and the need for improving water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta.

Public Involvement and Outreach and Study Management

Public outreach, involvement, and support for development of the Draft Feasibility Report and Preliminary Draft EIS include, a wide range of activities. These activities were designed, in part, to meet requirements of NEPA, Executive Order 12898 (Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations), and President Clinton's April 29, 1994, memorandum regarding the engagement of Federally recognized tribal governments. Reclamation and the cooperating agencies achieve these objectives through continued implementation of the 2003 Reclamation *SLWRI Strategic Agency and Public Involvement Plan*, providing multiple opportunities for the public and stakeholders to participate in development of the SLWRI.

Overall management of the SLWRI and regular engagement of cooperating agencies and other stakeholders occurs through a Project Coordination Team (PCT). Cooperating agencies for the SLWRI, pursuant to NEPA, include the USFS, Colusa Indian Community Council of the Cachil Dehe Band of Wintun Indians, U.S. Army Corps of Engineers (USACE), and U.S. Bureau of Indian Affairs. Other participants in the PCT include U.S. Fish and Wildlife Service (USFWS), NMFS, U.S. Bureau of Land Management, DWR, California Department of Fish and Game (DFG), and other Federal and State agencies. The Study Management Team (SMT) consists of key policy and decision makers with direct influence over policy guidance for the study. The SMT provides overall guidance, suggestions, and comments for the study, representing viewpoints from all participating agencies.

The 2003 Reclamation *Strategic Agency and Public Involvement Plan* was designed to assist communication between the PCT and stakeholders. This plan addresses four objectives, including (1) stakeholder identification, (2) project transparency, (3) issues and concerns resolution, and (4) project implementation. The plan has five main outreach elements: (1) stakeholder and public meetings and workshops, (2) tribal coordination, (3) environmental justice, (4) Technical Working Group coordination, and (5) PCT and SMT activities.

As part of the public involvement plan, briefings and workshops were held in fall 2003 and summer and fall 2004. The 2003 and 2004 briefings and workshops were held primarily to discuss the study and the study objectives, management measures, and plans identified for further development. Public scoping meetings were held in fall 2005, and the SLWRI *Environmental Scoping Report* was completed in February 2006. In addition to these activities, briefings have been provided to various agencies and organizations, including the California Water Commission in 2010 and 2011.

Release of this Draft Feasibility Report, the Preliminary Draft EIS, and their Appendices presents SLWRI findings to date, and provides another opportunity for public and stakeholder input.

A Draft EIS will be prepared considering input from stakeholders and the public and results of updated modeling studies. In accordance with NEPA, a Notice of Availability will be published by the U.S. Environmental Protection Agency, and formal public hearings will be held at that time to receive public and agency comments. The Feasibility Report and EIS will be finalized considering responses to public and agency comments.

Planning Objectives, Constraints, and Considerations

The following sections describe national planning objectives and planning objectives, constraints, and considerations specific to the SLWRI.

National Planning Objectives

The Federal objective is defined in the P&G:

> *The Federal objective of water and related resources project planning is to contribute to national economic development consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements.*

The National Water Resources Planning Policy, specified in the Water Resources Development Act of 2007 (Public Law 110-114, Section 2031), is that Federal water resources investments should reflect national priorities, encourage economic development, and protect the environment by doing the following:

- Seek to maximize sustainable economic development.
- Seek to avoid the unwise use of floodplains and flood-prone areas and minimize adverse impacts and vulnerabilities in any case in which a floodplain or flood-prone area must be used.
- Protect and restore the functions of natural systems and mitigate any unavoidable damage to natural systems.

In consideration of many complex water management challenges and competing demands for limited Federal resources, Federal agencies investing in water resources should strive to maximize public benefits, particularly compared to costs. Public benefits encompass environmental, economic, and social goals; include monetary and nonmonetary benefits; and allow for the inclusion of quantified and unquantified benefits. Stakeholders and decision makers expect the formulation and evaluation of a diverse range of alternative solutions. Such solutions may produce varying degrees of benefits and/or impacts relative to the three goals specified above. As a result, trade-offs among potential solutions will need to be assessed and properly communicated during the decision-making process.

SLWRI-Specific Planning Objectives

On the basis of the identified water resources problems, needs, and opportunities, study authorities, and other pertinent direction, including information contained in the August 2000 CALFED ROD, two primary and five secondary planning objectives were developed. Primary planning objectives are those which specific alternatives are formulated to address. Secondary planning objectives are actions, operations, or features that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary planning objectives.

Primary Planning Objectives

- Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from the RBDD.
- Increase water supply and water supply reliability for agricultural, M&I, and environmental purposes to help meet current and future water demands, with a focus on enlarging Shasta Dam and Reservoir.

Secondary Planning Objectives

- Conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River.
- Reduce flood damage along the Sacramento River.
- Develop additional hydropower generation capabilities at Shasta Dam.
- Maintain and increase recreation opportunities at Shasta Lake.
- Maintain or improve water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta.

Planning Constraints

Planning constraints help guide the feasibility study. Some planning constraints are more rigid than others. Examples of more rigid constraints include congressional direction in study authorizations; other current applicable laws, regulations, and policies; and physical conditions (e.g., topography, hydrology). Water resource planning efforts, such as the CALFED ROD, are less restrictive constraints, but are still influential in guiding the process. Several key constraints identified for the SLWRI are as follows:

- **Study Authorization** – Initial authorization for the SLWRI derives from Public Law 96-375, and additional guidance is contained in Public Law 108-361. These legislative actions authorized an investigation of the potential benefits of enlarging or replacing Shasta Dam and Reservoir.

- **CALFED ROD** – The 2000 CALFED ROD includes program goals, objectives, and projects primarily to benefit the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) system. The objectives of the SLWRI are consistent with the CALFED ROD for Shasta enlargement, as follows:

  > *Expand CVP storage in Shasta Lake by approximately 300,000 acre-feet. Such an expansion will increase the pool of cold water available to maintain lower Sacramento River temperatures needed by certain fish and provide other water management benefits, such as water supply reliability.*

  In addition to enlarging Shasta Dam and Reservoir, the Preferred Program Alternative in the CALFED ROD includes four other surface water and various groundwater storage projects to help reduce the gap between water supplies and projected demands. The CALFED ROD also includes numerous other projects to help improve the ecosystem functions of the Bay-Delta system.

The ROD has been adopted by various Federal and State agencies for further consideration. Developed plans should address the goals, objectives, and programs and projects of the CALFED ROD.

- **Laws, Regulations, and Policies** – Numerous laws, regulations, executive orders, and policies need to be considered, among them the P&G, NEPA, Fish and Wildlife Coordination Act, Clean Air Act, Clean Water Act, National Historic Preservation Act, California Public Resources Code (PRC), Federal and State Endangered Species Acts, California Environmental Quality Act (CEQA), and CVPIA.

Statewide Water Operation Considerations

Planning assumptions and information on water operations used to formulate comprehensive plans for the SLWRI were developed in 2006, and reflect the coordinated CVP and SWP operations described in Reclamation's 2004 *Long-Term CVP Operations Criteria and Plan* (OCAP) and related 2004 *Long-Term CVP and SWP OCAP Biological Assessment* (2004 OCAP BA). Since formulation and evaluation of SLWRI plans, new biological opinions (BO) have been issued on coordinated CVP and SWP operations by USFWS in December 2008 and NMFS in July 2009. Both agencies included a Reasonable and Prudent Alternative (RPA) in their respective BOs.

Several lawsuits were filed challenging the validity of the 2008 USFWS BO and 2009 NMFS BO and Reclamation's acceptance of the RPA included with each BO (*Consolidated Salmonid Cases, Delta Smelt Consolidated Cases*). On November 13, 2009, and March 5, 2010, the District Court for the Eastern District of California (District Court) concluded that Reclamation had violated NEPA by failing to perform any NEPA analysis before provisionally adopting the 2008 USFWS RPA and 2009 NMFS RPA.

On December 14, 2010, the District Court found the 2008 USFWS BO to be unlawful and remanded the BO to USFWS. The District Court issued a similar ruling for the 2009 NMFS BO on September 20, 2011. On May 4, 2011, in the *Delta Smelt Consolidated Cases*, the District Court ordered USFWS to prepare a draft BO by October 1, 2011, which was subsequently extended to an unspecified date to be agreed upon by involved parties. USFWS and Reclamation must prepare a final BO and final NEPA document by November 1, 2013, and December 1, 2013, respectively.

Reclamation and DWR use CalSim-II to study operations, benefits, and effects of new facilities and operational parameters for the CVP and SWP. A set of operational assumptions was developed in 2006 based on water operations described in the 2004 OCAP BA and the Coordinated Operations Agreement between Reclamation and DWR for the CVP and SWP, as ratified by Congress. These assumptions were used to guide development, modeling, and evaluation of potential effects of the No-Action Alternative and comprehensive plans

included in this Draft Feasibility Report and accompanying Preliminary Draft EIS.

The legal challenges and changing environmental conditions result in uncertainty with regard to both current and future operations. These operational uncertainties are likely to continue, and current and future water operation conditions may be different because operational constraints governing water operations are likely to change with release of revised USFWS and NMFS BOs. Modeling studies will be updated to reflect changes in water operations resulting from ongoing OCAP reconsultation and other relevant water resources projects and programs, including, potentially, BDCP/Delta Habitat Conservation and Conveyance Program (DHCCP) efforts. The results of these updated studies will be incorporated into future SLWRI documents.

Other Planning Considerations

Other planning considerations were specifically identified to help formulate, evaluate, and compare initial plans and, later, detailed alternatives. These considerations include coordination with other Federal and State agencies, consistency with planning objectives, avoidance of adverse effects to environmental and cultural resources, consideration of existing projects and programs, a 100-year period of analysis, and a 40-year repayment period for reimbursable costs.

Formulation of Alternative Plans

Consistent with the P&G and NEPA, the plan formulation process for the SLWRI was divided into multiple phases, as shown in Figure ES-4. Plans were developed based on two initial deliberative and iterative steps. First, problems, needs, opportunities, and planning objectives and constraints were specified. Second, a variety of management measures were identified that could be combined into alternative plans.

A management measure is a project action or feature that addresses a specific planning objective. Numerous management measures were identified for each planning objective of the SLWRI. Of the management measures considered, eight measures addressing primary planning objectives were identified for further consideration and potential inclusion in alternative plans. Additionally, eight measures addressing the secondary planning objectives were identified for further consideration and inclusion, if possible and appropriate, in alternative plans. Table ES-1 summarizes the 16 management measures carried forward to address the SLWRI primary and secondary planning objectives.

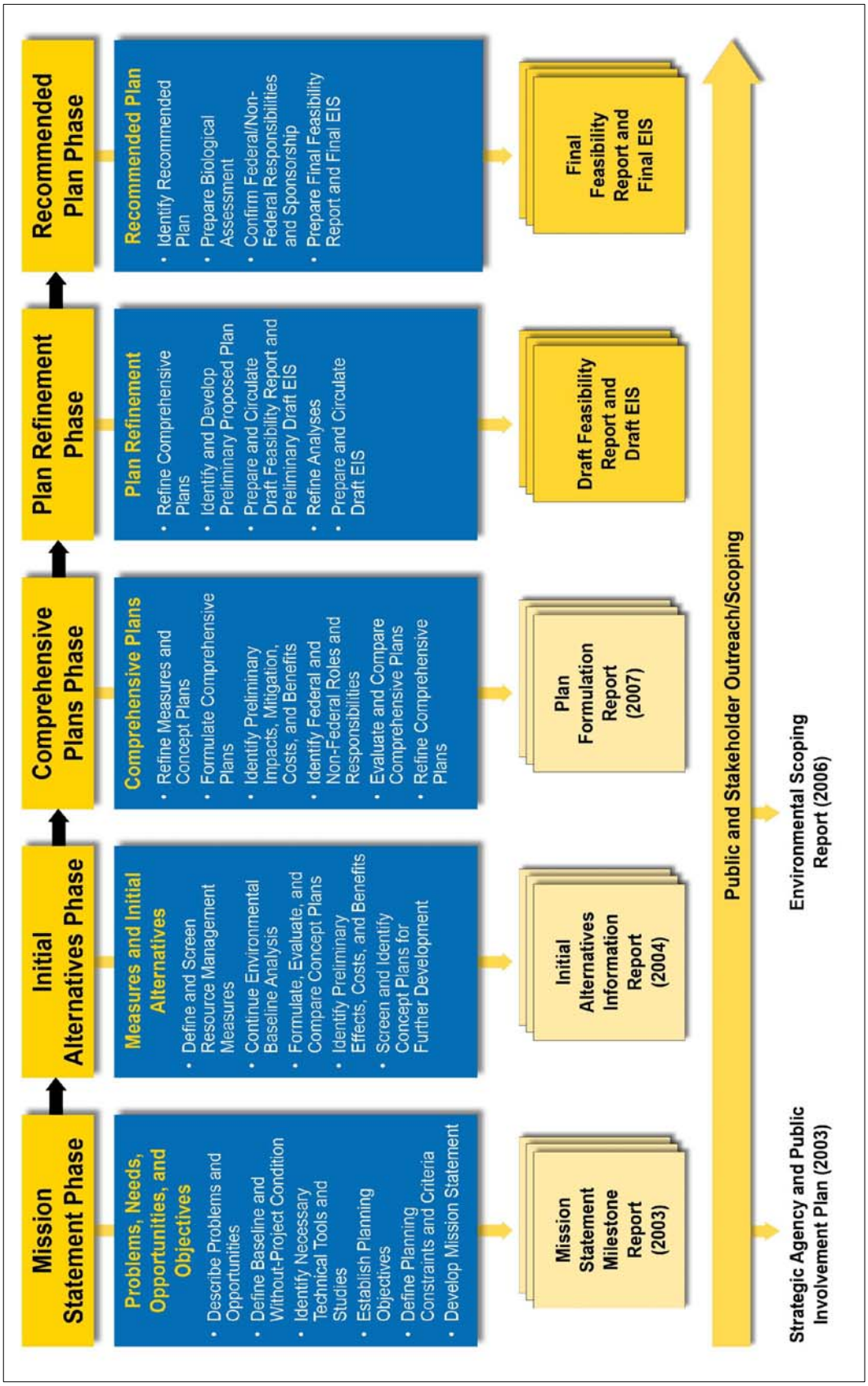


Figure ES-4. Plan Formulation Phases

Table ES-1. Retained Management Measures to Address Planning Objectives

Planning Objective	Resources Management Measure	
	Feature/Activity	**Description**
Primary Planning Objectives		
Increase Anadromous Fish Survival	Construct Instream Aquatic Habitat	Construct instream aquatic habitat downstream from Keswick Dam through side channel restoration
	Replenish Spawning Gravel	Replenish spawning gravel in the Sacramento River
	Modify Temperature Control Device	Make additional modifications to Shasta Dam for temperature control
	Enlarge Shasta Lake Cold-Water Pool	Raise Shasta Dam to increase the cold-water pool in the lake to benefit anadromous fish
	Modify Storage and Release Operations at Shasta Dam	Modify storage and release operations at Shasta Dam to benefit anadromous fish (included as part of adaptive management strategy)
Increase Water Supply Reliability	Increase Conservation Storage	Increase conservation storage space in Shasta Reservoir by raising Shasta Dam
	Reoperate Shasta Dam	Increase the effective conservation storage space in Shasta Reservoir by increasing the efficiency of reservoir operation for water supply reliability
	Reduce Demand	Identify and implement, to the extent possible, water use efficiency methods
Secondary Planning Objectives		
Conserve, Restore, and Enhance Ecosystem Resources	Restore Shoreline Aquatic Habitat	Construct shoreline fish habitat around Shasta Lake
	Restore Tributary Aquatic Habitat	Construct instream fish habitat on tributaries to Shasta Lake
	Restore Riparian Habitat	Restore riparian and floodplain habitat along the upper Sacramento River
Reduce Flood Damage	Modify Flood Operations Guidelines	Update Shasta Dam and Reservoir flood management operations
Develop Additional Hydropower Generation	Modify Hydropower Facilities	Modify existing/construct new generation facilities at Shasta Dam to take advantage of increased head
Maintain and Increase Recreation	Maintain and Enhance Recreation Facilities	Maintain and enhance recreation capacity, facilities, and opportunities
	Reoperate Reservoir	Increase recreation use by stabilizing early season filling in Shasta Lake
Maintain or Improve Water Quality	Maintain or Improve Water Quality	Improve operational flexibility for Delta water quality by increasing storage in Shasta Reservoir

Key:
Delta = Sacramento-San Joaquin Delta

Concept plans (plans that are conceptual in scope) were formulated from the management measures carried forward. The purpose of this phase of the formulation process was to (1) explore an array of different strategies to address the primary planning objectives, constraints, and considerations, and (2) identify concepts that warranted possible further development. The concept plans were intended to promote discussion and provide a background for the formulation of comprehensive plans in the remainder of the feasibility study, with input from participating agencies, stakeholders, and the public. The initial concept plans, and the concept plans carried forward for further development, were described in the Reclamation 2004 *Initial Alternatives Information Report* (IAIR), which was presented in a public workshop in Redding in October 2004, and used to help conduct the environmental scoping process in fall 2005.

Five comprehensive plans were formulated in addition to a No-Action Alternative, based on evaluation and refinement of the management measures and concept plans carried forward, comments received on the IAIR, input from the public scoping process, consideration of the four P&G planning criteria (completeness, effectiveness, efficiency, and accountability), and continued coordination. These five comprehensive plans were described in the Reclamation 2007 *Plan Formulation Report*.

Alternatives Considered and Eliminated

The comprehensive plans described in the *Plan Formulation Report* have been refined through technical studies and evaluations; these five comprehensive plans are the alternatives presented in this Draft Feasibility Report and Preliminary Draft EIS. Some actions considered during the plan formulation process were not retained for inclusion in comprehensive plans because the actions did not adequately meet, or were beyond the scope of, the purpose of and need for the SLWRI; did not contribute to both primary planning objectives; were not cost-effective; or had high social or environmental effects.

No-Action Alternative and Comprehensive Plans

The No-Action Alternative and five comprehensive plans are described briefly below. Each of the five comprehensive plans includes enlarging Shasta Dam and Reservoir and a variety of measures to address, in varying degrees, all of the SLWRI planning objectives. All of the comprehensive plans include eight common management measures:

- Enlarge Shasta Lake cold-water pool
- Modify temperature control device
- Increase conservation storage
- Reduce demand
- Modify flood operations

- Modify hydropower facilities
- Maintain and increase recreation opportunities
- Maintain or improve water quality

No-Action Alternative (No Additional Federal Action)

Under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, but would not take additional actions toward implementing a plan to raise Shasta Dam to help increase anadromous fish survival in the upper Sacramento River; help address water supply reliability issues in California; or help restore ecosystem resources, develop additional hydropower generation, reduce flood damage, increase recreation opportunities at Shasta Lake, or improve water quality in the Sacramento River and the Delta. Reasonably foreseeable actions include actions with current authorization, secured funding for design and construction, and environmental permitting and compliance activities that are substantially complete. The No-Action Alternative provides a basis for comparing the potential benefits and effects of the comprehensive plans.

Comprehensive Plan 1 (CP1) – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1	
Dam Raise	*6.5 feet*
Increased Storage	*256,000 acre-feet*
Focus	*Anadromous Fish Survival & Water Supply Reliability*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Mitigation Measures

CP1 consists primarily of raising Shasta Dam by 6.5 feet and implementing the eight common management measures described above, with a focus on both increasing anadromous fish survival and increasing water supply reliability. Raising Shasta Dam by 6.5 feet, in conjunction with spillway modifications, would result in an increase in full pool depth of 8.5 feet and an additional 256,000 acre-feet of storage capacity in Shasta Reservoir. Operations for water supply, environmental requirements, and hydropower would be similar to existing operations. Enlarging Shasta Reservoir would increase the depth and volume of the cold-water pool, increasing the ability of Reclamation to release cold water from Shasta Dam and regulate seasonal water temperatures for fish in the upper Sacramento River during critical periods. CP1 would also help reduce future water shortages through increasing water supply reliability for irrigation and M&I deliveries primarily during drought periods.

Comprehensive Plan 2 (CP2) – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP2 consists primarily of raising Shasta Dam by 12.5 feet and implementing the eight common management measures described above, with a focus on both increasing anadromous fish survival and increasing water supply reliability. Raising Shasta Dam by 12.5 feet, in conjunction with spillway modifications, would result in an increase in full pool depth of 14.5 feet and an additional 443,000 acre-feet of storage capacity in Shasta Reservoir. Operations for water supply, environmental requirements, and hydropower would be similar to existing operations. CP2 would increase the ability of Shasta Dam to regulate seasonal water temperatures for fish, primarily during critical periods, and would help reduce future water shortages through increasing water supply reliability for irrigation and M&I deliveries.

CP2	
Dam Raise	*12.5 feet*
Increased Storage	*443,000 acre-feet*
Focus	*Anadromous Fish Survival & Water Supply Reliability*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Mitigation Measures

Comprehensive Plan 3 (CP3) – 18.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

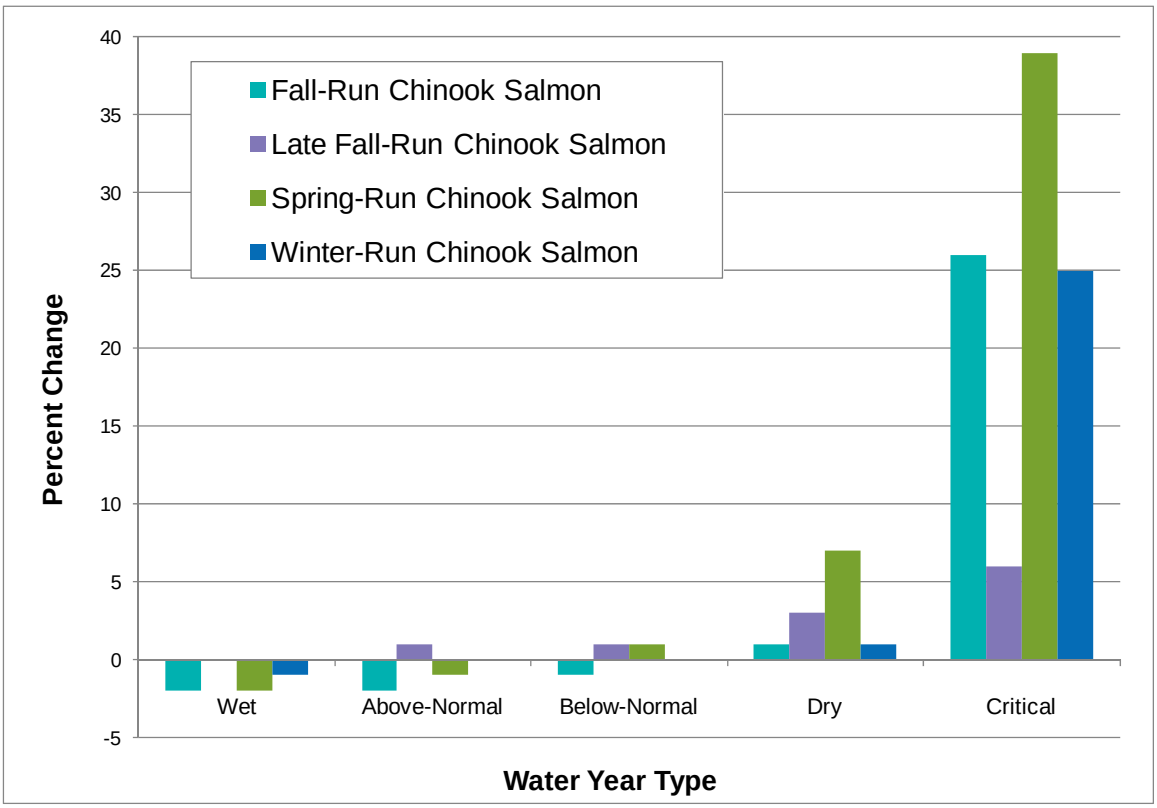
CP3 consists primarily of raising Shasta Dam by 18.5 feet and implementing the eight common management measures described above, with a focus on both increasing anadromous fish survival and increasing water supply reliability. Although higher dam raises are technically feasible, 18.5 feet is the largest dam raise that would avoid extensive and costly relocations, including moving the Pit River Bridge and Interstate 5. Raising Shasta Dam by 18.5 feet, in conjunction with spillway modifications, would result in an increase in full pool depth of 20.5 feet and an additional 634,000 acre-feet of storage capacity in Shasta Reservoir. Operations for water supply, environmental requirements, and hydropower would be similar to existing operations. CP3 would increase the ability of Shasta Dam to regulate seasonal water temperatures for fish, primarily during critical periods, and would help reduce future water shortages through increasing water supply reliability for irrigation and M&I deliveries.

CP3	
Dam Raise	*18.5 feet*
Increased Storage	*634,000 acre-feet*
Focus	*Anadromous Fish Survival & Water Supply Reliability*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Mitigation Measures

Comprehensive Plan 4 (CP4) – 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4	
Dam Raise	*18.5 feet*
Increased Storage	*634,000 acre-feet*
Focus	*Anadromous Fish Survival with Water Supply Reliability*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Adaptive Management (Reserving 378,000 acre-feet of Storage for Cold-Water Pool)
	Augment Spawning Gravel
	Restore Riparian, Floodplain, & Side Channel Habitat
	Mitigation Measures

CP4 consists primarily of raising Shasta Dam by 18.5 feet and implementing the eight common management measures, similar to CP3. As with CP3, this raise would increase the full pool depth by 20.5 feet and enlarge total reservoir storage capacity by 634,000 acre-feet. The additional storage would be used to increase anadromous fish survival (see Figure ES-5), while also increasing water supply reliability. Of the increased reservoir storage space, about 378,000 acre-feet would be dedicated to maintaining the cold-water volume in Shasta Reservoir or augmenting flows, as part of an adaptive management plan for anadromous fish. Operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as for CP1. CP4 also includes augmenting spawning gravel and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River. In addition to increasing anadromous fish survival, CP4 would also help reduce future water shortages through increasing water supply reliability for irrigation and M&I deliveries primarily during drought periods.



Note: Changes in outmigrating Chinook salmon simulated using SALMOD; Water Year Types Based on the Sacramento Valley Water Year Hydrologic Classification

Figure ES-5. Percent Change in Outmigrating Chinook Salmon for CP4

Comprehensive Plan 5 (CP5) – 18.5-Foot Dam Raise, Combination Plan

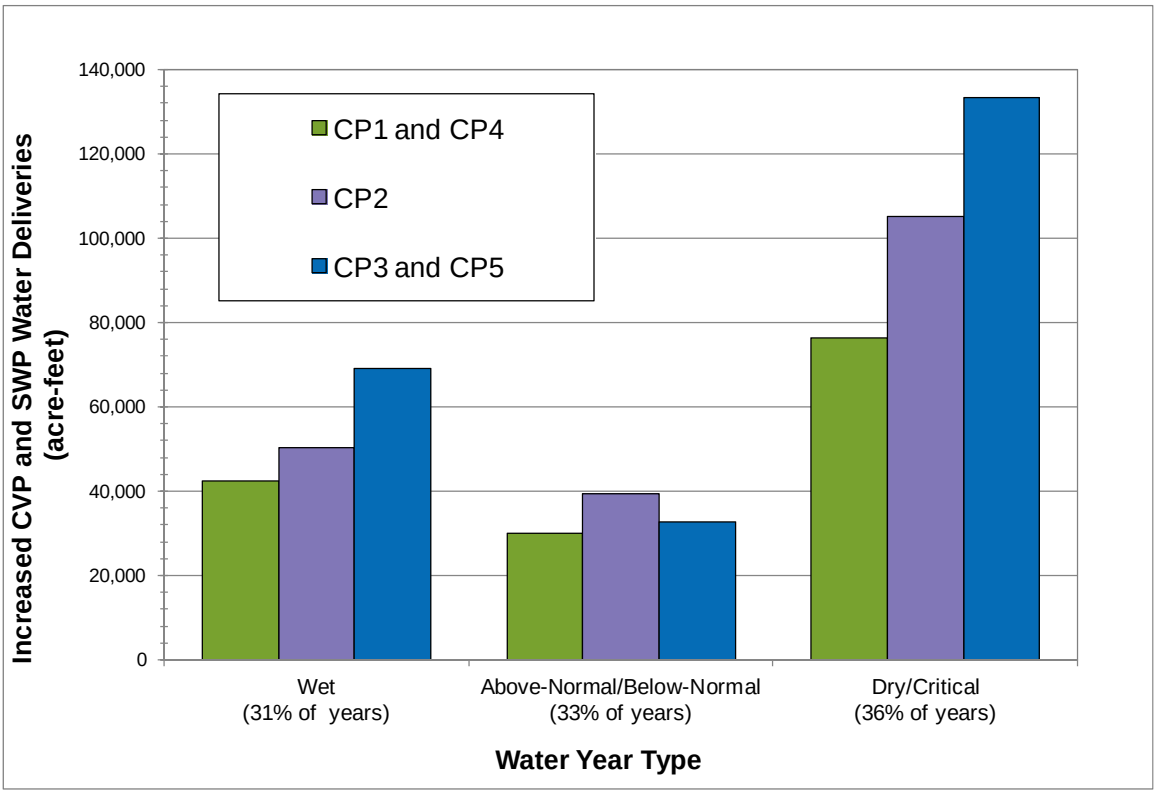
CP5	
Dam Raise	*18.5 feet*
Increased Storage	*634,000 acre-feet*
Focus	*Water Supply Reliability, Anadromous Fish Survival, Ecosystem Restoration, and Recreation*
Major Components	*Dam Modifications & Reservoir Area Relocations*
	Construct Resident Fish Habitat at Shasta Lake & along Tributaries
	Augment Spawning Gravel
	Restore Riparian, Floodplain, & Side Channel Habitat
	Increase Recreation Opportunities
	Mitigation Measures

CP5 consists primarily of raising Shasta Dam by 18.5 feet and implementing the eight common management measures, similar to CP3, but with a focus on addressing both the primary and secondary planning objectives. In addition, CP5 includes (1) restoring fisheries and riparian habitat at several locations along the lower reaches of the tributaries to Shasta Lake, (2) restoring resident fish habitat in Shasta Lake, (3) augmenting spawning gravel in the upper

Sacramento River, (4) restoring riparian, floodplain, and side channel habitat along the upper Sacramento River, and (5) increasing recreation opportunities at Shasta Lake. Under CP5, operations, and benefits to anadromous fish survival and water supply reliability, would be similar to CP3.

Summary of Comprehensive Plan Features, Benefits, and Costs

Each of the comprehensive plans involves raising Shasta Dam by 6.5 feet to 18.5 feet, increasing the storage capacity in Shasta Reservoir by 256,000 acre-feet to 634,000 acre-feet, and implementing the eight common management measures. For all of the comprehensive plans, the additional storage would be used to increase the ability of Reclamation to regulate water temperatures for anadromous fish and increase water supply reliability for irrigation and M&I deliveries (Figure ES-6), primarily in drought periods. Table ES-2 summarizes the potential benefits and costs for each comprehensive plan. As shown in Table ES-2, each of the comprehensive plans would contribute in varying degrees to all of the primary and secondary planning objectives, and all of these plans would have net economic benefits, except CP2.



Note: Deliveries were simulated using CalSim-II and water year types were based on the Sacramento Valley Water Year Hydrologic Classification.

Figure ES-6. Comparison of Increased Water Deliveries by Water Year Type

Table ES-2. Summary of Potential Benefits and Estimated Costs of Comprehensive Plans

Item	CP1	CP2	CP3	CP4	CP5
Raise Shasta Dam (feet)	**6.5**	**12.5**	**18.5**	**18.5**	**18.5**
Total Increased Reservoir Storage (TAF)	256	443	634	634	634
Benefits					
Increase Anadromous Fish Survival					
Dedicated Reservoir Storage (TAF)	-	-	-	378	-
Increase in Outmigrating Chinook Salmon (thousand fish)[1]	366	234	607	1,199	607
Spawning Gravel Augmentation (tons)[2]	-	-	-	10,000	10,000
Side Channel Rearing Habitat Restoration (miles)	-	-	-	0.8	0.8
Increase Water Supply Reliability					
Total Increased Firm Water Supplies (TAF/year)[3]	76.4	105.1	133.4	76.4	133.4
Increased Firm Water Supplies NOD (TAF/year)[3]	9.6	19.8	29.6	9.6	29.6
Increased Firm Water Supplies SOD (TAF/year)[3]	66.8	85.3	103.8	66.8	103.8
Increased Water Use Efficiency Funding	Yes	Yes	Yes	Yes	Yes
Increased Emergency Water Supply Response Capability	Yes	Yes	Yes	Yes	Yes
Reduce Flood Damages					
Increased Reservoir Capacity for Capture of High Flows	Yes	Yes	Yes	Yes	Yes
Develop Additional Hydropower Generation					
Increased Hydropower Generation (GWh/year)	42	68	96	138	96
Ecosystem Restoration					
Shoreline Enhancement (acres)	-	-	-	-	130
Tributary Aquatic Habitat Enhancement (miles)[4]	-	-	-	-	6
Riparian, Floodplain, and Side Channel Habitat Restoration (acres)	-	-	-	2.9	2.9
Increased Ability to Meet Flow and Temperature Requirements Along Upper Sacramento River	Yes	Yes	Yes	Yes	Yes
Maintain or Improve Water Quality					
Improved Delta Water Quality	Yes	Yes	Yes	Yes	Yes
Increased Delta Emergency Response Capability	Yes	Yes	Yes	Yes	Yes
Maintain and Increase Recreation					
Recreation (increased user days, thousands)[5]	83	141	224	224	224
Modernization of Relocated Recreation Facilities	Yes	Yes	Yes	Yes	Yes
Economics ($millions)[6]					
Cost					
Construction Cost	827	913	1,064	1,070	1,073
Annual Cost	42.6	46.4	53.7	54.0	54.1
Annual Economic Benefits [7]					
Estimated Value (at inflation)[8]	47.6	43.7	65.4	92.2	65.5
Estimated Value (2% above inflation)[9]	68.8	64.6	88.7	117.2	89.3
Net Economic Benefits[7]					
Estimated Value (at inflation)[8]	5.0	- 2.7	11.7	38.2	11.4
Estimated Value (2% above inflation)[9]	26.2	18.1	35.1	63.3	35.2

Notes:

[1] Average annual increase in juvenile Chinook salmon outmigrating downstream from the Red Bluff Diversion Dam.

[2] Average amount per year for 10-year period.

[3] Total increased dry and critical year deliveries.

[4] Provides fishery connectivity.

[5] Visitor days and recreation values are at least equal to numbers shown.

[6] Based on April 2010 price levels, 4-1/8 discount rate, and 100-year period of analysis.

[7] Only includes increases in outmigrating Chinook salmon, firm water deliveries, hydropower generation, and recreation.

[8] Assumes the costs of water supplies and hydropower increase at the same rate as inflation.

[9] Assumes water supply and hydropower costs increase at 2 percent above inflation.

[10] Full notes and an expanded key for this table can be found in Chapter 4 of this Draft Feasibility Report in Table 4-7.

Key:
- = not applicable

GWh/year = gigawatt-hours per year
NOD = north of Delta

SOD = south of Delta
TAF = thousand acre-feet

Summary of Potential Environmental Effects

A thorough evaluation of environmental effects was performed as part of the NEPA process. The accompanying Preliminary Draft EIS summarizes the environmental impacts of the comprehensive plans, the duration and quantification of each impact, the level of significance of each impact before mitigation, recommended mitigation measures and the level of significance of each impact after mitigation. The Preliminary Draft EIS also describes the environmental commitments common to all comprehensive plans, short-term use of the human environment, maintenance and enhancement of long-term productivity, and potential irreversible or irretrievable commitments of resources for the comprehensive plans.

All comprehensive plans are similar in terms of their potential environmental effects, although some adverse effects would be exacerbated by larger dam raises and by the associated scale of the effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Generally, adverse effects would be mitigated to less-than-significant levels with prescribed mitigation measures. Some adverse effects for all of the comprehensive plans would remain unavoidable despite mitigation measures. Adverse effects such as altered flow regimes along the Sacramento River, changes to the areas inundated by Shasta Lake, and disturbances associated with construction activities have the potential to affect environmental resources. However, these adverse effects would be mitigated to the extent practicable.

CP1 and CP2 would impact resources within the dam inundation area less than the other comprehensive plans because CP1 and CP2 would raise the dam by 6.5 feet and 12.5 feet, respectively, compared to the 18.5-foot increase proposed for CP3, CP4, and CP5. However, a majority of the reservoir area relocations are required under any dam raise.

Plan Evaluation and Comparison

Four accounts have been established to display, and facilitate evaluation of, the effects of alternative plans: National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). These four accounts encompass all significant effects of a plan on the human environment, as required by NEPA (42 U.S. Code 4321 et seq.). Under the P&G, the NED account is the only required account. The other accounts are only required if by law, or if they have a material bearing on the decision-making process.

As shown in Table ES-3, all comprehensive plans except CP2 are cost-efficient, providing positive net NED benefits. Based on analysis to date, CP4 would generate the maximum net economic benefits, $38.2 million annually, assuming the cost of water supply increases at the same rate as inflation. A sensitivity

analysis was also performed assuming that water supply and hydropower costs would increase above the inflation rate, to account for potential growing scarcity of water and energy supplies in the future and increasing demands. Assuming an increase of water supply and hydropower costs at 2 percent above inflation, CP4 would generate $63.3 million in net benefits.

Table ES-3. Summary of Annual Costs and Economic Benefits[1]

Item	CP1	CP2	CP3	CP4	CP5
Annual Cost ($ millions)					
Total Annual Cost	42.6	46.4	53.7	54.0	54.1
Annual Economic Benefits ($ millions)					
Estimated Value (at inflation)[2]	47.6	43.7	65.4	92.2	65.5
Estimated Value (2% above inflation)[3]	68.8	64.6	88.7	117.2	89.3
Benefit/Cost Ratio					
Estimated Value (at inflation)[2]	1.12	0.94	1.22	1.71	1.21
Estimated Value (2% above inflation)[3]	1.62	1.39	1.65	2.17	1.65
Net Economic Benefits ($ millions) [4]					
Estimated Value (at inflation)[2]	5.0	(2.7)	11.7	38.2	11.4
Estimated Value (2% above inflation)[3]	26.2	18.1	35.1	63.3	35.2

Notes:
[1] Based on April 2010 price levels, a 100-year period of analysis, and 4-1/8 percent interest rate.
[2] Assumes the costs of water supplies and hydropower increases at the same rate as inflation.
[3] Includes increase of water supply and hydropower costs at 2 percent above inflation
[4] All numbers are rounded for display purposes; therefore, net values may not sum.

The comprehensive plans were also compared based on the planning objectives and the four P&G criteria of completeness, effectiveness, efficiency, and acceptability. It was found that, at this stage of the SLWRI planning process, all comprehensive plans ranked similarly. Each of the plans is estimated to be complete and each appears to be effective in achieving its intended objectives. Each comprehensive plan would contribute to the objectives of the CVPIA, and also would contribute directly and indirectly, in varying degrees, to the four CALFED objectives of water quality, water supply reliability, ecosystem quality, and Delta levee integrity.

Comprehensive plans involving a 6.5-foot and 12.5-foot raise of Shasta Dam require the majority of the construction and annual costs associated with an 18.5-foot dam raise, as shown in Table ES-2, as well as the majority of environmental effects from reservoir area relocations, but provide only a portion increased storage capacity of an 18.5-foot raise. Based on studies to date, the three comprehensive plans involving a dam raise of 18.5 feet (CP3, CP4, and CP5) best address the planning objectives. This is primarily because of (1) a high certainty (completeness) that the plans could achieve their intended benefits and (2) relatively high effectiveness and economic efficiency. At this stage of the planning process, CP4 has the potential to provide the greatest net economic benefits based on analysis to date.

Rationale for Selection of a Recommended Plan

A plan recommending Federal action is to be the plan that best addresses the targeted water resources problems, considering public benefits relative to costs. The basis for selecting the recommended plan is to be fully reported and documented, including the criteria and considerations used in selecting a recommended course of action by the Federal Government. When the Feasibility Report and EIS are finalized, the Secretary of the Interior will use both documents and supporting information to provide a recommendation to Congress. This recommendation will be documented in a ROD and used by the U.S. Congress, along with the finalized Feasibility Report and EIS, to determine interest in, and the form of, project authorization if a plan is recommended for implementation. Most of the activities pursued by the Federal Government require assessing trade-offs and, in many cases, the final decision requires judgment regarding the appropriate extent of monetized and nonmonetized benefits and impacts.

At this stage of the Federal planning and NEPA processes (as described in this Draft Feasibility Report and the Preliminary Draft EIS), the potential effects of the comprehensive plans have been evaluated and compared based on established criteria. As a result, an 18.5-foot raise of Shasta Dam has been identified as the preliminary proposed plan at this time because it appears feasible under a variety of operations.

Operation of the existing CVP and SWP may change as a result of the ongoing OCAP reconsultation, and the proposed plan for operating an enlarged dam and reservoir is uncertain at this time. Operations of the preliminary proposed plan are still being refined based on updates to modeling studies and input from agencies, stakeholders, and the public.

Major components, benefits, and effects of the preliminary proposed plan would be similar to CP3, CP4, and CP5, but it is recognized that changes may occur to the comprehensive plans with changes in water operations and other relevant water resources projects and programs, including, potentially, BDCP/DHCCP efforts. Ultimately, the alternative that best meets the stated planning objectives, maximizes net public benefits, and is determined to be technically, environmentally, economically, and financially feasible, will be identified in the Final Feasibility Report and FEIS with supporting rationale and documentation.

Determination of Feasibility of Preliminary Proposed Plan

Project feasibility includes the following four elements:

- Technical feasibility, consisting of engineering, operations, and constructability analyses verifying that it is physically and technically possible to construct, operate, and maintain the project.

- Environmental feasibility, consisting of analyses verifying that constructing or operating the project will not result in unacceptable environmental consequences to endangered species or cultural, Indian trust, or other resources.

- Economic feasibility, consisting of analyses verifying that constructing the project is an economically sound investment of capital (i.e., that the project would result in positive net benefits or that the project's benefits would exceed the costs).

- Financial feasibility, entailing examining and evaluating project beneficiaries' ability to repay their appropriate portion of the Federal investment in the project over a period of time, consistent with applicable law.

Evaluations of the technical, environmental, and economic feasibility of the preliminary proposed plan to raise Shasta Dam by 18.5 feet are based on evaluations of CP3, CP4, and CP5. For the purpose of illustrating financial feasibility, CP4 is used as an example to characterize cost allocation, cost assignment, and the ability to pay analysis of the preliminary proposed plan. As discussed above, further refinements to the measures and comprehensive plans are expected after additional water operations and related analyses.

Technical Feasibility

The preliminary proposed plan is projected to be technically feasible, constructable, and can be operated and maintained. Designs and cost estimates for raising Shasta Dam by 18.5 feet have been developed to a feasibility level. A Design, Estimating and Construction (DEC) Review was performed by Reclamation in August 2008 for all of the 18.5-foot dam raise options (CP3, CP4, and CP5). Based on recommendations from the DEC Review, designs and costs were refined to bring all features to a feasibility level. The DEC Review concluded that when the DEC recommendations were adequately addressed, all of the 18.5-foot dam raise alternatives would be at a level suitable (i.e., feasibility level) for use for congressional authorization and appropriation.

Environmental Feasibility

All of the comprehensive plans are included in the SLWRI Preliminary Draft EIS. Environmental effects were evaluated and mitigation measures for each of the comprehensive plans were identified. At this stage in the planning process, an Environmentally Preferable Alternative has not been identified in the Preliminary Draft EIS. An Environmentally Preferable Alternative, consistent with NEPA, will be identified in the Final Feasibility Report and FEIS. Based on current CVP/SWP operational assumptions and studies to date, CP4 appears to provide the greatest environmental benefits; however, it is recognized that further refinement and changes may occur to this and other alternatives after additional analyses and responses to comments by agencies, stakeholders, and the public.

As part of the project planning and environmental assessment process, Reclamation and the State CEQA lead agency would incorporate certain environmental commitments and best management practices into any plan selected to avoid or minimize potential effects. Reclamation has also committed, contingent on congressional authorization, to coordinate the planning, engineering, design and construction, and operations and maintenance phases of the project with applicable resource agencies.

Economic Feasibility

Based on evaluations of CP3, CP4, and CP5, the preliminary proposed plan is projected to be economically feasible, and would generate net positive NED benefits ranging from $11.4 million to $38.2 million annually, assuming water supply and hydropower costs increase at the same rate as inflation. Assuming an increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity of water and energy supplies in the future and increasing demand, the project would generate net benefits ranging from $35.1 million to $63.3 million annually. At this time, based on analyses to date, operations under CP4 would provide the greatest net NED benefits of the alternatives evaluated.

Financial Feasibility

Financial feasibility consists of (1) an allocation of costs to project purposes, (2) determination of reimbursable and nonreimbursable costs, (3) commitment by project beneficiaries to pay the reimbursable costs, and (4) determination of project beneficiaries' ability to pay their allocated costs, including capital costs and operations, maintenance, and replacement costs. Based on analysis to date, CP4 provides the greatest net NED benefits. For this reason, CP4 is used as an example in the following subsections to characterize the financial feasibility of the preliminary proposed plan.

Preliminary Cost Allocation

A separable costs-remaining benefits (SC-RB) analysis was performed for CP4. It is important to note that the largest portion of the costs (total cost of $1,070 million) would be expended to implement plan features required to accomplish the primary planning objectives. The allocation of costs using the SC-RB method and a 100-year period of analysis for impacts and benefits is summarized in Table ES-4.

Cost Assignment

Table ES-5 illustrates assignment of costs of the preliminary proposed plan using CP4 as an example. The assignment percentages are based on percentages shown in Table ES-4. As can be seen, the assignment of costs includes costs to accomplish four project purposes (irrigation water supply, municipal and industrial water supply, fish and wildlife enhancement, and hydropower) consistent with the planning objectives. The only costs allocated to a nonreimbursable category are for fish and wildlife enhancement corresponding to the anadromous fish survival objective. As shown in Table

ES-5 for the example plan, of the allocated costs, approximately 61 percent are estimated to be nonreimbursable and approximately 39 percent would be reimbursable.

Table ES-4. Example Construction Cost Allocation Summary Using CP4

Item/ Calculation	Irrigation Water Supply	M&I Water Supply	Fish and Wildlife Enhancement	Hydro-power	Total
Allocated Total Annual Costs ($ millions)					
Average Annual Benefits	8.3	18.7	49.2	7.7	83.9
Single-Purpose Projects	23.8	18.8	49.7	7.7	-
Benefit Limited by Single Purpose	8.3	18.7	49.2	7.7	83.9
Separable Annual Costs	4.8	6.2	11.4	0.0	22.5
Remaining Benefits	3.5	12.5	37.8	7.7	61.4
% Remaining Benefits	5.7%	20.3%	61.5%	12.5%	100.0%
Allocated Remaining Joint Cost	1.8	6.4	19.4	3.9	31.5
Total Allocated Costs	6.6	12.6	30.8	3.9	54.0
Allocated Construction Costs ($ millions)					
Construction Cost	132.5	198.6	654.9	84.0	1,069.9
% of Total Construction Cost	12.4%	18.6%	61.2%	7.9%	100.0%

Notes:
[1] Based on April 2010 price levels, 4-1/8 percent interest rate, and 100-year period of analysis.
[2] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
[3] Subject to refinement/change during remainder of feasibility study.

Key:
- = not applicable
IDC = interest during construction
M&I = municipal and industrial
O&M = operations and maintenance

Table ES-5. Example Construction Cost Assignment Using CP4

Purpose /Action	Total		Cost Assignment			
			Nonreimbursable		Reimbursable	
	Percent	Cost ($ millions)	Percent	Cost ($ millions)	Percent	Cost ($ millions)
Irrigation Water Supply	12.4%	132.5	0%	0.0	100%	132.5
Municipal and Industrial Water Supply	18.6%	198.6	0%	0.0	100%	198.6
Fish and Wildlife Enhancement	61.2%	654.9	100%	654.9	0%	0.0
Hydropower	7.9%	84.0	0%	0.0	100%	84.0
Total	100.0%	1,069.9	61.2%	100.0	38.8%	100.0

Notes:
[1] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
[2] Subject to refinement/change during remainder of feasibility study.

Financial Analyses Similar to the preliminary cost allocation and cost assignment analyses, CP4 is used as an example to characterize the financial feasibility of the preliminary proposed plan. Based on costs allocated to various project purposes for CP4, an assessment of financial repayment capability of project beneficiaries was conducted for two repayment approaches. For irrigation water supply, the marginal increase to CVP water rates is estimated to be either $1.77 or $140 per acre-foot, depending upon the approach. For M&I water supply, the marginal increase to CVP water rates is estimated to be either $51 or $978 per acre-foot, depending upon the approach. For hydropower, it is expected that a 5 percent increase in rates would be supportable by those that purchase power from Western Area Power Administration.

Based on current CVP/SWP operational assumptions and studies to date, under CP4, beneficiaries have the ability to pay depending upon the approach; however, it is recognized that further refinement and changes may occur to this and other alternatives.

Implementation Considerations

The following sections discuss key considerations related to potential project implementation, including risk and uncertainty, unresolved issues, major topics of interest identified through public outreach, implementation requirements, and Federal and non-Federal responsibilities.

Risk and Uncertainty

Certain assumptions were made for aspects of this report based on engineering and scientific judgment. Careful consideration was given to the methodologies and evaluations for hydrology and system operations, cost estimates, and biological analyses. Analyses were developed with advanced modeling and estimating tools using historical data and trends. While this is effective in helping predict outcomes for future operations, biological conditions, and costs, many uncertainties could affect the findings in this Draft Feasibility Report.

Significant uncertainties associated with the SLWRI include the following:

- **Hydrology and Climate Change** – Uncertainty exists regarding the potential for, and magnitude of, climate change causing changes in temperature, precipitation, and snow levels.

- **Water System Operations** – Predictions of future water system operations depend on assumptions about future facilities, operational constraints, and changes in Delta exports based on Federal regulations, including the ongoing OCAP reconsultation, and planning policies that are subject to change.

- **Water Supply Reliability and Demands** – Projecting accurate and quantified water supply and shortages in California is complicated. There are numerous variables and, just as important, numerous opinions regarding these variables, depending on anticipated population growth scenarios, land use patterns, and water use efficiency actions.

- **Anadromous Fish Populations** – Predictions of fish survival require assumptions with various levels of uncertainty, including the future number of spawners returning each year, future habitat conditions outside the project area, and potential effects of climate change. Adaptive management measures can be applied to reduce uncertainty by deliberately and iteratively designing, implementing, monitoring, and adjusting system operations to minimize adverse impacts to fisheries.

- **Cost Estimates** – Varying uncertainties are associated with the material and unit costs used to develop cost estimates, including the price of construction materials and labor costs. Trends from the past few years were used to try to reliably estimate the cost of materials and labor, but other factors could further influence price changes.

Unresolved Issues

Unresolved issues will need to be addressed before potential project implementation. Multiple subject areas need to be considered during upcoming phases of the SLWRI, including the McCloud River, identification of a non-Federal sponsor, Native American and cultural resources, impacts on biological resources and associated off-site mitigation, water rights, and CVP and SWP operational conditions.

McCloud River

Although the McCloud River is not formally designated as a National or State wild and scenic river, Section 5093.542 of the PRC specifies that the McCloud River should be maintained in its free-flowing condition, and its wild trout fishery protected, from 0.25 miles below McCloud Dam downstream to the McCloud River Bridge. Section 5093.542 was established through enactment of the Wild and Scenic Rivers Act, as amended (PRC Sections 5093.50 – 5093.70).

Section 5093.542(c) states the following:

> *Except for participation by the Department of Water Resources in studies involving the technical and economic feasibility of enlargement of Shasta Dam, no department or agency of the state shall assist or cooperate with, whether by loan, grant, license, or otherwise, any agency of the federal, state, or local government in the planning or construction of any dam, reservoir, diversion, or other water impoundment facility that*

> *could have an adverse effect on the free-flowing condition of the McCloud River, or on its wild trout fishery.*

Section 5093.542(d) states the following:

> *All state agencies exercising powers under any other provision of law with respect to the protection and restoration of fishery resources shall continue to exercise those powers in a manner to protect and enhance the fishery [of the protected segments of the McCloud River].*

Participation by various State agencies in planning and potential construction activities associated with modifying Shasta Dam and Reservoir, including related permitting and approval processes, varies by an agency's mandate and PRC Section 5093.542. DFG has taken the position that it must participate in preparing the EIS to comply with Section 5093.542(d). Other State agencies, including DWR and the State Water Resources Control Board (SWRCB), have participated to a limited extent or expressed their intent to participate in the SLWRI. The 2000 CALFED Program Plan states that Section 5093.542 "seeks to protect the free-flowing McCloud River but also provides for investigations for potential enlargement of Shasta Dam." Reclamation will continue to coordinate with the State and potential non-Federal sponsors to develop strategies to support State agency participation in the SLWRI and necessary permitting processes, such as those related to water rights and CEQA.

Non-Federal Sponsor

To date, interest has been expressed in potential project implementation to address the identified SLWRI planning objectives. If authorized for construction, the proposed plan would likely require a portion of its costs to be reimbursed by a non-Federal sponsor(s). Identified reimbursable costs include irrigation water supply, M&I water supply, and hydropower. In April 2009, Reclamation and Westlands Water District signed an *Agreement in Principle for the Potential Sharing of Costs of Enlarging Shasta Dam and Reservoir*.

Native American and Cultural Resources

This Draft Feasibility Report and accompanying Preliminary Draft EIS are consistent with the National Historic Preservation Act Section 106, and describe supporting analyses, studies, coordination, impacts, and mitigation, as necessary. Although no Federally recognized tribes reside in the immediate Shasta Lake area, members of the Winnemem band of the Wintu Indians have raised concerns about potential impacts of enlarging Shasta Dam and Reservoir on sites they value for historical, cultural, and religious significance. Colusa Indian Community Council of the Cachil Dehe Band of Wintun Indians is a cooperating agency for the SLWRI, pursuant to NEPA. The Winnemem Wintu and other tribal groups will continue to have the opportunity to participate, and are anticipated to continue to provide input to the SLWRI through the Section

106 process as an invited consulting party, as well as through the NEPA process.

Impacts on Biological Resources

The physical environment and associated landscapes within and adjacent to the primary study area contain a wide array of habitat used by a diverse assemblage of wildlife with varying habitat needs and home ranges. To date, species-specific surveys performed as part of the SLWRI have included focused investigations for a number of special-status species in the inundation and relocation areas. The scale of these surveys has been limited, and because of a variety of external factors, surveys have not addressed habitat for species with a large home range or at a watershed scale. Therefore, for species that have large home ranges (e.g., Pacific fisher), or that use a wide range of habitats for some aspect of their life history, analyses presented in this document assume presence over a conservatively large geographic area to cover the full range of impacts anticipated for these species.

Off-Site Mitigation for Impacts on Biological Resources

Details about off-site opportunities to mitigate impacts on biological resources in the primary study area are not yet available. Potential mitigation lands containing wetland and special-status species habitat comparable to habitat that would be affected by modifying Shasta Dam and Reservoir have been identified near the study area. How conservation and enhancement efforts on these lands may be applied for mitigation of loss of habitat will be discussed in more detail in future documents.

Water Rights

Improving the reliability of water supplies is a primary planning objective for the SLWRI. Water rights for the expanded Shasta Reservoir, which are appropriated by the SWRCB, must be in place before the project can be operated. Evaluation of water rights will remain a focus of the SLWRI.

Coordinated CVP and SWP Operational Conditions

Planning assumptions and information on water operations used to develop comprehensive plans for the SLWRI were developed in 2006, and reflect the coordinated CVP and SWP operational conditions and criteria described in the 2004 Reclamation OCAP. Since that time, as discussed previously, new BOs have been issued by USFWS and NMFS, and both have been challenged.

The legal challenges and changing environmental conditions result in uncertainty with regard to both current and future operations. These operational uncertainties are likely to continue, and current and future water operations conditions may be different because constraints governing water operations are likely to change with release of revised USFWS and NMFS BOs. Existing SLWRI modeling analyses are being used for comparison purposes, and reflect expected variation among the comprehensive plans, including the type and relative magnitude of anticipated impacts and benefits. Therefore, because of

the lingering uncertainty about future water operations, this Draft Feasibility Report and Preliminary Draft EIS are based on existing studies.

Modeling studies will be updated to reflect changes in water operations resulting from ongoing OCAP reconsultation and other relevant water resources projects and programs, including, potentially, BDCP/DHCCP efforts. The results of these updated studies will be incorporated into future SLWRI documents.

Major Topics of Interest

The public, stakeholders, other Federal agencies, and State and local agencies identified several areas of concern during SLWRI meetings and workshops. The focus of interest varied among participants in the outreach activities, but a common theme centered on potential impacts in the Shasta Lake area that could result from enlargement of the reservoir. Key topics of concern included the following:

- Potential adverse effects on cultural resources in the Shasta Lake area.
- Potential effects on recreation and recreation providers in the Whiskeytown-Shasta-Trinity NRA.
- Potential effects on special-status species around Shasta Lake, including terrestrial State-designated fully protected species and aquatic special-status species in the Sacramento River and in the Delta (e.g., delta smelt).
- Potential effects on the lower McCloud River and its special designation under California PRC 5093.542.
- Potential effects on Delta water quality and south Delta water levels.
- Potential effects on Central Valley hydrology below CVP and SWP facilities and resulting effects on water supplies for water contractors and other water users.
- Consistency with the 2000 CALFED ROD.

Implementation Requirements and Timeline

After the feasibility study is completed, and if a plan has been recommended for approval, a number of requirements will remain before the project can be implemented. These requirements are described below.

Feasibility Report Approval

Reclamation's Final Feasibility Report will be submitted by the Commissioner of Reclamation to the Secretary of the Interior. The Secretary may accept or revise the Final Feasibility Report. After review by the Office of Management

and Budget, in accordance with Executive Order 12322, the Secretary will transmit a Final Feasibility Report, FEIS, and ROD to the U.S. Congress to determine the type and extent of Federal interest in enlarging Shasta Dam and Reservoir if a plan is recommended for implementation.

Project Authorization and Funding

The proposed project would be considered for authorization by Congress and, if authorized, a separate appropriation authorization would be required. The project would be considered for inclusion in the President's budget based on (1) national priorities, (2) magnitude of the Federal commitment, (3) level of local support, (4) willingness of the non-Federal sponsor to fund its share of the project costs, and (5) budgetary constraints that may exist at the time of funding.

Regulatory and Related Requirements for Environmental Compliance

Potential modifications to Shasta Dam and Reservoir would be subject to the requirements of Federal, State, and local laws, policies, and environmental regulations, as described in this Draft Feasibility Report and accompanying Preliminary Draft EIS. Reclamation would need to obtain various permits and regulatory authorizations before any project construction could begin. Major permits and approvals potentially required for project implementation are shown in Table ES-6. These would be in addition to compliance with a number of environmental regulatory requirements as part of the NEPA process.

Federal Responsibilities

If recommended for implementation, Reclamation and/or future project partners or beneficiaries would perform preconstruction and design studies for the recommended plan, which may require updated economic and/or environmental analyses and documentation. After project cooperation agreements are signed and non-Federal sponsors have provided any required financial contributions and assurances, the Federal Government would likely construct the project modifications and related mitigation requirements. Reclamation and other Federal agencies (e.g., USFS) would be responsible for various operations and maintenance activities.

Table ES-6. Summary of Major Permits and Approvals for Project Implementation

Agency Permit/Approval	Recommended Prerequisites for Submittal[1]
Federal	
USACE Clean Water Act Section 404	• Application • ESA compliance document for submittal to USFWS/NMFS/DFG • Section 401 Water Quality Certification permit or application • NEPA documentation (environmental compliance documents) • Section 106 compliance documentation • Wetland delineation • Section 404 (b)(1) evaluation and identification of Least Environmentally Damaging Practical Alternative • Mitigation and monitoring plan
USFWS/NMFS Endangered Species Act Section 7 Consultation	• Regular informal technical consultation • ESA compliance document • Draft environmental compliance documents
USFWS/NMFS/DFG Fish and Wildlife Coordination Act	• Regular informal technical consultation • ESA compliance document • Draft environmental compliance documents
SHPO[2]/ACHP National Historic Preservation Act, Section 106	• Historic Property Inventory Report • Native American consultation
State – PRC 5093.542 (c) and (d), pertaining to the McCloud River, may limit the ability of State agencies to review and process permits and related approvals for modifications of Shasta Dam and Reservoir.	
RWQCB Clean Water Act Section 401	• Application • Fish and Game Code Section 1602 application • CWA Section 404 permit or application • Draft environmental compliance documents • Mitigation and monitoring plan (if needed)
DFG California Endangered Species Act Section 2081 – Incidental Take Permit or 2080.1 Consistency Determination	• Informal technical consultation • Application, if requesting a 2081 Incidental Take Permit • Biological Opinion and incidental take statement, if requesting a consistency determination (preferred approach)
DFG Fish and Game Code Section 1600 Streambed Alteration Agreement	• Application • Section 401 Water Quality Certification permit or application • CWA Section 404 permit or application • Draft environmental compliance documents • Mitigation plan
Central Valley Flood Protection Board California Code, Title 23 – Encroachment Permit	• Application
SWRCB Amended Water Right	• Application • Draft (possibly final) environmental compliance documents
State Lands Commission Land Use Lease	• Application • Draft environmental compliance documents
State of California Department of Transportation Encroachment Permit	• Application • Permit Engineering Evaluation Report

Table ES-6. Summary of Major Permits and Approvals for Project Implementation (contd.)

Agency Permit/Approval	Recommended Prerequisites for Submittal[1]
Local	
SCAQMD Authority to Construct and Permit to Operate	• Application • Preapplication meeting (encouraged)

Notes:
[1] All permit applications require detailed project description information.
[2] PRC 5093.542 (c) and (d), pertaining to the McCloud River, may limit the ability of State agencies to review and process permits and related approvals for modifications of Shasta Dam and Reservoir.
[3] An expanded key for this table can be found in Chapter 5 of this Draft Feasibility Report in Table 5-5.

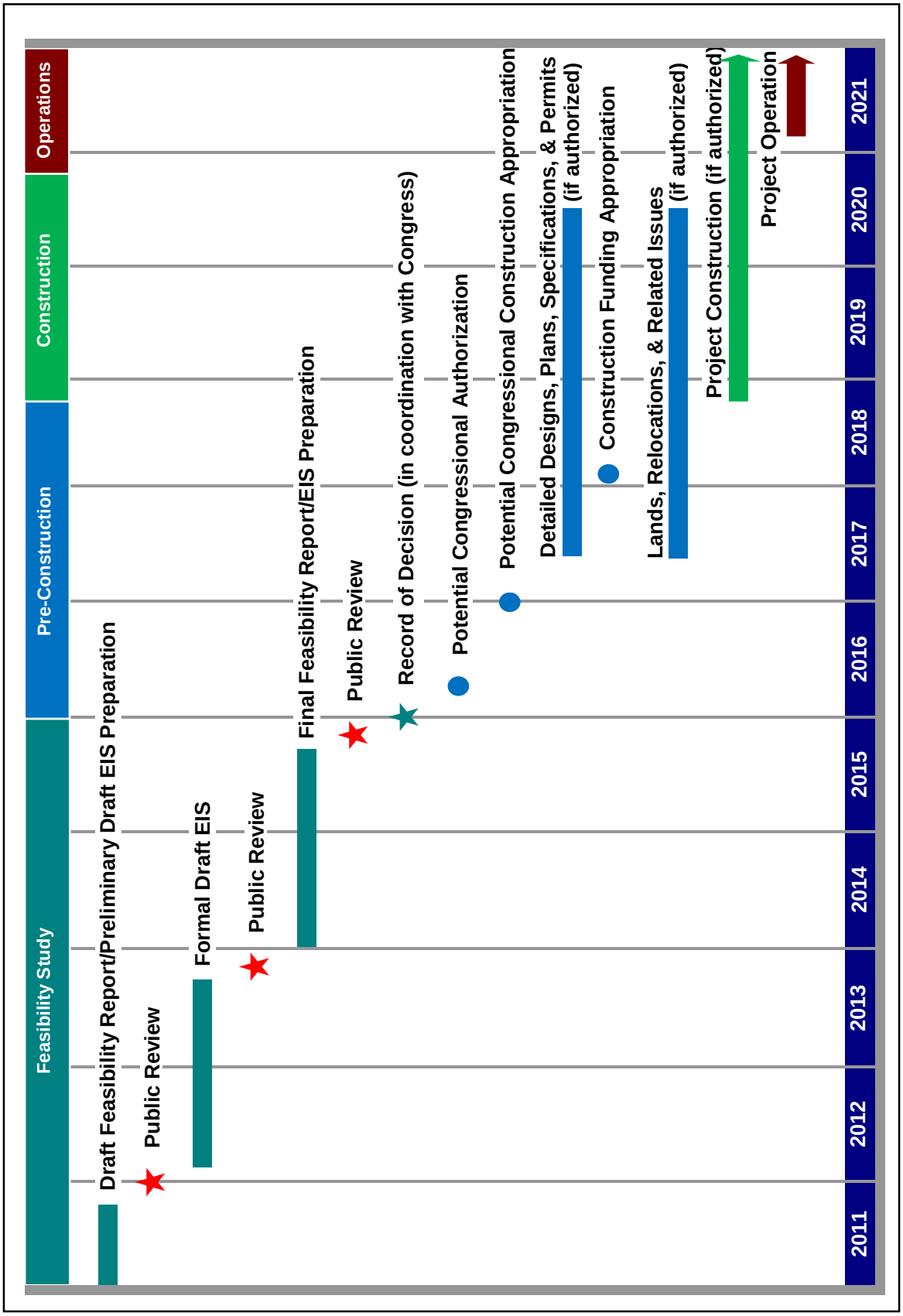
Key:
ACHP = Advisory Council on Historic Preservation
CWA = Clean Water Act
ESA = Endangered Species Act
RWQCB = Regional Water Quality Control Board
SCAQMD = Shasta County Air Quality Management District
SHPO = State Historic Preservation Office

Non-Federal Responsibilities

Before implementation, the non-Federal sponsor(s) for both reimbursable and nonreimbursable costs would agree to perform items of local and state cooperation specific to the authorized purposes of the project. A non-Federal sponsor needs to be identified for each of the reimbursable project purposes. For most and possibly all of the reimbursable purposes, the non-Federal sponsor would need to share in the cost of the recommended plan.

Potential Implementation Timeline

A timeline of major actions to complete the feasibility study and future milestones leading to project implementation are shown in Figure ES-7. If congressional authorization occurs, detailed project designs and any necessary real estate acquisitions could be initiated, and project construction could begin approximately 2 years later. The initial phase of construction would include acquiring any necessary real estate interests and/or relocating displaced parties according to Public Law 91-646, acquiring necessary permits, continuing detailed design work, and relocating infrastructure. Construction activities would likely span 4 or more years.



Note: Subject to refinement/change during remainder of feasibility study.

Figure ES-7. Shasta Lake Water Resources Investigation and Potential Implementation Timeline

Findings

Based on analyses to date, all comprehensive plans to enlarge Shasta Dam and Reservoir appear to be technically and environmentally feasible for implementation by the Federal Government.

Based on analyses to date, all 18.5-foot dam raise alternatives appear to be economically justified for implementation by the Federal Government. The 6.5-foot dam raise alternative is marginally justified.

To date, one comprehensive plan (CP4) has been analyzed for financial feasibility. Based on costs allocated to various project purposes, and the preliminary financial analysis to date, CP4 appears to be financially justified for implementation by the Federal Government.

Next Steps for the Feasibility Study

Based on the findings of the SLWRI to date, the next steps recommended for the feasibility study are as follows:

- Solicit public input on the Draft Feasibility Report and Preliminary Draft EIS.
- Continue to refine and evaluate comprehensive plans and identified measures to respond to public comments and reflect potential changes to existing and likely future conditions. Future evaluations will include continued operations and related modeling to evaluate potential changes to the Sacramento River basin and Delta existing and future conditions resulting from the ongoing OCAP reconsultation and other relevant water resources projects and programs, including, potentially, BDCP/DHCCP.
- Perform a quantitative climate change analysis to describe potential effects that future climate change and revised operations will have on fisheries, water supply, water quality, and other resource areas.
- Develop specific details about off-site opportunities to mitigate impacts on biological resources in the primary study area. Additional discussion of mitigation and associated mitigation ratios for lands around Shasta Reservoir will be developed, as well as detailed mitigation plans and accompanying cost estimates.
- Identify and confirm non-Federal sponsor(s).

- Update estimates of benefits of the comprehensive plans, identify the proposed plan (consistent with the P&G) and the environmentally preferable alternative (consistent with NEPA), and allocate costs to project purposes (e.g., cost allocation). Assess the financial capability of project beneficiaries. In addition, if the California Water Commission's 2012 Water Bond measure passes, investigate use of bond funding for the public benefits of raising Shasta Dam and Reservoir.

- Continue to coordinate with stakeholders and other agencies to address and resolve issues related to Native American and cultural resources, water rights, ongoing biological investigations, and related projects and programs.

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- Water Quality Technical Report

Biological Resources Appendix
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- Botanical Resources Technical Report
- Wildlife Resources Technical Report

Cultural Resources Appendix
- Cultural Technical Report (sensitive; not for public distribution)

Socioeconomics Appendix
- Socioeconomics, Population, and Housing Technical Report
- Power and Energy Technical Report

Fish and Wildlife Coordination Act Report Appendix

Abbreviations and Acronyms

°F	degrees Fahrenheit
2004 NMFS BO	2004 Biological Opinion on the Long-Term CVP and SWP OCAP
2004 OCAP BA	2004 Long-Term CVP and SWP OCAP Biological Assessment
2004 OCAP	2004 Long-Term CVP Operations Criteria and Plan
2005 USFWS BO	2005 Reinitiation of Formal and Early Section 7 ESA Consultation on the Coordinated Operations of the CVP and SWP and the OCAP to Address Potential Critical Habitat Issues
2008 OCAP BA	2008 Biological Assessment on the Continued Long-Term Operations of the CVP and SWP
2008 USFWS BO	2008 Proposed Coordinated Operations of the CVP and SWP
2009 NMFS BO	2009 BO and Conference Opinion on the Long-Term Operations of the CVP and SWP
AFRP	Anadromous Fish Restoration Program
AFS	anadromous fish survival
Bay Area	San Francisco Bay Area
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
BDCP	Bay Delta Conservation Plan
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BO	biological opinion
CALFED	CALFED Bay-Delta Program
CalSim-II	California Statewide Simulation Model
Caltrans	California Department of Transportation
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CMP	Common Model Package
CNPS	California Native Plant Society
CO	combined objective
CP	Comprehensive Plan

CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVPM	Central Valley Production Model
CWA	Clean Water Act
CWC	California Water Code
D-1485	Delta and Suisun Marsh and Water Right Decision 1485
Delta	Sacramento-San Joaquin Delta
DEC	Design, Estimating and Construction
DFG	California Department of Fish and Game
DHCCP	Delta Habitat Conservation and Conveyance Program
District Court	District Court for the Eastern District of California
DSM2	Delta Simulation Model
DWR	California Department of Water Resources
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
EQ	environmental quality
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FWCA	Fish and Wildlife Coordination Act
GWh	gigawatt-hour
HCP	Habitat Conservation Plan
I-5	Interstate 5
IAIR	Initial Alternatives Information Report
IDC	interest during construction
IMPLAN	IMpact analysis for PLANning
Investigation	Shasta Lake Water Resources Investigation
I/O	input/output
IRWMP	Integrated Regional Water Management Plans
kW	kilowatts
LCPSIM	Least Cost Planning Simulation Model
LTGen	LongTermGen
M&I	municipal and industrial
MAF	million acre-feet
MSE	mechanically stabilized earth
MW	megawatt
NCCP	Natural Community Conservation Plans
NCCPA	California Natural Community Conservation Planning Act

NED	national economic development
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NOP	Notice of Preparation
NRA	National Recreation Area
O&M	operations and maintenance
OCAP	Operations Criteria and Plan
OSE	other social effects
P&G	Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies
PAM	Planning Aid Memorandum
PCA	Project Cooperation Agreement
PCT	Project Coordination Team
PG&E	Pacific Gas and Electric Company
PM	particulate matter
PMF	probable maximum flood
PRC	California Public Resources Code
RBDD	Red Bluff Diversion Dam
RBPP	Red Bluff Pumping Plant
RCD	Resource Conservation District
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RED	regional economic development
ROD	Record of Decision
RPA	Reasonable and Prudent Alternative
RWQCB	Regional Water Quality Control Board
SALMOD	Salmonid Population Model
SB	Senate Bill
SCAQMD	Shasta County Air Quality Management District
SC-RB	Separable Costs-Remaining Benefits
SLWRI	Shasta Lake Water Resources Investigation
SMT	Study Management Team
SRCAF	Sacramento River Conservation Area Forum
SRTTG	Sacramento River Temperature Task Group
SRWQM	Sacramento River Water Quality Model
State	State of California
STNF	Shasta-Trinity National Forest
STNF LRMP	*Shasta-Trinity National Forest Land and Resource Management Plan*

SVAB	Sacramento Valley Air Basin
SVWMP	Sacramento Valley Water Management Program
SWP	State Water Project
SWP Power	SWP Power California
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
TCD	temperature control device
TWG	Technical Working Groups
UPRR	Union Pacific Railroad
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAPA	Western Area Power Administration
WQCP	Water Quality Control Plan
WSR	water supply reliability

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Chapter 1
Introduction

Purpose, Scope, and Organization of Draft Feasibility Report

The Shasta Lake Water Resources Investigation (SLWRI or Investigation) is a feasibility study being conducted by the U.S. Department of the Interior, Bureau of Reclamation (Reclamation), in coordination with cooperating agencies, other resource agencies, stakeholders, and the public. The SLWRI is being conducted consistent with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&G) (WRC 1983), National Environmental Policy Act (NEPA), and other pertinent local, State of California (State), and Federal laws and policies. This Draft Feasibility Report evaluates the potential enlargement of Shasta Dam, and has a companion Preliminary Draft Environmental Impact Statement (EIS), published under separate cover.

Figure 1-1. Location of Shasta Dam and Reservoir

Major previous Reclamation studies and reports investigating potential enlargement of Shasta Dam and Reservoir include the *Enlarged Shasta Lake Investigation Preliminary Findings Report* (1983), *Shasta Dam and Reservoir Enlargement, Appraisal Assessment of the Potential for Enlarging Shasta Dam and Reservoir* (1999), *Strategic Agency and Public Involvement Plan* (2003), *Mission Statement Milestone Report* (2003), *Initial Alternatives Information Report* (2004), *Environmental Scoping Report* (2006), and *Plan Formulation Report* (2007).

The primary purpose of this report is to present the results of the SLWRI to date, and to (1) determine the type and extent of Federal and non-Federal interest in alterative plans to improve anadromous fish survival in the upper Sacramento River (see Figure 1-1), increase water supply reliability in the Central Valley of California, and address related water resources needs and opportunities, (2) evaluate benefits and effects of alternative plans, and (3) determine engineering, environmental, social, economic, and financial feasibility of the preliminary proposed plan.

This Draft Feasibility Report includes the following topics:

- Description of study authorization, project background, study area, and prior studies, projects and programs pertinent to the SLWRI (Chapter 1).
- Description of identified problems, needs, and opportunities and existing and likely future water resources and related conditions in the study area (Chapter 2).
- Description of planning objectives, management measures, formulation and evaluation of concept plans, and formulation and description of comprehensive alternative plans, including potential benefits and costs (Chapter 3).
- Evaluation and comparison of comprehensive alternative plans, and rationale for plan selection (Chapter 4).
- Description and determination of feasibility of the preliminary proposed plan, including features and benefits, an example illustrating allocation and apportionment of costs, Federal and non-Federal responsibilities, and potential implementation schedule; and a discussion of risk and uncertainties and unresolved issues (Chapter 5).
- Coordination and public involvement, including stakeholder outreach and agency and Tribal coordination, and pubic and agency review and comment (Chapter 6).
- A summary of plan formulation, major findings to date, and next steps of the Investigation (Chapter 7).

Study Authorization

Public Law 96-375 (1980) provides feasibility study authority for the SLWRI and allows the Secretary of the Interior to do the following:

> *…engage in feasibility studies relating to enlarging Shasta Dam and Reservoir, Central Valley Project, California or to the construction of a larger dam on the Sacramento River, California, to replace the present structure.*

The CALFED Bay-Delta Authorization Act (Public Law 108-361, October 25, 2004), under Authorizations for Federal Activities Under Applicable Law, Section 103(c), authorizes the Secretary of the Interior to carry out the activities described in paragraphs (1) through (10) of Subsection (d), which include the following:

> *...(1)(A)(i) planning and feasibility studies for projects to be pursued with project-specific study for enlargement of (1) the Shasta Dam in Shasta County.*

Public Law 108-361 Section 103(a)(1) also states the following:

> *The Record of Decision is approved as a general framework for addressing the Calfed Bay-Delta Program, including its components relating to water storage, ecosystem restoration, water supply reliability (including new firm yield), conveyance, water use efficiency, water quality, water transfers, watersheds, the Environmental Water Account, levee stability, governance, and science.*

The CALFED Bay-Delta Program (CALFED) Programmatic Record of Decision (ROD) (CALFED 2000a) called for the Secretary of the Interior to do the following:

> *…engage in feasibility studies for the purpose of determining the potential costs, benefits, environmental impacts, and feasibility of using the Sacramento River for conveying water from the enlarged Shasta Dam and Reservoir or the larger dam to points of use downstream from the dam.*

Other Federal legislation also influences the SLWRI. Two laws of special note include the 1965 Public Law 89-336 and 1992 Public Law 102-575. Public Law 89-336 created the Whiskeytown-Shasta-Trinity National Recreation Area (NRA) and directed that the area be administered by the U.S. Forest Service (USFS). Public Law 102-575, the Central Valley Project Improvement Act (CVPIA), directed numerous changes to the operation of the Central Valley Project (CVP). Among these changes was adding protection, restoration, and enhancement of fish and wildlife and associated habitats as project purposes, resulting in significant changes to water supply deliveries, river flows, and related environmental conditions in the study area. To minimize impacts to CVP water contractors, the CVPIA also directed the Secretary of the Interior to develop a least-cost plan to increase the yield of the CVP by the amount dedicated to fish and wildlife purposes.

Summary of Problems, Needs, Opportunities, and Planning Objectives

On the basis of the study authorization, information from prior studies, projects, programs, existing and likely future water resources conditions, and input to the study process through public outreach, a number of water and related resources problems, needs, and opportunities were identified for the SLWRI. Planning objectives were then developed on the basis of identified problems, needs, and

opportunities, study authorities, and other pertinent direction, including information contained in the 2000 CALFED ROD.

Problems, Needs, and Opportunities

Water and related resources problems, needs, and opportunities include anadromous fish survival, water supply reliability, and other environmental resources, as summarized below and discussed in detail in Chapter 2.

Anadromous Fish Survival

The population of Chinook salmon in the Sacramento River has significantly declined over the last 40 years (DFG 2010). As with other Sacramento-San Joaquin Delta (Delta) tributaries, water temperature is one of the most significant factors affecting Chinook salmon abundance in the Sacramento River, especially in dry and critically dry years[1]. Various actions have been taken to address this problem, ranging from minimum flow requirements in the river to structural changes at Shasta Dam. Despite these steps, additional actions are needed to address anadromous fish survival in the upper Sacramento River.

Water Supply Reliability

Demands for water in the State exceed available supplies (Reclamation 2008a). Dramatic increases in statewide population, land use changes, regulatory requirements, and limitations on storage and conveyance facilities have resulted in unmet water demands and subsequent increases in competition for water supplies among urban, agricultural, and environmental uses. Challenges are greatest during drought years when water supply becomes less available (DWR 2009). As the population of California grows and the demand for adequate water supplies becomes more acute, the ability of the State to maintain a healthy and vibrant industrial and agricultural economy while protecting aquatic species will be increasingly difficult.

Other Environmental Resources

Other identified needs include growing demands for existing and new energy sources in California; the need to restore environmental values in the Shasta Lake area and downstream along the Sacramento River; the need for additional flood protection along the upper Sacramento River; the need for additional recreation opportunities in the north Sacramento Valley; and the need for improved water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta.

SLWRI Specific Planning Objectives

To address identified problems, needs, and opportunities described above, primary and secondary planning objectives were developed for the SLWRI. Primary planning objectives are those which specific alternatives are formulated

[1] Throughout this document, water year types are defined according to the Sacramento Valley Water Year Hydrologic Classification unless specified otherwise.

to address. Secondary planning objectives are actions, operations, or features that should be considered in the plan formulation process, but only to the extent possible through pursuit of the primary planning objectives.

- **Primary Planning Objectives**
  - Increase the survival of anadromous fish populations in the Sacramento River, primarily upstream from the Red Bluff Diversion Dam (RBDD).
  - Increase water supply and water supply reliability for agricultural, municipal and industrial (M&I), and environmental purposes to help meet current and future water demands, with a focus on enlarging Shasta Dam and Reservoir.
- **Secondary Planning Objectives**
  - Conserve, restore, and enhance ecosystem resources in the Shasta Lake area and along the upper Sacramento River.
  - Reduce flood damage along the Sacramento River.
  - Develop additional hydropower generation capabilities at Shasta Dam.
  - Maintain and increase recreation opportunities at Shasta Lake.
  - Maintain or improve water quality conditions in the Sacramento River downstream from Shasta Dam and in the Delta.

Figure 1-2. Shasta Dam Under Construction

Background

Shasta Dam was constructed from September 1938 to June 1945 (Figure 1-2). Storage of water in Shasta Reservoir began in December 1943. Installation of gates, valves, and other finish work, was completed following World War II and the project was fully operational in April 1949. Approximately 37 miles of the Union Pacific Railroad (UPRR) main line, and 21 miles of U.S. Highway 99 (Interstate 5 (I-5)) were relocated around the reservoir during construction. At the time, Shasta Dam, at 602 feet tall, was exceeded only by Hoover Dam (located in Clark County, Nevada) in height and Grand Coulee Dam (located in Grant County, Washington) in volume and surface area; today, multiple dams are larger in both respects worldwide.

Shasta Reservoir stores about 55 percent of the total annual water supply delivered by the CVP. Shasta Dam and Reservoir were constructed as an integral element of the CVP. Shasta Dam (Figure 1-3) is operated in conjunction with other CVP facilities to provide for the management of floodwater, storage of surplus winter runoff for irrigation in the Sacramento and San Joaquin valleys, M&I water supply, maintenance of navigation flows, protection of fish in the Sacramento River and Delta, and hydropower generation. The CVPIA added "fish and wildlife mitigation, protection, and restoration" as a priority equal to water supply, and added "fish and wildlife enhancement" as a priority equal to hydropower generation.

Figure 1-3. Present Shasta Dam

Shasta Lake supports extensive water-oriented recreation. Shasta Dam and Reservoir are within the Shasta Unit of the Whiskeytown-Shasta-Trinity NRA. Recreation within these lands is managed by USFS.

Reclamation operates Shasta Dam and Reservoir facilities in accordance with guidelines provided by the U.S. Army Corps of Engineers (USACE) for flood damage reduction. All outflows from Shasta Dam flow into and through Keswick Reservoir, located about 5 miles west of Redding. Keswick Reservoir also receives inflows from Whiskeytown Reservoir on Clear Creek.

Study Area

The SLWRI includes both a primary study area and an extended study area because of the potential influence of the proposed modification of Shasta Dam and Reservoir and subsequent system operations and water deliveries on resources over a large geographic area. The primary study area (see Figure 1-4) includes the following:

- Shasta Dam and Shasta Lake
- Lower reaches of three primary tributaries flowing into Shasta Lake (Sacramento, McCloud, and Pit rivers) and all smaller tributaries flowing into the lake
- Trinity and Lewiston reservoirs
- Sacramento River between Shasta Dam and the RBDD facilities, including tributaries at their confluence

The location of the RBDD was chosen as the downstream boundary of the primary study area because cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBDD (NMFS 1993). The RBDD is directly adjacent to the Red Bluff Pumping Plant (RBPP), which is currently under construction. After the RBDD, the river landscape changes to a broader, alluvial stream system. The broader, slower nature of an alluvial stream system allows ambient air temperature to have a greater effect on the temperature of the Sacramento River.

The extended study area includes other areas of California that could potentially be indirectly influenced by modifying Shasta Dam and Reservoir. The extended study area encompasses the following:

- Sacramento River downstream from the RBDD facilities, including portions of major tributaries, namely the American and Feather river basins downstream from CVP/State Water Project (SWP) facilities
- Sacramento-San Joaquin Delta
- San Joaquin River basin at and downstream from CVP facilities (Friant and New Melones reservoirs)
- Facilities and water service areas of the CVP and SWP (see Figures 1-5 and 1-6)

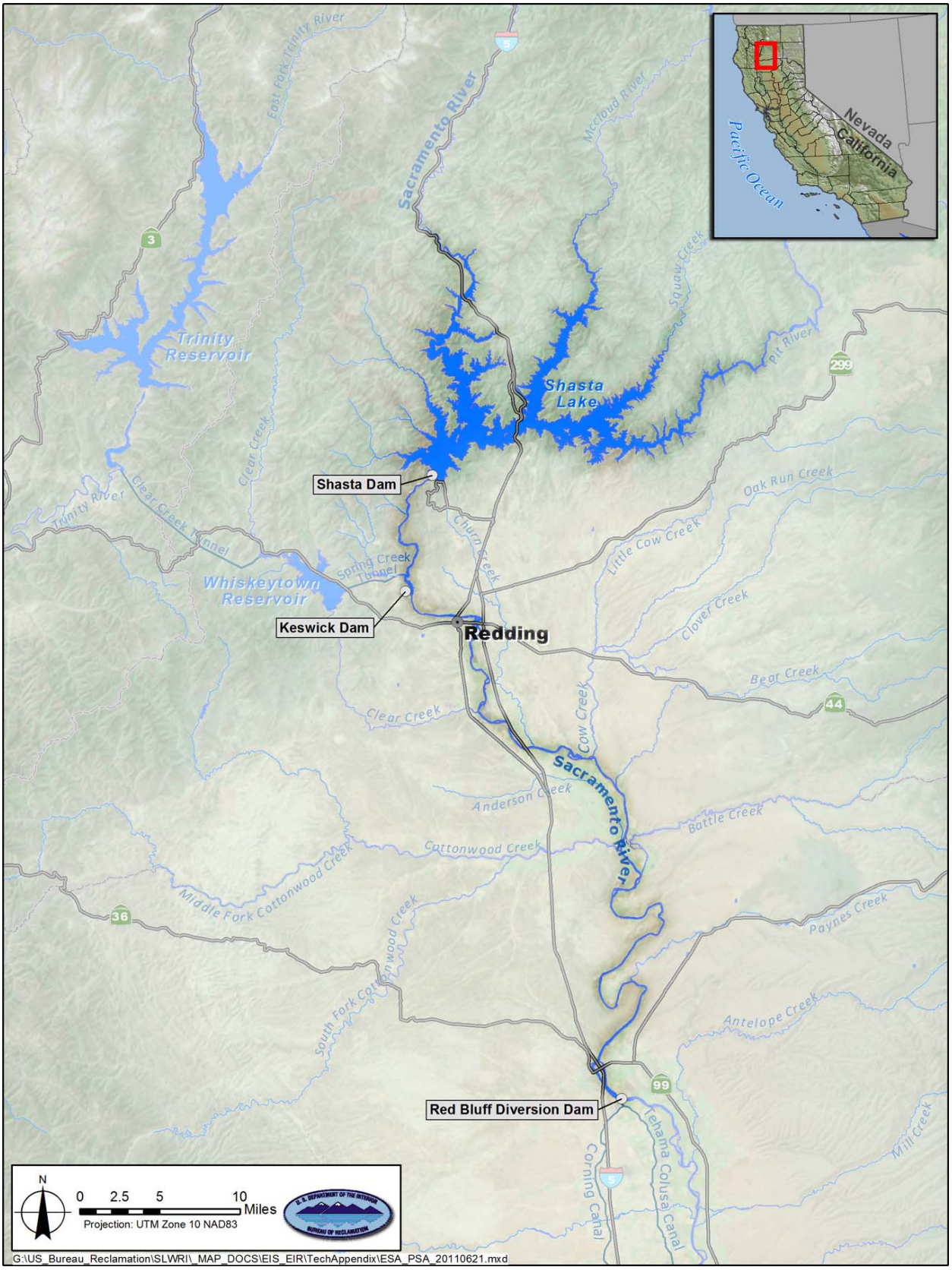

Figure 1-4. Shasta Lake Water Resources Investigation Primary Study Area

Figure 1-5. Central Valley Project and State Water Project Water Service Areas

Figure 1-6. Major Central Valley Project and State Water Project Facilities

The Central Valley of California is home to more than 4 million people and a wide variety of fish and wildlife, including about 180 special-status plant and animal species. The Central Valley river basins provide drinking water to over two-thirds of the Californian population. The robust economy of this region centers on an agricultural industry that is a major source of reliable, high-quality crops marketed to the Nation and the world.

Shasta Dam and Lake are located on the upper Sacramento River in Northern California (see Figure 1-4), about 9 miles northwest of the City of Redding; the entire lake is within Shasta County. At the top of the joint-use capacity[2] or full pool,[3] Shasta Reservoir stores 4.55 million acre-feet (MAF) and covers an area of about 29,500 acres with a shoreline of about 400 miles. The reservoir controls runoff from about 6,420 square miles. The four major tributaries to Shasta Lake are the Sacramento River, McCloud River, Pit River, and Squaw Creek, in addition to numerous minor tributary creeks and streams.

Most of the outflow from Shasta Dam travels south in the Sacramento River to the Delta. From the Delta, flows mingle with runoff, primarily from the San Joaquin River watershed, and travel to the Pacific Ocean through San Francisco Bay. The total drainage area of the Sacramento River at the Delta is about 26,300 square miles. The average annual runoff volume to the Delta from the Sacramento River watershed is about 17.2 MAF. This represents about 62 percent of the total 27.8 MAF inflow to the Delta.

Related Studies, Projects, and Programs

Various Federal and State agencies, including Reclamation, USACE, and the California Department of Water Resources (DWR), and numerous local working groups and private organizations are conducting activities pertinent to the SLWRI. Following is a summary of these pertinent prior and ongoing activities in the study area.

Federal

Department of the Interior – Bureau of Reclamation

As the owner and operator of the CVP, including Shasta Dam and Reservoir, Reclamation has many ongoing projects or continuing programs and plans relevant to the SLWRI:

- **Central Valley Project** – The CVP, the largest surface water storage and delivery system in California (see Figure 1-6), supplies water to more than 250 long-term water contractors in the Central Valley,

[2] Top of joint-use capacity is the reservoir water surface elevation at the top of the reservoir capacity allocated to joint use (i.e., flood control and conservation purposes).
[3] Full pool is the volume of water in a reservoir when the reservoir is fully used for all project purposes, including flood control.

Tulare Lake basin, and San Francisco Bay Area (Bay Area) (Reclamation 2008a and 2011a). CVP service areas are shown in Figure 1-5. Shasta Reservoir accounts for approximately 40 percent of the total storage capacity of the CVP and provides for over half of the total annual water supplies delivered by the CVP. Annually, the CVP has the potential to supply about 7.0 MAF for agricultural, urban, and wildlife uses (Reclamation 2008a). The CVP also provides flood damage reduction, navigation, power, recreation, and water quality benefits.

- **Prior Studies of Enlarging Shasta Dam** – Several studies have been conducted to assess the feasibility of increasing storage space in Shasta Reservoir. Evaluations of raising Shasta Dam considered structural modifications, environmental and related impacts, water supply and hydropower benefits, costs, and Federal interest. Reclamation initiated the SLWRI based on these studies and conclusions in the August 2000 CALFED ROD establishing the need for additional studies focusing on limited dam raise/reservoir enlargement options.

- **Central Valley Project Improvement Act** – The CVPIA addresses conflicts over water rates, irrigation land limitations, and environmental impacts of the CVP. A major purpose of the CVPIA is to provide equal priority and consideration to protection, restoration, and enhancement of fish, wildlife, and associated habitats of the Delta estuary and tributaries when evaluating the purpose of the CVP. The CVPIA also addresses the operational flexibility of the CVP and methods to expand the use of voluntary water transfers and improved water conservation. The CVPIA dedicated approximately 1.2 MAF of water annually to fish, wildlife, and habitat restoration. Of this water, 800,000 acre-feet was dedicated to environmental needs as Section 3406(b)2 water, approximately 200,000 acre-feet was designated for wildlife refuges, and approximately 200,000 acre-feet was dedicated for increased Trinity River flows for fisheries restoration. Through operations flexibility, this results in a net reduction of 516,000 acre-feet per year on average, and 585,000 acre-feet in the driest years, previously available to CVP contractors (Reclamation 2008a).

  Additionally, the CVPIA initiated CVP yield studies and provided for numerous fish and wildlife restoration projects throughout the Central Valley, including habitat restoration projects and modifications to CVP facilities and operations. Many of these projects have either been completed or are currently underway, based on funding from a variety of sources, including the CVPIA and CALFED. Some of the projects relevant to the SLWRI include the RBDD Fish Passage Improvement Project, Trinity River Restoration Program, and construction of the Shasta Dam temperature control device.

- **Operations Criteria and Plan (OCAP)** – In June 2004, Reclamation prepared the *Long-Term CVP Operations Criteria and Plan* (2004 OCAP) to provide a baseline description of facilities and the operating environment of the CVP and SWP. Using operational information in the 2004 OCAP, Reclamation and DWR developed the 2004 *Long-Term CVP and SWP OCAP Biological Assessment* (2004 OCAP BA), prepared as part of the consultation process required by Section 7 of the Endangered Species Act (ESA). Reclamation consulted with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) on the 2004 OCAP, and the two agencies issued biological opinions. NMFS issued the 2004 *Biological Opinion on the Long-Term CVP and SWP OCAP* (2004 NMFS BO) and USFWS issued the 2005 *Reinitiation of Formal and Early Section 7 ESA Consultation on the Coordinated Operations of the CVP and SWP and the OCAP to Address Potential Critical Habitat Issues* (2005 USFWS BO). In 2007, the District Court for the Eastern District of California (District Court), in Natural Resources Defense Council v. Kempthorne, found the 2005 USFWS BO to be unlawful and inadequate. In May 2008, in Pacific Coast Federation of Fishermen's Associations v. Gutierrez, the District Court found the 2004 NMFS BO to be unlawful and inadequate. The District Court remanded both biological opinions (BO) to the fishery agencies.

  In August 2008, Reclamation reinitiated consultation with the fishery agencies based on the 2008 *Biological Assessment on the Continued Long-Term Operations of the CVP and SWP* (2008 OCAP BA). USFWS issued the *Formal ESA Consultation on the Proposed Coordinated Operations of the CVP and SWP* in December 2008 (2008 USFWS BO), finding that the long-term operations of the CVP and SWP, as described in the 2004 OCAP BA, would jeopardize the continued existence of the delta smelt (USFWS 2008). In June 2009, NMFS issued the *Biological Opinion and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS BO), finding that the same operations would jeopardize populations of listed salmonids, steelhead, green sturgeon, and orcas. Because both agencies made jeopardy determinations, both agencies included a Reasonable and Prudent Alternative (RPA) in their respective BOs.

  Several lawsuits were filed challenging the validity of the 2008 USFWS BO and 2009 NMFS BO and Reclamation's acceptance of the RPA included with each BO (*Consolidated Salmonid Cases, Delta Smelt Consolidated Cases*). On November 13, 2009, and March 5, 2010, the District Court concluded that Reclamation had violated NEPA by failing to perform a NEPA analysis before provisionally adopting the 2008 USFWS RPA and 2009 NMFS RPA. On December 14, 2010, the District Court found the 2008 USFWS BO to be unlawful and remanded the BO to USFWS. The District Court issued a similar

ruling for the 2009 NMFS BO on September 20, 2011. On May 4, 2011, in the *Delta Smelt Consolidated Cases*, the District Court ordered USFWS to prepare a draft BO by October 1, 2011, which was subsequently extended to an unspecified date to be agreed upon by involved parties. Reclamation and USFWS must then prepare a final BO and final NEPA document by November 1, 2013, and December 1, 2013, respectively.

A set of operational assumptions was developed in 2006 based on water operations described in the 2004 OCAP BA and the Coordinated Operations Agreement between Reclamation and DWR for the CVP and SWP, as ratified by Congress. These assumptions were used to guide development, modeling, and evaluation of potential effects of the No-Action Alternative and comprehensive plans included in this Draft Feasibility Report and accompanying Preliminary Draft EIS. Rationale for the decision to use these existing evaluations as the basis of analysis in the Draft Feasibility Report and accompanying Preliminary Draft EIS is provided in Chapter 2, "Water Resources and Related Conditions." Modeling studies will be updated to reflect changes in water operations resulting from ongoing OCAP reconsultation and other relevant water resources projects and programs, including, potentially, Bay Delta Conservation Plan (BDCP)/Delta Habitat Conservation and Conveyance Program (DHCCP) efforts. The results of these updated studies will be incorporated into future SLWRI documents.

- **RBDD Fish Passage Improvement Project** – The RBDD, located on the Sacramento River downstream from Shasta Dam, provides CVP irrigation water via the Tehama-Colusa and Corning canals. Ineffective fish passage at the dam led to development of the RBDD Fish Passage Improvement Project, anticipated to relieve conflicts between fish passage and agricultural diversion needs (Reclamation 2008c). Construction on the RBDD began in April 2010.

- **Trinity River Restoration Program** – The 2.5 MAF Trinity Reservoir conveys water from the Trinity River to the Sacramento River basin for export to the Central Valley. The Trinity ROD proposes rehabilitation of the Trinity River through restoration activities to restore and maintain the river's fishery resources impacted by Trinity Dam and Reservoir (Reclamation 2000). One of the major elements of the Trinity River ROD is reducing the average annual water exports from the Trinity River basin into the Sacramento River basin.

- **Battle Creek Salmon and Steelhead Restoration Project** – The Battle Creek Salmon and Steelhead Restoration Project focuses on restoring the winter-run, spring-run, fall-run and late fall-run Chinook salmon and steelhead populations in Battle Creek, one of the most

important anadromous fish spawning streams in the Sacramento Valley. Actions include removing dams, constructing fish screens and ladders, and augmenting flows to increase salmonid habitat. Construction began in 2010.

Department of the Interior – Bureau of Land Management

The Bureau of Land Management (BLM) is responsible for administering natural resources, lands, and mineral programs on approximately 250,000 acres of public land in Northern California, and is involved in numerous restoration and conservation projects in the study area.

Department of the Interior – Fish and Wildlife Service

USFWS has participated in numerous projects and programs within the study area because the upper Sacramento River is recognized as critical habitat for endangered winter-run Chinook salmon and other threatened or endangered species. The Anadromous Fish Restoration Program (AFRP) was developed to accomplish the CVPIA goal of doubling natural production of anadromous fish in Central Valley streams on a long-term, sustainable basis through improvement of natural ecosystem functions (i.e., increased stream flows, eliminating entrainment at diversions) (USFWS 1995).

As part of the Fish and Wildlife Coordination Act (FWCA) (48 statute 401, as amended, 16 U.S. Code (USC) 661 et seq.), in early February 2007, USFWS provided Reclamation with a revised draft *Planning Aid Memorandum* (PAM). The PAM is intended to (1) summarize USFWS views and position on planning and implementation efforts under water resources legislation and programs such as the CVPIA and CALFED, (2) identify potential beneficial and adverse effects to fish and wildlife resources for further evaluation, and (3) provide recommendations to the SLWRI planning process to maximize project benefits for aquatic and terrestrial species, while congruent with the USFWS Mitigation Policy, as published in the *Federal Register*, Vol. 46, No. 15 January 23, 1981, and amended in the *Federal Register* of February 4, 1981. The PAM focuses on the SLWRI planning process, pertinent environmental analysis and protections, and allocation of project benefits should Shasta Lake be enlarged.

Department of Commerce – National Marine Fisheries Service

NMFS is required under the Federal ESA to assess factors affecting listed salmonid species in the Central Valley, identify recovery criteria, identify the entire suite of actions necessary to achieve these goals, and estimate the cost and time required to carry out the actions. One program to attain these goals, the *Proposed Recovery Plan for Sacramento River Winter-Run Salmon*, presents restoration goals and actions, including improved water quality and flows, some of which would be applied within the SLWRI study area (NMFS 1997). In addition, the *Public Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Central Valley Spring-run Chinook Salmon and the Distinct Population Segment of Central*

Valley Steelhead (NMFS 2009b) also presents actions to help meet recovery goals.

Department of Agriculture – Forest Service

USFS manages recreation within the Whiskeytown-Shasta-Trinity NRA, which includes nearly all lands along the Shasta Lake shoreline. USFS is also involved in fire hazard and fuel reduction projects, forest health and ecosystem management, timber sales, conservation planning, wildlife monitoring, wildlife habitat improvement, recreation facilities, and administration of the *Aquatic Conservation Strategy of the Northwest Forest Plan* (USFS 1994).

Environmental Protection Agency

The U.S. Environmental Protection Agency (EPA) is involved in remediation and cleanup activities related to the Iron Mountain Mine Superfund site in the Spring Creek drainage, which is a tributary to Keswick Reservoir. These activities are significantly reducing acid and metal contamination in surface water entering the Sacramento River.

Department of Defense – U.S. Army Corps of Engineers

In 1977, USACE prescribed the operating space and developed the operating rules at Shasta Dam and Reservoir for flood damage reduction. In addition to Shasta Dam and Reservoir regulation rules, USACE has conducted various studies and implemented many projects and programs that affect the upper Sacramento River and its tributaries. Several key efforts include the March 1999 *Post-Flood Assessment* (USACE) and the *Sacramento and San Joaquin River Basins Comprehensive Study* (USACE 2002).

State

Following are State projects and plans relevant to the SLWRI.

California Department of Water Resources

DWR is the owner and operator of the SWP, and manages ongoing projects or continuing programs relevant to the SLWRI:

- **State Water Project** – The SWP delivers water to the Feather River Settlement Contractors and SWP contract entitlements in the Feather River basin, Bay Area, San Joaquin Valley, Tulare basin, and Southern California water service areas. The SWP has contracted a total of 4.23 MAF for average annual delivery: about 2.5 MAF for the Southern California Transfer Area; nearly 1.36 MAF for the San Joaquin Valley; and the remaining 370,000 acre-feet for the San Francisco Bay, central coast, and Feather River areas. Modifications of Shasta Dam and Reservoir could increase net water supplies for the SWP.

- **California Water Plan** – The *California Water Plan*, through the Bulletin 160 series, helps define California's agricultural, environmental, and urban water needs and identifies potential solutions

to these needs. The most recent plan, distributed by DWR in 2009, evaluates water supplies and applied water in California, and quantifies estimates of future water demands considering population growth and climate change (DWR 2009). Analysis and conclusions presented in the 2009 *California Water Plan Update* were used in assessing the need for modification of Shasta Dam and Reservoir to provide additional water supply reliability outside the CVP.

- **Integrated Regional Water Management Plans** – Integrated Regional Water Management Plans (IRWMP) are collaborative endeavors to manage diverse aspects of water resources in a regional approach. IRWMPs integrate planning for water supply, water quality, wastewater treatment, stormwater management, and flood control on a regional scale that involves multiple jurisdictions, watersheds, political regions, agencies, and stakeholders.

  The Sacramento Valley IRWMP was formally adopted under California Water Code (CWC) 10541 on December 12, 2006, as a framework to guide the management of water resources in the Sacramento Valley in an integrated and regional approach (Northern California Water Association 2006). Input from water agencies, landowners, local governments, and conservation organizations was used to develop the IRWMP, which was adopted with formal resolutions by more than 40 public water entities in the Sacramento Valley. The Sacramento Valley IRWMP region includes the Sacramento Valley floor and foothills area, overlies the Sacramento and Redding groundwater basins, and encompasses parts of 10 counties.

State Water Resources Control Board

The State Water Resources Control Board (SWRCB) is responsible for allocating surface water rights, setting statewide policy to protect water quality, coordinating and supporting the State's nine Regional Water Quality Control Boards, and enforcing laws and regulations protecting the State's waterways. Both the CVP and SWP operate pursuant to water right permits and licenses issued by SWRCB for water storage, releases, and diversions.

Over time, SWRCB has issued decisions that modify the terms and conditions of CVP and SWP water rights. In August 1978, SWRCB adopted the Water Quality Control Plan (WQCP) for the Delta and Suisun Marsh and Water Right Decision 1485 (D-1485), requiring Reclamation and DWR to operate the CVP and SWP to meet all of the 1978 WQCP objectives, except a portion of the southern Delta salinity objectives. In 1991, SWRCB issued revised water quality objectives in the *Delta Water Quality Control Plan for Salinity, Temperature, and Dissolved Oxygen* (SWRCB 1991). In May 1995, SWRCB adopted the *Bay-Delta Water Quality Control Plan* (SWRCB 1995) superseding both the 1978 and 1991 plans.

Beginning in 1996, SWRCB engaged in proceedings to determine responsibility for meeting water quality standards in the Delta. Because the issues were so complex, SWRCB divided the water right proceedings into eight phases. SWRCB completed Phases 1 through 7 of these proceedings in 1999, leading to issuance of D-164 in December of 1999. The SWRCB adopted D-1641 as part of the SWRCB's implementation of the 1995 *Bay Delta Plan.* D-1641 amended certain water rights, including temporarily amending certain terms and conditions of the CVP and SWP water rights, by assigning responsibilities to the persons or entities holding those rights to help meet certain water quality and flow requirements outlined in the 1995 *Bay Delta Plan*, including new protections for Delta fisheries. The goal of phase 8 was to allocate permanent responsibility for satisfying the flow-related water quality objectives of the 1995 Bay-Delta WQCP among water right holders in the watersheds of the Sacramento, Cosumnes, and Calaveras rivers. As a result of the 2009 Delta Reform Act, SWRCB has initiated a new administrative process to evaluate water outflow requirements on upstream tributaries to the Delta. This may, if implemented, significantly impact CVP and SWP operations, as well as those of other upstream reservoirs.

California Department of Fish and Game

The California Department of Fish and Game (DFG) manages California's fish and wildlife resources, overseeing the restoration and recovery of species listed by the California Endangered Species Act (CESA) as threatened and endangered. DFG participates in conservation planning, environmental compliance and permitting, coordinated resources management planning, and restoration and recovery programs within the study area.

Delta Stewardship Council

As part of the 2009 Comprehensive Water Package, the California Legislature enacted Senate Bill (SB) 7X 1 (2009 Delta Reform Act). Effective February 2010, the 2009 Delta Reform Act created the Delta Stewardship Council, which is tasked with protecting the Delta and the critical role the Delta serves through implementing two "coequal goals" of providing a more reliable water supply for California, and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals are to be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place (CWC Section 85054). Members of the council include representatives from different areas of the State who offer diverse expertise in fields such as agriculture, science, the environment, and public service.

The California Legislature established the Delta Stewardship Council to do the following:

> *…provide for the sustainable management of the Sacramento-San Joaquin Delta ecosystem, to provide for a more reliable water supply for the state, to protect and enhance the quality of water supply from the Delta, and to establish a governance*

> *structure that will direct efforts across state agencies to develop a legally enforceable Delta Plan.*

The council is entrusted to integrate issues, such as water flows, water quality, environmental protection, emergency management, economics, the Delta as an evolving place, conveyance alternatives, upstream impacts, flood management and climate change into one coherent management system.

Delta Plan To fulfill its purpose and implement the coequal goals, the Delta Stewardship Council is developing a Delta Plan. In November 2011, the council published a *Draft Delta Plan Program Environmental Impact Report* (Delta Stewardship Council 2011) that, when finalized, is to serve as a basis for future findings of consistency by State and local agencies with regard to "covered actions." A covered action might be any action that impacts the coequal goals. The Delta Stewardship Council is also responsible for determining whether the BDCP for new Delta conveyance meets certain requirements listed in CWC Section 85320, and is eligible to be incorporated into the Delta Plan. Implementing the Delta Plan in conjunction with the BDCP could change CVP and SWP operations and could possibly affect operations of Shasta Dam and Reservoir. However, the Delta Plan, as with the BDCP, is still in the planning phase, and no specific plan has been authorized for implementation.

California Water Commission

The California Water Commission is comprised of nine members, responsible for advising the Director of DWR, approving DWR rules and regulations, monitoring and reporting on SWP construction and operations, and holding public hearings on proposed SWP facilities. Additionally, the commission advises congressional appropriations committees on funding for USACE and Reclamation water resource projects in California. Under the Safe, Clean, and Reliable Drinking Water Supply Act of 2012, the commission is further tasked with selecting water storage projects for State bond funding toward project benefits "that improve the operation of the state water system, are cost effective, and provide a net improvement in ecosystem and water quality conditions." If this bond measure passes in November 2012, these funds may be eligible for public benefits associated with modifying of Shasta Dam and Reservoir.

Federal-State

Following are programs and plans relevant to the SLWRI that were developed or are being developed as collaborations between Federal and State agencies.

Sacramento Valley Water Management Program

The Sacramento Valley Water Management Program (SVWMP) is a collaborative effort to increase water supplies for farms, cities, and the environment by responding to water rights issues associated with implementation of the 1995 Bay-Delta WQCP (SWRCB 1995). SVWMP and originated from Phase 8 of the SWRCB water right proceedings.

Through the SVWMP efforts, a *Short-Term Settlement Agreement* was executed in December 2002 by more than 40 water suppliers in the Sacramento Valley (Upstream Water Users), Reclamation, DWR, USFWS, DFG, Contra Costa Water District, and SWP contractors representing agricultural and municipal water users in Southern California, the central coast, and the San Joaquin Valley. The *Short-Term Settlement Agreement* specifically identified an enlargement of Shasta Dam as a potential long-term project (SVWMP 2002). Execution of this agreement resulted in the SWRCB dismissing the Phase 8 process on January 31, 2003.

The *Short-Term Settlement Agreement* includes stipulations regarding implementing a series of short-term projects identified in the *Short-Term Workplan* (SVWMP 2001) to fill unmet demands in the Sacramento Valley, and to provide between 92,500 acre-feet and 185,000 acre-feet of water to off-set CVP and SWP water supplies used to meet Upstream Water Users' responsibilities for the 1995 *Bay Delta Plan*, respectively, during certain water year types. These projects would be owned and operated by the Upstream Water Users.

Reclamation and DWR issued a Notice of Intent (NOI) and Notice of Preparation (NOP), respectively, in August 2003 to prepare a Programmatic EIS/Environmental Impact Report (EIR) to analyze the potential effects of implementing five categories of short-term projects: water management, reservoir reoperation, system improvements, surface water and groundwater planning, and other nonstructural actions such as water transfers. This Programmatic EIS/EIR is not yet available; therefore, a programmatic approach to implementing projects identified in the *Short-term Workplan* has not been developed. However, some individual projects identified in the *Short-Term Workplan* have been prepared and/or implemented by various organizations participating in the SVWMP.

CALFED Bay-Delta Program

CALFED, a collaboration of 25 Federal, State, and local agencies, established a program after the Bay-Delta Accord to address water quality, ecosystem quality, water supply reliability, and levee system integrity. Major CALFED programs include the Conveyance, Water Transfer, Environmental Water Account, Water Use Efficiency, Water Quality, Levee System Integrity, Ecosystem Restoration and Watershed Management, and Storage programs.

The *CALFED Final Programmatic EIS/EIR* (CALFED 2000b) Program Plan identified an enlargement of Shasta Lake as one of five surface water storage projects to be investigated and "aggressively pursue[d]" by CALFED. The Program Plan proposed investigating a:

> *Shasta Lake enlargement [that] would include a 6- to 8-foot raise of the existing dam, expanding capacity by approximately 300 TAF. The enlargement could help offset losses of Trinity*

> *River diversions to the Sacramento River, improve the cold water reserve in Shasta Lake to regulate Sacramento River water temperatures, and improve overall water supply reliability.*

The Program Plan also addressed the California Public Resources Code's protection of the McCloud River stating that:

> *The most significant environmental impact appears to be inundation of a few hundred yards of the McCloud River; the California Public Resources Code Section 5093.542 seeks to protect the free-flowing McCloud River but also provides for investigations for potential enlargement of Shasta Dam.*

Following issuance of the *CALFED Final Programmatic EIS/EIR* in July 2000, the CALFED agencies issued a programmatic ROD in August 2000 that identified 12 action plans. Specifically, plans were identified for the Governance, Ecosystem Restoration, Watersheds, Water Supply Reliability, Storage, Conveyance, Environmental Water Account, Water Use Efficiency, Water Quality, Water Transfer, Levees, and Science programs. The CALFED agencies then began implementing Stage 1 of the ROD, including the first 7 years of a 30-year program to establish a foundation for long-term actions.

Building on the Program Plan, the CALFED Storage Program Preferred Program Alternative includes a proposed 6.5-foot raise of Shasta Dam which would expand the reservoir by approximately 256,000 acre-feet. Potential benefits of an expanded reservoir include an increased pool of cold water available to maintain lower Sacramento River temperatures needed by certain fish, and other water management benefits, such as water supply reliability.

In 2004, the CALFED Bay-Delta Authorization Act (Public Law 108-361) approved the CALFED ROD as a "general framework for addressing the CALFED Bay-Delta Program" (Section 103 (a) (1)). Further, Public Law 108-361 authorized the Secretary of the Interior to carry out the activities described in paragraphs (1) through (10) of Subsection (d), which includes "planning and feasibility studies for projects to be pursued with project-specific study for enlargement of (1) the Shasta Dam in Shasta County" (Section 103 (d) (1) (A) (i)).

To provide historical background and context for development of the SLWRI, the following description is quoted from the 2000 CALFED ROD:

> *<u>Bay-Delta Accord</u>: Seeking solutions to the resource problems in the Bay-Delta, State and Federal agencies signed an agreement in June 1994 to (1) coordinate their actions to meet water quality standards to protect the Bay-Delta estuary; (2) coordinate the operation of the State Water Project (SWP); and the Central Valley Project (CVP) more closely with recent*

environmental mandates; and (3) develop a process to establish a long-term Bay-Delta solution to address four categories of problems: ecosystem quality, water quality, water supply reliability, and levee system vulnerability.

This agreement laid the foundation for the Bay-Delta Accord and CALFED [Bay-Delta Program]. The Accord, formally called the Principles for Agreement on Bay-Delta Standards between the State of California and the Federal Government, detailed interim measures for both environmental protection and regulatory stability in the Bay-Delta. On December 15, 1994, the Accord was signed by State and Federal resource agencies, as well as by stakeholders representing many local water agencies and environmental organizations. Under the terms of a December 1999 extension, the Accord formally expires when this ROD is executed [August 28, 2000]. Thereafter, the provisions in the Accord are replaced in their entirety by the provisions and agreements in this ROD and associated documents.

Introduction: The CALFED Bay-Delta Program is an unprecedented effort to build a framework for managing California's most precious natural resource: water. California and the Federal government in partnership are launching the largest, most comprehensive water management program in the world. This is the most complex and extensive ecosystem restoration project ever proposed. It is also one of the most intensive water conservation efforts ever attempted. It is the most far-reaching effort to improve the drinking water quality of millions of Californians as well as an unprecedented commitment to watershed restoration. And it is the most significant investment in storage and conveyance in decades.

The CALFED Bay-Delta Program began in May 1995 to address the complex issues that surround the Bay-Delta. The CALFED Bay-Delta Program is a cooperative, interagency effort of 18 State and Federal agencies with management or regulatory responsibilities for the Bay-Delta. The CALFED Program is a collaborative effort including representatives of agricultural, urban, environmental, fishery, and business interests, Indian tribes and rural counties who have contributed to the process.

The San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) estuary is the largest estuary on the West Coast. It is a maze of tributaries, sloughs, and islands and a haven for plants and wildlife, supporting over 750 plant and animal species. The

Bay-Delta includes over 738,000 acres in five counties. The Bay-Delta is critical to California's economy, supplying drinking water for two-thirds of Californians and irrigation water for over 7 million acres of the most highly productive agricultural land in the world.

The Bay-Delta is also the hub of California's two largest water distribution systems - the Central Valley Project (CVP) operated by the U.S. Bureau of Reclamation (Reclamation) and the State Water Project (SWP) operated by the California Department of Water Resources (DWR). Together, these water development projects divert about 20 to 70 percent of the natural flow in the system depending on the amount of runoff available in a given year. These diversions, along with the effects of increased population pressures throughout California, exotic species, water pollution, and numerous other factors have had a serious impact on the fish and wildlife resources in the Bay-Delta estuary.

The droughts of 1987-92 demonstrated just how vulnerable California is to water shortages. More recent conflicts between water quality, fish protection and water supply also demonstrate how little flexibility there is in the current system. With the State's population expected to grow from 34 million today to 59 million in 2040, the need to conserve, to build our capacity, and to manage our water system more efficiently is no longer just a goal, it is a reality.

Before CALFED, all agreed on the importance of the Bay-Delta estuary for both fish and wildlife habitat and as a reliable source of water, but few agreed on how to manage and protect this valuable resource. The CALFED Bay-Delta Program was established to develop a long-term comprehensive plan that will restore ecological health and improve water management for beneficial uses of the Bay-Delta system. Over the last five years, hundreds of individuals have spent thousands of hours discussing and debating options for a long-term restoration and management plan for the Bay-Delta estuary. The task is fourfold: 1) to restore the ecological health of a fragile and depleted Bay-Delta estuary; 2) improve the water supply reliability for the State's farms, tribal communities, and growing cities that draw water from the Delta and its tributaries, including 7 million acres of the world's most productive farmland; 3) protect the drinking water quality of the 22 million Californians who rely on the Delta for their supplies; and 4) protect the Delta levees that ensure its integrity as a conveyance and ecosystem. Through the Bay-Delta

Advisory Council, State and Federal agencies and tribes have worked with stakeholders and the public to shape these options into this framework for a comprehensive plan.

The CALFED Program and the CALFED Agencies have approached many ecosystem and water management issues from a regional perspective: what makes the most sense for the affected region. The regions, which include their respective watersheds, are the Sacramento Valley, the San Francisco Bay Area, the Delta, Westside San Joaquin Valley, San Joaquin River/South San Joaquin Valley, and Southern California. Although each region raises unique ecosystem and water management issues, each region's issues affect the health and function of the Bay-Delta system as a whole. Those regional issues nevertheless need regional solutions that contribute to overcoming the challenges facing the Bay-Delta system. In crafting regional solutions, the CALFED Program has also identified and considered the other, independent actions taken by Federal, State, Tribal, and local agencies operating outside the CALFED Program. In addition, CALFED has taken into account its obligations to comply with ongoing commitments, such as the commitments included in the State's area of origin laws.

Consistent with the stated purposes of CALFED since its outset in 1995, it is not the intent of this program to address or solve all of the water supply problems in California. CALFED is directly or indirectly tied to a number of specific project proposals that would help toward meeting California's water needs for a wide variety of beneficial uses. CALFED is an important piece of a much larger picture that is the continuing responsibility of local, regional, Tribal, State and Federal jurisdictions.

Common Assumptions for Water Storage Projects

A Common Assumptions work group was established to develop common baseline conditions against which the feasibility of various water storage investigations would be assessed. A major task of the Common Assumptions effort was to develop common analytical tools. The work group assembled a number of modeling tools under one package, termed the Common Model Package (CMP).

The CMP includes the California Statewide Simulation Model (CalSim-II), Delta Simulation Model (DSM2), Sacramento River Water Quality Model (SRWQM), the Salmonid Population Model (SALMOD), LongTermGen (LTGen), SWP Power California (SWP Power), the Least Cost Planning Simulation Model (LCPSIM), and the Central Valley Production Model

(CVPM). CalSim-II is a statewide water resources planning model, primarily reflecting the Central Valley and Delta operations of the CVP and SWP. The model is used to evaluate water supply facilities and demands; regulatory standards, including minimum flow requirements, water rights, contracts, and water quality standards; system operations; and likely foreseeable actions. DSM2 simulates hydrodynamic and water quality conditions in the Delta. SRWQM assesses water temperature conditions in the Sacramento River between Keswick Dam and the RBDD. Output from SRWQM and CalSim-II are used as inputs to SALMOD, which is a model used to help identify salmon populations in the upper Sacramento River. LTGen and SWP Power also use CalSim-II output and help identify power generation in the CVP and SWP, respectively. LCPSIM and CVPM are economic models that estimate potential monetary benefits of M&I water supplies to the SWP and irrigation water supplies to the CVP.

Bay-Delta Conservation Plan

The BDCP is being prepared through a collaboration of Federal, State, and local water agencies, Federal and State fish agencies, environmental organizations, and other interested parties. The goal of the BDCP is to identify water flow and habitat restoration actions to recover endangered and sensitive species and their habitats in the Delta while improving California's water supply reliability.

The BDCP is a Habitat Conservation Plan (HCP) intended to provide for the conservation of species and habitats covered by the plan. HCPs and Natural Community Conservation Plans (NCCP) are planning documents required as part of permit applications under Section 10(a) of the ESA and California Natural Community Conservation Planning Act (NCCPA). The BDCP is intended as a comprehensive conservation strategy for the Delta, designed to advance the coequal planning goals of restoring ecological functions of the Delta and improving water supply reliability for large portions of the State of California.

A range of alternatives for providing species/habitat protection and improving water supply reliability as part of the BDCP will be evaluated through development of an EIS/EIR. Lead agencies for the EIS/EIR are DWR, Reclamation, USFWS, and NMFS, in cooperation with DFG, EPA, and USACE. To provide support for the BDCP environmental review process, DWR formed the DHCCP in 2008 as a partnership with Reclamation. The DHCCP manages a number of activities to support the BDCP including engineering, real estate services, and identification and development of habitat restoration and water conveyance options.

Currently, several alternative Delta conveyance facilities are being evaluated as part of the plan. Among these alternatives is a through-Delta facility and an isolated facility that would convey water around the Delta for local supply and export through a hydraulically isolated channel or tunnel. An isolated facility could improve water quality for urban and agricultural water users and could

eliminate reverse flow in the Delta and improve Delta water quality and flow by releasing water to south Delta channels. Modifications of Shasta Dam and Reservoir could allow for increased system flexibility and further use of new Delta conveyance facilities, providing for even greater increases in water supply reliability.

Regional and Local

Following are regional and local activities relevant to the SLWRI.

Sacramento River Conservation Area Program

The Sacramento River Conservation Area Forum (SRCAF) is a nonprofit organization formed in compliance with California's 1986 SB1086 legislation to manage aquatic resources along the upper Sacramento River from Keswick Dam to Verona. The program established and managed by SRCAF is responsible for preserving remaining riparian habitat, reestablishing a continuous riparian ecosystem along the Sacramento River between Redding and Chico, and reestablishing riparian vegetation along the river from Chico to Verona. The *Upper Sacramento River Fisheries and Riparian Habitat Management Plan* (Resources Agency 1989) identifies specific actions to help restore the Sacramento River fishery and riparian habitat between Keswick Dam and the confluence of the Feather River, including actions specific to the study area.

Iron Mountain Mine Restoration Plan

The Iron Mountain Mine Trustee Council was formed to oversee restoration activities associated with the Iron Mountain Mine, and comprises representatives from five agencies (USFWS, DFG, NMFS, BLM, and Reclamation). The Iron Mountain Mine complex is a Superfund site in the Spring Creek drainage, which is a tributary to Keswick Reservoir. A restoration plan identifies actions to address injuries to, or lost use of, natural resources resulting from acid mine drainage from the Iron Mountain Mine complex (USFWS, DFG, NOAA, BLM, Reclamation 2002). The plan includes restoration of salmonid populations, riparian habitat, and instream ecological functions.

Riparian Habitat Joint Venture

The Riparian Habitat Joint Venture promotes conservation and restoration of riparian habitat to support native bird populations. Recommended conservation efforts in the SLWRI study area include conservation of lower Clear Creek as a prime breeding area for yellow warblers and song sparrows. The Sacramento River is targeted for restoration of riparian habitat to support the yellow-billed cuckoo, bank swallow, Swainson's hawk, and yellow-breasted chat.

Resource Conservation Districts

Resource Conservation Districts (RCD) are locally governed agencies responsible for conserving resources within their districts by implementing projects on public and private lands, and educating landowners and the public

about resource conservation. Activities include resources management, watershed management, conservation, and restoration programs. In the primary study area, districts include the Western Shasta County RCD and Tehama County RCD. To the east are the Fall River and Pit River RCDs, and to the west and north are the Trinity County and Shasta Valley RCDs.

Other Programs and Private Organizations

Other programs, plans, and private organizations related to the SLWRI include the following:

- Battle Creek Watershed Conservancy
- California Trout
- Cantara Trustee Council
- Clear Creek Coordinated Resource Management Plan
- Cottonwood Creek Watershed Group
- Cow Creek Watershed Management Group
- McCloud River Coordinated Resource Management Plan
- Pit River Watershed Alliance
- Sacramento River Preservation Trust
- Sacramento River Watershed Program
- Sacramento Watersheds Action Group
- Shasta Land Trust
- Stillwater-Churn Creek Watershed Alliance
- Sulphur Creek Coordinated Resource Management Plan
- The Nature Conservancy (McCloud River Preserve and Lassen Foothills projects)
- The Trust for Public Land

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Chapter 2
Water Resources and Related Conditions

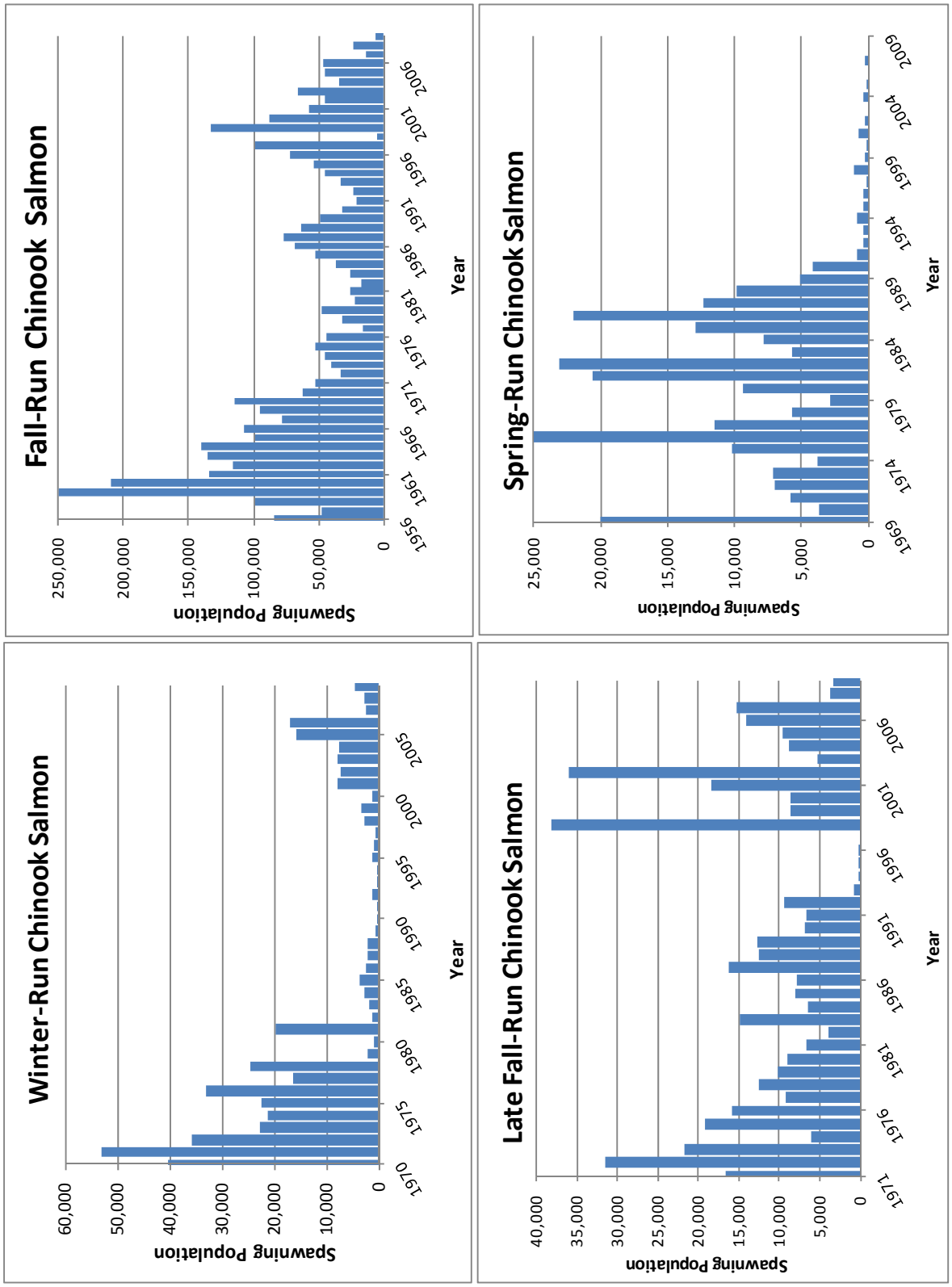
The plan formulation process for Federal water resources studies and projects is specified in the P&Gs (WRC 1983). The initial steps in this process include specifying water resources problems, needs, and opportunities to be addressed, and inventorying, forecasting, and analyzing existing and likely future conditions in the study area. Identified problems, needs, and opportunities serve as the basis for planning objectives, which guide the formulation of alternative plans. The plan formulation process is further described in Chapter 3, "Plan Formulation."

Water and Related Resources Problems, Needs, and Opportunities

Based on the overall feasibility study authority, and concerns expressed about existing and likely future water and related resources issues, following is a description of identified major water resources problems, needs, and opportunities in the primary SLWRI study area.

Anadromous Fish Survival

The population of Chinook salmon in the Sacramento River has significantly declined over the past 40 years (Figure 2-1) (DFG 2010). Numerous factors have contributed to this decline, including unstable water temperature, loss of historic spawning areas and suitable rearing habitat, water diversions from the Sacramento River, drought conditions, limited suitable spawning gravels, fluctuations in river flows, toxic acid mine drainage, high rates of predation, unsustainable fish harvests, and unsuitable ocean conditions. As a result, Sacramento River winter-run Chinook salmon have been listed as endangered under the Federal Endangered Species Act, and spring-run Chinook salmon have been listed as threatened, along with other anadromous fish species in the upper Sacramento River, including Central Valley steelhead and North American green sturgeon.



Source: DFG, 2010

Figure 2-1. Chinook Salmon Historic Spawning Populations in Sacramento River

One of the most significant environmental factors affecting the abundance of Chinook salmon and steelhead in the upper Sacramento River is unsuitable water temperature (NMFS 2009b). Water temperatures that are too high or, less commonly, too low, can be detrimental to the various life stages of Chinook salmon. Elevated water temperatures can negatively impact holding and spawning adults, egg viability and incubation, preemergent fry, and rearing juveniles and smolts, significantly diminishing the next generation of returning spawners. Stress caused by high water temperatures also may reduce the resistance of fish to parasites, disease, and pollutants. Releases of cold water stored behind Shasta Dam can significantly improve seasonal water temperatures in the Sacramento River for anadromous fish, particularly winter-run Chinook salmon, during critical periods.

The 2009 NMFS *Public Draft Recovery Plan* states that prolonged droughts depleting the cold-water storage of Shasta Reservoir, or some related failure to manage cold-water storage, could extirpate the entire Sacramento River winter-run Chinook salmon population. The Recovery Plan emphasizes that under current conditions, even 2 consecutive years of drought could reduce Shasta Reservoir cold-water storage to levels insufficient to support the Sacramento River winter-run Chinook spawning and incubation season. This could result in complete year-class failure, virtually eliminating all of a single year's spawning and incubating winter-run Chinook in the Sacramento River (NMFS 2009b).

Conversely, water that is too cold is detrimental to the rapid growth of rearing juveniles. Following construction of Shasta Dam, water released in the spring was unusually cold and prevented the characteristic rapid growth of fall-run and late fall-run juvenile Chinook salmon. Reduced growth rates result in increased risk for predation and entrainment at unscreened and inadequately screened diversions.

Various Federal, State, and local projects are addressing each of the aforementioned factors contributing to anadromous fish population declines. Recovery actions range from changing the timing and magnitude of reservoir releases to changing the temperature of released water. In May 1990, SWRCB issued Order 90-5, which included temperature objectives for the Sacramento River to protect winter-run Chinook salmon. The 1993 NMFS BO for winter-run Chinook salmon reinforced this order and established certain operating parameters for Shasta Reservoir. The BO established an RPA comprising 13 separate actions that changed the patterns of water storage and withdrawal at Shasta, Trinity, and Whiskeytown reservoirs. This BO and SWRCB actions set surrogate or minimum flows in the river downstream from Keswick Dam primarily to affect water temperatures during key periods.

In addition to flow requirements, structural changes have been made at Shasta Dam to change the temperature of released water, such as construction of a temperature control device (TCD), which was completed in 1997. The TCD can selectively draw water from different depths within the lake, including the

deepest, to help maintain river water temperatures beneficial to salmon. The TCD is effective in helping to reduce winter-run Chinook salmon mortality in some critically dry years[1], and for fall- and spring-run Chinook salmon in below-normal years.

However, implementing requirements in the Trinity River ROD (as amended) may reduce water temperature improvements provided by the TCD at Shasta Dam. One of the major elements of the Trinity River ROD is reducing the average annual export of Trinity River water from 74 percent to 52 percent of the flow (Reclamation 2000). This reduces flow from the Trinity River basin into Keswick Reservoir, and then into the Sacramento River. Because water diverted from the Trinity River is generally cooler than flows released from Shasta Dam, implementing the Trinity River ROD offsets some of the benefits derived from the TCD.

Although some fluctuations occur from year to year, the overall trend for the past 10 years has shown increases in Sacramento River winter-run Chinook salmon populations (DFG 2010). This increasing trend in salmon populations is likely due primarily to minimum release requirements at Shasta Dam, and to the TCD. In addition, Reclamation's construction of the RBPP is expected to benefit Chinook salmon populations in the Sacramento River. However, there is a residual need for generally cooler water in the Sacramento River, especially in dry and critically dry water years.

In the future, the effects of climate change on operations at Shasta Lake could potentially result in changes to water temperature, flow, and ultimately, fish survival. As described in the Climate Change Projection Appendix, climate change could result in increased inflows to Shasta Lake and higher reservoir releases due to an increase in winter and early spring inflow into the lake from high intensity storm events. The change in reservoir releases could be necessary to manage flood events resulting from these potentially larger storms. Climate change could also result in reduced end-of-September carryover storage volumes, resulting in lower lake levels for a portion of the year, and a smaller cold-water pool, resulting in warmer water temperature and reduced water quality within Shasta Reservoir.

Most importantly, it is expected that climate change may result in increased water temperatures downstream from Shasta Dam, particularly in summer months, and more frequent wet and drought (particularly extended drought) years. Increased water temperatures and extended drought periods may compound the threats to anadromous fish in the Sacramento River. Winter-run Chinook salmon are particularly vulnerable to potential climate warming, prolonged droughts, and catastrophic environmental events because they have only one remaining population that spawns during the summer months, when water temperature increases are expected to be the greatest (NMFS 2009b).

[1] Water year types are based on the Sacramento Valley Water Year Hydrologic Classification

Water Supply Reliability

California's water supply system faces critical challenges with demands exceeding supplies for urban, agricultural, and environmental water uses across the State. The 2009 *California Water Plan Update* (DWR) concludes that California is facing one of the most significant water crises in its history; drought impacts are growing, ecosystems are declining, water quality is diminishing, and climate change is affecting statewide hydrology. Compounding these issues, Reclamation's *Water Supply and Yield Study* (2008a) describes dramatic increases in population, land use changes, regulatory requirements, and limitations on storage and conveyance facilities, further straining available water supplies and infrastructure to meet water demands. Furthermore, projected unmet water demands are expected to increase competition for water supplies among urban, agricultural, and environmental uses.

The following subsections discuss key issues related to water supply reliability in California, including current and estimated water shortages, anticipated effects of population growth and climate change on water supply and demand, and limitations on system flexibility. The final subsection discusses strategies for meeting future statewide water supply needs.

Estimated Water Supply Shortages

Projecting accurate and quantified water supply and shortages in California is complex; there are numerous variables and, just as important, numerous opinions regarding these variables. Table 2-1 shows estimated water demands, available supplies, and shortages for the Central Valley and the State under existing conditions (Reclamation 2008a). Current water supply shortages for the State are estimated at 2.3 and 4.2 MAF for average and dry years, respectively. As shown in Table 2-2, without further investment in water management and infrastructure, future statewide shortages are expected to increase to approximately 4.9 and 6.1 MAF in average and dry years, respectively, by 2030. Representative demands for dry and average years were based on water use data from the 2005 *California Water Plan Update* (DWR), adjusted for population growth, increasing urban water use, and reductions in irrigated acreage and environmental flow due to insufficient water supplies. Shortages were determined on a regional basis, assuming that limitations on conveyance and storage would prevent surpluses from one region or use category from filling shortages in another.

Table 2-1. Estimated Water Demands, Supplies, and Shortages Under Existing Conditions

Item	Hydrologic Basin						State of California	
	Sacramento		San Joaquin		Two-Basin Total			
	Average Year[1]	Dry Year[1]	Average Year[1]	Dry Year[1]	Average Year[1]	Dry Year[1]	Average Year[1]	Dry Year[1]
Population (million)	2.9		2.0		4.9		36.9	
Water Demand (MAF)								
Urban	0.9	0.9	0.6	0.6	1.5	1.5	8.9	9.0
Agricultural	8.7	8.7	7.0	7.0	15.7	15.7	34.2	34.2
Environmental	11.9	9.4	3.1	2.3	15.0	11.7	17.5	13.9
Total	***21.5***	***19.0***	***10.7***	***9.9***	***32.2***	***28.9***	***60.6***	***57.1***
Water Supply (MAF)								
Urban	0.9	0.9	0.6	0.6	1.5	1.5	8.8	8.4
Agricultural	8.7	8.6	6.9	7.0	15.6	15.6	33.2	32.0
Environmental	11.5	8.7	2.5	1.8	14.0	10.5	17.5	12.6
Total	***21.1***	***18.2***	***10.0***	***9.4***	***31.1***	***27.6***	***60.6***	***53.0***
Total Shortage (MAF)[2]	**0.4**	**0.8**	**0.7**	**0.5**	**1.1**	**1.3**	**2.3**	**4.1**

Sources: Reclamation 2008a, Department of Finance 2010.

Notes:

[1] Representative dry and average year supplies and demands were based on adjusted water use and supply data from the 2005 California Water Plan Update (DWR 2005).

[2] Total shortages are calculated as the sum of shortages for each category by region and, therefore, may not equal the difference between total demands and supplies. For categories where supply is greater than demand, the shortage is equal to zero.

Key:
MAF = million acre-feet

Table 2-2. Estimated Water Demands, Supplies, and Shortages for 2030

Item	Sacramento and San Joaquin Hydrologic Basins		State of California	
	Two-Basin Total			
	Average Year[1]	Dry Year[1]	Average Year[1]	Dry Year[1]
Population (million)	10.5		49.2	
Water Demand (MAF)				
Urban	2.4	2.5	11.9	12.0
Agricultural	15.0	15.0	31.4	31.4
Environmental	14.9	11.7	17.5	14.0
Total	***32.3***	***29.2***	***60.8***	***57.4***
Water Supply (MAF)				
Urban	1.5	1.5	8.4	8.0
Agricultural	15.6	15.6	32.8	31.5
Environmental	14.0	10.5	16.3	12.6
Total	***31.1***	***27.6***	***57.5***	***52.1***
Total Shortage (MAF)[2]	**1.8**	**2.2**	**4.9**	**6.1**

Sources: Reclamation 2008a, Department of Finance 2010.

Notes:

[1] Representative dry and average year supplies and demands were based on water use and supply data from the 2005 *California Water Plan Update* (DWR 2005) adjusted for population growth, increasing urban water use, and reductions in irrigated acreage and environmental flow due to insufficient water supplies.

[2] Total shortages are calculated as the sum of shortages for each category by region and, therefore, may not equal the difference between demands and supplies. For categories where supply is greater than demand, the shortage is equal to zero.

Key: MAF = million acre-feet

Potential Effects of Population Growth on Water Demands

A major factor in California's future water picture is population growth. California's population is expected to increase by just over 60 percent by 2050 (California Department of Finance 2010) and could force some of the existing water supplies currently identified for agricultural uses to be redirected to urban uses. Some portion of increased population in the Central Valley would occur on lands currently used for irrigated agriculture. Water that would have been needed for these lands for irrigation would instead be used to serve replaced urban demands. However, this would only partially offset the required agricultural-to-urban water conversion needed to sustain projected urban water demands, since much of the growth would occur on nonirrigated agricultural lands.

The 2009 *California Water Plan Update* (DWR) estimates changes in future water demands by 2050 considering three different population growth scenarios as well as climate change. Table 2-3 shows results of this study for an average water year (DWR 2009). The first scenario (Current Trends) assumes that recent population growth trends will continue until 2050. The second scenario (Slow and Strategic Growth) assumes that population growth will be slower than currently projected. The third scenario (Expansive Growth) assumes that

population growth will be faster than currently projected, with nearly 70 million people living in California in 2050. Estimated reductions in agricultural water demands in Table 2-3 represent decreases in future agricultural water demands due to conversion from agricultural to urban land uses. Under the Current Trends and Expansive Growth scenarios, as much as 3 MAF and 8 MAF, respectively, of increased demand is projected, adding to the current water shortages estimated in Table 2-1.

Table 2-3. Estimated Annual Change in Water Demand in California for 2050 Considering Different Population Growth Scenarios

Item	Current Trends	Slow and Strategic Growth	Expansive Growth
Population (million)	59.5	44.2	69.8
Irrigated Crop Acreage (million)	8.6	9	8.3
Water Demand Change[1] (MAF)			
Urban	7	2	11
Agricultural	-4.5	-5.5	-4
Environmental	1	2	1
Total	***3***	***-1.5***	***8***

Source: DWR 2009

Note:

[1] Water demand change is the difference between the average demands for 2043—2050 and 1998—2005.

Key:

MAF = million acre-feet

Potential Effects of Climate Change on Water Supply and Demand

Another potentially significant factor affecting water supply reliability is climate change. Potential impacts due to climate change are many and complex (DWR 2006), varying through time and geographic location across the State (Reclamation 2011b). Changes in geographic distribution, timing, and intensity of precipitation are projected for the Central Valley (Reclamation 2011b), which could broadly impact rainfall runoff relationships important for flood management as well as water supply. Additionally, when climate change is considered in projections of future water demand, annual water demand is higher than under a repeat of historical climate (DWR 2009). Other possible impacts range from potential sea level rise, which could impact coastal areas and water quality, to impacts to overall system storage for water supply.

A reduction in total system storage is widely predicted to occur with climate change. Precipitation held in snowpack makes up a significant quantity of total annual supplies needed for urban, agricultural, and many environmental uses. It is expected that in the future, climate change may significantly reduce water held in snowpack in the Sierra Nevada (Reclamation 2011b, DWR 2009). Further potential for reductions in water conservation space in existing reservoirs in the Central Valley is anticipated because of increasing needs for

additional space for flood management purposes. These potential reductions could significantly impact available water supplies, especially for reservoirs immediately upstream from large urban areas such as Folsom Lake on the American River, upstream from the greater Sacramento metropolitan area. During drought periods, supplies could be further reduced, and expected water shortages would be significantly greater. Possible effects of climate change on water supply in California are discussed in greater detail in the Climate Change Projection Appendix.

System Flexibility

In addition to concerns about future water supply and demand, California's Federal and State water systems lack flexibility in timing, location, and capacity to meet the multiple objectives of the projects. CVP and SWP flexibility has diminished with population growth and increased environmental and ecosystem commitments and requirements (Reclamation 2008a). Complicating this issue is the variability associated with water resources in California. Precipitation in California is seasonably, temporally, and spatially variable, and urban, agricultural, and environmental water users have variable needs for quantity, quality, timing, and place of use.

California's water systems face the threat of too much water during floods, and too little water to meet demands during dry and critical water years. Chronic water shortages have led to increases in groundwater usage, which has led to groundwater overdraft in many regions across the State. Groundwater overdraft can cause permanent declines in groundwater levels, long-term reductions in groundwater supplies, land subsidence, decreases in water quality, a greater potential for salt water intrusion, and lasting environmental impacts. Challenges are greatest during drought years, when water supplies are less available (DWR 2009).

Increasing CVP/SWP operational constraints have led to growing competition for limited system resources between various users and uses. Urban and required environmental water uses have each increased, resulting in increased competition and conflicting demands for limited water supplies. For example, the CVPIA, implemented in 1993, dedicated 800 thousand acre-feet (TAF) of CVP water supplies to the environment as well as additional water supplies for the Trinity River and wildlife refuges. Table 2-4 illustrates the impacts of the CVPIA, modeled using CalSim-II, on urban and agricultural water deliveries to the north and south of the Delta. Dry year agricultural water deliveries were particularly impacted with deliveries to agricultural users, both north and south of the Delta, reduced by about 50 percent. Current biological opinions (2008 USFWS BO and 2009 NMFS BO), resulting in increased Delta pumping constraints and other operational restrictions, coupled with drought conditions, have even further decreased CVP deliveries. As competition for limited resources grows, water management flexibility and adaptability will be even more necessary in the future.

Table 2-4. Impact of CVPIA on CVP Deliveries

CVP Contract Deliveries	All Years			Driest Years		
	Pre-CVPIA Implementation (TAF)	Post-CVPIA Implementation (TAF)	Percent Change	Pre-CVPIA Implementation (TAF)	Post-CVPIA Implementation (TAF)	Percent Change
NOD Urban	176	167	-5%	166	145	-13%
NOD Agriculture	279	234	-16%	169	84	-50%
SOD Urban	134	122	-9%	114	96	-16%
SOD Agriculture	1,588	1,137	-28%	931	471	-49%
Total	**2,176**	**1,660**	**-24%**	**1,381**	**796**	**-42%**

Source: Reclamation 2008a
Note:
[1] Deliveries were modeled using CalSim-II.
Key:
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
NOD = north of Delta
SOD = south of Delta
TAF= thousand acre-feet

Strategies to Address Water Supply Needs

As noted by Reclamation's *Water Supply and Yield Study* (2008a), the *California Water Plan Update* (DWR 2009), and CALFED (2000a), an integrated portfolio of solutions, regional and statewide, is needed to meet future water supply needs. The *Water Supply and Yield Study* stated that a "variety of storage and conveyance projects and water management actions have the potential to help fill [the] gap" between water supply and demand in California. The 2009 *California Water Plan Update*, concluded that California must invest in reliable, high quality, and affordable water conservation; efficient water management; and development of water supplies to protect public health, and improve California's economy, environment, and standard of living. However, even with major efforts by multiple agencies to address the complex water resources issues in the State, demands are expected to continue to exceed supplies in the future.

To avoid major impacts to the economy, overall environment, and standard of living in California, actions to conserve existing supplies and optimize the use of existing facilities will be needed. Additionally, development of additional water sources and increased storage and delivery capability are critical for providing reliable water supplies for expanding M&I uses and to maintain adequate supplies for agricultural and environmental purposes.

Ecosystem Resources

The health of the Sacramento River ecosystem, as elsewhere in the Central Valley, has been impacted in the last century by conflicts over the use of limited natural resources, particularly water resources. Humans have harnessed many of California's rivers and streams for beneficial uses such as hydropower, flood damage reduction, and water supply, contributing to a decline in habitat and

native species populations, and a resulting increase in endangered or threatened species listings under the Federal ESA and CESA.

Construction of Shasta Dam has had both negative and positive effects on environmental resources in the region. Negative effects of Shasta Dam include blocking historic fish migration into the upper watersheds of the Sacramento River, modifying seasonal flow patterns and the natural riverine processes they support, and inundating fish and wildlife habitat.

While construction of the dam displaced valuable riverine and upland habitat, it also created shoreline and shallow water habitat for aquatic, terrestrial, and avian species in the reservoir area. For example, Shasta Lake is home to the largest concentration of nesting bald eagles in California, with 18 pairs nesting within 0.5 miles of the shoreline in any given year.

Shasta Lake Area

Various activities have impacted natural resources upstream from Shasta Dam, within the lake, on adjacent lands, and in and near tributary streams. The greatest impact in the area has probably come from historical mining, ore processing practices and resulting acid mine drainage, and fire suppression.

To guide management of the Shasta-Trinity National Forest (STNF), USFS has prepared the *Shasta-Trinity National Forest Land and Resource Management Plan* (STNF LRMP) (USFS 1995). Primary goals of the STNF LRMP, which was implemented in 1995, are to integrate a mix of management activities that allows use and protection of forest resources; meets the needs of guiding legislation; and addresses local, regional, and national issues. The STNF LRMP is intended to guide implementation of the *Aquatic Conservation Strategy of the Northwest Forest Plan* (USFS 1994) for protection and management of riparian and aquatic habitats adjacent to Shasta Lake.

Opportunities exist to further support ongoing USFS programs. These opportunities include improving and restoring environmental conditions by developing self-sustaining natural habitat in the area of Shasta Lake and its tributaries to benefit fish and wildlife resources.

Downstream from Shasta Dam

Land and water resources development has caused major resource problems and challenges in the Sacramento River basin, including decreases in anadromous fish and wildlife populations and losses of riparian, wetland, floodplain, and shaded riverine habitat. These decreases and losses have resulted in reduced populations of many plant and animal species.

The quantity, quality, diversity, and connectivity of riparian, wetland, floodplain, and shaded riverine habitat along the Sacramento River have been severely limited through confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, channel stabilization, and land

development. Modification of seasonal flow patterns by dams and water diversions also has inhibited the natural channel-forming processes that drive riparian habitat succession. It is estimated that less than 5 percent of the historical acreage of riparian habitat within the Sacramento River basin remains today (Huber-Lee et al. 2003).

Decreases in quality and quantity of habitat have resulted in reduced populations of various fish and wildlife species. The low populations and questionable sustainability of these species have led to an increase in listings under the Federal ESA and CESA in recent years. Introduction of nonnative species has also contributed to the decline in native animal and plant species. In addition, lack of linear continuity of riparian habitat has impacted the movement of wildlife species among habitat areas, adversely affecting dispersal, migration, emigration, and immigration. For many species, this has resulted in reduced wildlife numbers and population viability.

Ecosystem restoration along the Sacramento River has been the focus of several programs, including the SB 1086 Program, CVPIA, CALFED, and Central Valley Habitat Joint Venture. These and numerous local programs have been established to address ongoing conflicts over the use of limited resources within the Central Valley. Much effort has been directed in the upper Sacramento River region above the location of the RBDD toward restoring or improving anadromous fisheries, which provide recreational and commercial values in addition to their environmental value. Despite these efforts, a significant need remains to conserve and restore ecosystem resources along the Sacramento River.

Endangered and threatened fish and wildlife populations, critical habitat, and sensitive Delta ecosystems are also declining. The decline is especially pronounced in the case of pelagic fish species in the Delta, including delta smelt, striped bass, threadfin shad, and longfin smelt. Recent monitoring results indicate that the threatened delta smelt population continues to remain at or near all-time lows and, as a result, delta smelt have been recommended for relisting as endangered. Observations of sharp declines in fish population have resulted in restrictions on Delta water operations to protect fish populations during environmentally sensitive periods. Legal actions concerning the impacts of CVP and SWP operations on fish populations, such as the December 2007 *Natural Resources Defense Council v. Kempthorne* (delta smelt), court decision and the May 2008 *Pacific Coast Federation of Fishermen's Associations v. Gutierrez* (anadromous fish species) court decision, continue to shape water management in the Sacramento River basin and Delta.

In recognition of the challenges facing water management in California, and the need to develop new strategies for a sustainable Delta ecosystem that would continue to support its economic functions, various planning efforts are underway. Current planning efforts, such as the BDCP/DHCCP, are focused on developing ecological solutions to recover endangered and sensitive species in

the Delta while increasing water supply reliability through various actions including improving Delta conveyance. Greater operational flexibility within the CVP/SWP system is needed to address ecosystem concerns in the Sacramento River and Delta.

Flood Management

Large and small communities and agricultural lands in the Central Valley are subject to flooding along the Sacramento River. USACE, in partnership with DWR, has worked to assess basin-wide flood management issues and identify options in the Sacramento River basin to address these issues. Measures to reduce high flows in the Sacramento River include spilling floodwater into bypass areas through historical overflow areas, streams, conveyance canals, and weirs. The comprehensive flood control system in the Sacramento River basin includes river, canal, and stream channels, levees, flood relief bypasses, weirs, flood relief structures, a natural overflow area, outfall gates, and drainage pumping plants. USACE and DWR continue to develop improvements associated with the Sacramento River Bank Protection Project and to assist in local flood damage reduction projects along the Sacramento River. DWR is currently developing the Central Valley Flood Protection Plan, addressing flood issues throughout the Sacramento and San Joaquin valleys and the Delta.

Flooding poses risks to human life, health, and safety. Threats to the public from flooding are caused by many factors, including overtopping or sudden failures of levees, which can cause deep and rapid flooding with little warning, threatening lives and public safety. In addition, urban development in flood-prone areas has exposed the public to the risk of flooding.

Physical impacts from flooding occur to residential, agricultural, commercial, industrial, institutional, and public property. Damages occur to buildings, contents, automobiles, and outside property, including agricultural crops, equipment, and landscaping. Physical damages include cleanup costs and costs to repair roads, bridges, sewers, power lines, and other infrastructure components. Nonphysical flood losses include income losses and the cost of emergency services, such as flood fighting and disaster relief.

Even though a project to enlarge Shasta Dam and Reservoir has the potential to significantly reduce flood flows in the upper Sacramento River, influencing factors exist that can conflict with flood operation. Flood management operations at Shasta Dam, even with explicit rules provided in the Shasta Dam and Lake Flood Control Diagram (USACE 1977), are difficult to manage during a flood event. This is primarily due to the extreme inflow volumes to Shasta Reservoir that can occur over long periods, numerous points of inflow along the river downstream from Shasta Dam, and multiple points of operational interest downstream. The primary downstream control point along the Sacramento River that determines reservoir releases under real-time operations is Bend Bridge.

Other unofficial factors enter into flood management decisions, such as peak flows at Hamilton City or other rural communities that are at risk of flooding. These factors, combined with the uncertainty of storm forecasting, could lead to a reduction in flood operation flexibility at Shasta Dam. Should this occur, it could cause a cascading impact on effective flood management downstream to the Delta. Accordingly, there is a need to review flood control operations at Shasta Dam.

Hydropower

Were California a nation, it would be the twelfth largest consumer of electricity world-wide (California Energy Commission 2002). Among the 50 States, California is the second largest consumer of electricity. Although California has 12 percent of the Nation's population, it uses only 7 percent of the Nation's electricity. This makes California the most energy-efficient State per capita in the Nation. Even so, demands for electricity are growing at a rapid pace.

As an example, over the next 10 years, California's peak demand for electricity is expected to increase 30 percent, from about 50,000 megawatts (MW) to about 65,000 MW. There are, and will continue to be, increasing demands for new electrical energy supplies, including clean energy sources, such as hydropower. Executive Orders S-14-08 and S-21-09, issued in 2008 and 2009 respectively, established a goal of using renewable energy sources, including hydropower, for 33 percent of the State's energy consumption by 2020 (California Public Utilities Commission 2011). Adding to the need for additional energy sources, existing nuclear power plants are nearing the end of their design lives and some may be offline within the next 10 to 20 years.

Recreation

As the population of the State of California continues to grow, demands will increase significantly for water-oriented recreation at and near the lakes, reservoirs, streams, and rivers of the Central Valley. This increase in demand will be especially pronounced at Shasta Lake. USFS manages recreation uses at Shasta Lake. USFS has expressed concern about seasonal capacity problems at existing marinas and USFS facilities. A significant and increasing need exists to improve recreation-related facilities and conditions at Shasta Lake. Any increase in the water surface area at the lake would be one element of a plan to help meet future recreation demands.

Water Quality

The Sacramento River and the Delta support fish and wildlife while providing water supplies for urban, agricultural, and environmental uses across the state. The Sacramento River downstream from Keswick Dam is critical habitat for the migration and reproduction of Chinook salmon (NMFS 2009b) and the Delta is one of the largest ecosystems for fish and wildlife habitat and production in the United States (California Water Boards, SWRCB, and Cal/EPA 2006). However, saltwater intrusion, municipal discharges, agricultural drainage, and water project flows and diversions have led to water quality issues within the

Delta, particularly related to salinity, that have resulted in significant declines in pelagic populations (California Water Boards, SWRCB, and Cal/EPA 2006). In the Sacramento River and its tributaries, water temperatures, which are vital for anadromous fish survival, are affected by variations in climate and rainfall as well as operating conditions of various Federal, State, and local water supply systems. Additionally, urban and agricultural runoff, and runoff and seepage from abandoned mining operations, have resulted in elevated levels of pesticides, phosphorous, mercury, and other metals in the Sacramento River.

Several environmental flow goals and objectives in the Central Valley, including the Delta, have been established through legal mandates to address the impacts of water operations and water quality deterioration on the Sacramento River basin and Delta ecosystems and on endangered and threatened fish populations. Planning efforts, such as the BDCP, are intended allow implementation of projects that restore and protect water supply and reliability, water quality, and ecosystem health in the Delta to proceed within a stable regulatory framework. Additional operational flexibility is needed to provide further opportunities to improve Sacramento River and Delta water quality conditions. Increasing storage in Shasta Reservoir could provide increased CVP operational flexibility to meet water quality goals in the Delta, as well as provide more cold-water storage in critical years to improve Sacramento River water temperatures.

Existing and Likely Future Resources Conditions in Study Area

Following is a brief description of significant reservoir area infrastructure and existing and future resource conditions in the study area. Detailed information on the study area is contained in the Preliminary Draft EIS and supporting appendices.

Shasta Dam and Reservoir are located on the upper Sacramento River in Northern California, about 9 miles northwest of the City of Redding; the dam and entire reservoir are within Shasta County. Because of the potential influence of the proposed modification of Shasta Dam, and subsequent water deliveries over a large geographic area, the SLWRI includes both a primary and extended study area, as described in Chapter 1. Figure 1-4 shows the geographic extent of the primary study area. This chapter will focus on the primary study area but will also provide information about potentially affected resources in the extended study area.

The information used to assess existing and future resources conditions for water operations was developed in 2006 for the SLWRI, and was based on the coordinated CVP and SWP operational conditions and criteria described in the 2004 OCAP BA (Reclamation 2004c) and the Coordinated Operations Agreement between Reclamation and DWR for the CVP and SWP, as ratified by Congress. The rationale for using existing studies as the basis of analysis in

the Draft Feasibility Report and accompanying Preliminary Draft EIS is given in this section.

Reservoir Area Infrastructure

Existing infrastructure in the primary study area includes Shasta Dam and Reservoir, associated water management facilities, numerous recreation amenities, and various other public and private infrastructure (Reclamation 2003c), as described below.

Figure 2-2. Shasta Dam and Reservoir Looking North Toward Mount Shasta

Shasta Dam is a curved, gravity-type, concrete structure that rises 533 feet above the streambed with a total height above the foundation of 602 feet. The dam has a crest width of about 41 feet and a length of 3,460 feet. At full pool, Shasta Lake has a storage capacity and water surface area of 4.55 MAF and 29,500 acres, respectively. Seasonal flood control storage space in Shasta Reservoir is about 1.3 MAF. Figure 2-2 is an aerial view of Shasta Dam and Reservoir. Figure 2-3 shows the relationship between reservoir surface area and storage capacity at various water surface elevations.

The Shasta Powerplant consists of five main generating units and two station service units with a combined capacity of 715,000 kilowatts (kW). Several elevation and plan views of Shasta Dam and Powerplant are provided in the Engineering Summary Appendix. These drawings were prepared before construction of the existing temperature control facilities on the upstream face of the dam.

The existing TCD at Shasta Dam was constructed from 1996 through 1997. It is a multilevel water intake structure located on the upstream face of the dam. The TCD allows operators to draw water from the top of the reservoir during the winter and spring when surface water temperatures are cool, and from deeper in the reservoir in the summer and fall when surface water is warm. It also improves oxygen and sediment levels in downstream river water. The TCD helps Reclamation fulfill contractual obligations for both water delivery and power generation while benefiting fish, such as Chinook salmon, that require cooler water temperatures.

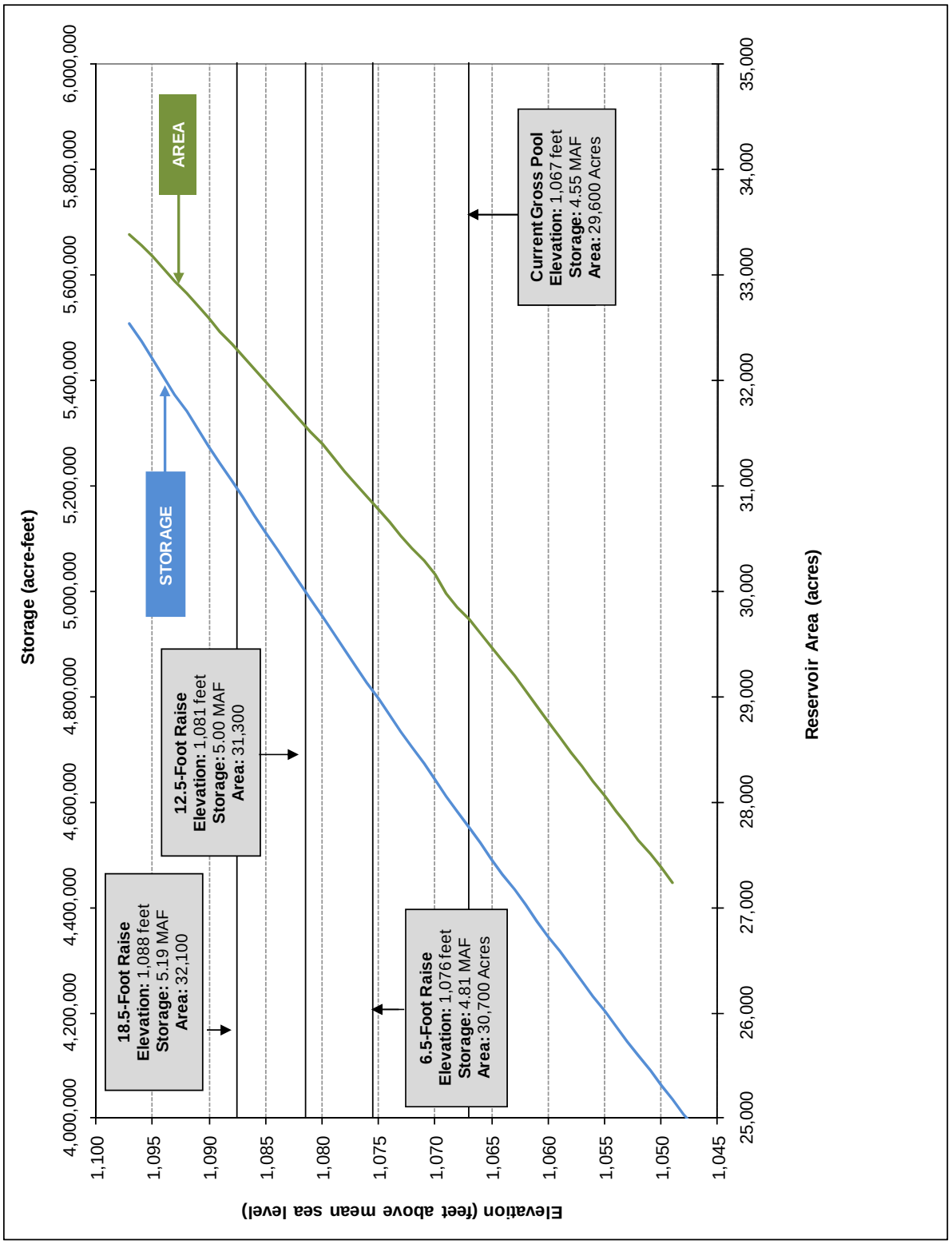


Figure 2-3. Shasta Reservoir Area-Capacity Relationships

Shasta Dam is operated in conjunction with Keswick Dam and Reservoir, located about 9 miles downstream from Shasta Dam. In addition to regulating outflow from Shasta Dam, Keswick Dam controls runoff from 45 square miles of drainage area. Keswick Dam is a concrete, gravity-type structure with a spillway over the center of the dam. The spillway has a discharge capacity of 248,000 cubic feet per second (cfs) at a full pool elevation of 587 feet above mean sea level (elevation 587). Storage capacity of Keswick Reservoir below the top of the spillway gates at full pool is 23,800 acre-feet. The powerplant has a nameplate generating capacity of 105,000 kW and can pass about 15,000 cfs at full pool.

Table 2-5 summarizes the pertinent data and features of Shasta Dam and Reservoir and Keswick Dam and Reservoir. Shasta Dam operations are summarized later in this chapter in the section on "Physical Resources Environment."

Existing Conditions Summary

The following sections summarize existing conditions for physical, biological, cultural, and socioeconomic resources within the SLWRI study area. Additional detailed information is included in the accompanying Preliminary Draft EIS and the Physical Resources Appendix, Biological Resources Appendix, Cultural Resources Appendix, and Socioeconomics Appendix.

Physical Resources Environment

Elements of the existing physical environment described in this section include topography, geology, and soils; geomorphology, sedimentation, and erosion; climate and air quality; hydrology; water quality; noise and vibration; hazardous materials; and agricultural and important farmlands.

Topography, Geology, and Soils Shasta Dam and Lake are located on the northern edge of the Central Valley. The topography of the area surrounding Shasta Lake is generally steep and mountainous. Ground surface elevations near Shasta Lake range from above elevation 14,000 at Mount Shasta to approximately elevation 1,070 at Shasta Lake. Other topographic features in the primary study area include major tributary drainages above Shasta Dam – the Sacramento, McCloud, and Pit rivers, and Squaw Creek, as well as several smaller drainages. Downstream from Shasta Dam are numerous major tributaries to the Sacramento River. Much of the extended study area is contained within the Central Valley, which is almost completely enclosed by mountains and has only one outlet, through San Francisco Bay, to the Pacific Ocean. Topography in the extended study area is dominated by the flat expanses of the Sacramento River basin, Delta, and San Joaquin River basin. Topography of the Delta includes a network of over 700 miles of interconnecting waterways with more than 600 islands and tracts, with land surfaces ranging from about elevation 20 to more than 20 feet below mean sea level.

Table 2-5. Pertinent Data – Shasta Dam and Reservoir and Keswick Dam and Reservoir

General			
Drainage Areas (excluding Goose Lake basin)		**Mean Annual Runoff (1908 – 2006)**	
Sacramento River at Shasta Dam	6,421 sq-mi	Sacramento R. at Shasta Dam	5,737,000 acre-feet
Sacramento River at Keswick Dam	6,468 sq-mi	Sacramento R. near Red Bluff	8,421,000 acre-feet
Sacramento River near Red Bluff	8,900 sq-mi	Sacramento River maximum flows	
Sacramento River near Ord Ferry	12,250 sq-mi	At Shasta Lake (January 16, 1974)	216,000 cfs
Pit River at Big Bend	4,710 sq-mi	Near Red Bluff (February 28, 1940)	291,000 cfs
McCloud River above Shasta Lake	604 sq-mi	At Ord Ferry (February 28,1940)	370,000 cfs
Sacramento River at delta above Shasta Lake	425 sq-mi		
Shasta Dam and Reservoir			
Shasta Dam (concrete gravity)		**Shasta Reservoir**	
Crest elevation	1,077.5 feet	Full pool elevation	1,067.0 feet
Freeboard above full pool	10.5 feet	Minimum operating level elevation	840.0 feet
Height above foundations	602 feet	Take line elevation	Irregular
Height above streambed	487 feet	Surface area	
Length of crest	3,500 feet	Minimum operating level	6,700 acres
Width of crest	30 feet	Full pool	29,500 acres
Slope, upstream	Vertical	Take line	90,000 acres
Slope, downstream	1 on 0.8 cu-yd	Storage capacity	
Structure volume	8,430,000 cu-yd	Minimum operating level	587,000 acre-feet
Normal tailwater elevation	585 feet	Full pool	4,552,000 acre-feet
Spillway (gated ogee)		**Shasta Powerplant**	
Crest length		Main units	
Full pool	360 feet	5 turbines, Francis type	515,000 hp (total)
Net	330 feet	5 units @ 142 MW	710 MW (total)
Crest gates (drum type)		Station units	
Number and size	3@110 feet x 28 feet	2 generators, 2,500 kW each	5,000 kW (total)
Top elevation when lowered	1,037.0 feet	Elevation centerline turbines	586 feet
Top elevation when raised	1,065.0 feet	Maximum tailwater elevation	632.5 feet
Discharge capacity at pool (elevation 1,065 feet)	186,000 cfs	Total discharge at pool (1,065 feet)	14,500 cfs

Table 2-5. Pertinent Data – Shasta Dam and Reservoir and Keswick Dam and Reservoir (contd.)

Shasta Dam and Reservoir (contd.)			
Spillway (gated ogee) (contd.)		**Shasta Powerplant (contd.)**	
Flashboard gates	3@110 feet x 2 feet	Total discharge at pool (827.7 feet)	16,000 cfs
Top elevation when lowered	1,067.0 feet	Power outlets (15-foot steel penstocks)	
Bottom elevation when raised	1,069.5 feet	5 with invert elevation of intake	807.5 feet
Outlets (102-inch-diameter conduit with 96-inch-diameter wheel-type gate)			
4 with invert elevation	737.75 feet	Capacity at elevation 1,065	81,800 cfs
8 with invert elevation	837.75 feet	Capacity at elevation 827.7	12,200 cfs
6 with invert elevation	937.75 feet		
Keswick Dam and Reservoir			
Keswick Dam (concrete gravity)		**Keswick Reservoir**	
Crest elevation	595.5 feet	Elevation – maximum operating level	587.0 feet
Freeboard above maximum operating level	8.5 feet	Elevation – minimum operating level	574.0 feet
Height of dam above foundation	159 feet	Surface area at maximum operating level	643 acres
Height of dam above streambed	119 feet	Storage capacity	
Length of crest	1,046 feet	At maximum operating level	23,800 acre-feet
Width of crest	20 feet	At minimum operating level	16,300 acre-feet
Volume	197,000 cu-yd	**Keswick Powerplant**	
Normal tailwater elevation	487 feet	3 generator units	105,000 kW (total)
Spillway (gated ogee)			
Crest length	200 feet		
Crest gates (fixed wheel)	4 gates, 50 feet x 50 feet each		
Discharge capacity at pool, elevation 587	248,000 cfs		

Key:
cfs = cubic feet per second
cu-yd = cubic yard
elevation = elevation in feet above mean sea level
hp = horsepower
kW = kilowatt
MW = megawatt
R = River
sq-mi = square mile

The geology of the study area is highly complex, containing portions of five geomorphic provinces: the Klamath Mountain, Coast Range, Great Valley, Cascade Range, and Modoc Plateau. Shasta Lake is located within the Klamath Mountain Geomorphic Province at the north end of the Sacramento Valley. Geology of the Klamath Mountains to the north and west of the study area, including Shasta Lake and its tributaries, comprises older bedrock materials, sedimentary basin deposits, and volcanic deposits. Alluvial deposits overlay a large portion of this area, and soils are mainly derived from metamorphic rock and deep alluvium. Limestone caves provide habitat for several cave-dwelling species in the area. The segment of the study area along the Sacramento River downstream to the location of the RBDD encompasses portions of the Klamath Mountain, Great Valley, and Cascade Range geomorphic provinces. The Cascade Range to the east comprises primarily volcanic formations and volcanic sedimentary deposits. The Great Valley Geomorphic Province (also referred to as the Central Valley) is a large structural trough formed between the uplands of the California Coast Range to the west and the Sierra Nevada to the east. This trough is filled with a sequence of sediments ranging in age from Jurassic to Recent.

Principal formations downstream along the Sacramento River to Red Bluff include the Tehama, Riverbank, Chico, and Red Bluff formations, which contain marine and nonmarine sedimentary rocks eroded from the surrounding Cascade Range and Klamath Mountains. The deep alluvial and aeolian soils of the Central Valley floor make up some of the best agricultural land in the State. Delta soils comprise primarily intertidal deposits of soft mud and peat, with organic peat soils up to 60 feet deep in some areas.

Geomorphology, Sedimentation, and Erosion Much of the area around Shasta Lake and adjacent to the lower reaches of its tributaries is characterized by active and historic mass wasting processes. The steep hillsides and coarse soils are subject to mud flows, debris flows, slides, and other forms of mass erosion. The Sacramento River between Shasta Lake and Red Bluff is characterized by steep, vertical banks, and the river is primarily confined to its channel with limited overbank floodplain areas, resulting in limited channel migration and meander. Downstream from Red Bluff, the Sacramento River is active and sinuous, meandering across alluvial deposits within a wide meander belt. Natural geomorphic processes in the Delta and Sacramento River have been highly modified by changes to upstream hydrology (reservoirs and stream flow regulation) and construction of levees, channels, and other physical features.

Watersheds for many of the tributaries of Shasta Lake have been significantly altered by a number of factors that cause sediment influxes and accelerated erosion, including logging and hydraulic mining; construction of dams, roads, reservoirs, and channel modifications; wildfires; and agricultural and urban activities. Slides and sheet wash typically supply debris and sediments to the tributary streams of Shasta Lake during the rainy season. Because much of the

terrain is steep, landslides are common and vary in intensity. In addition to sediment carried into Shasta Lake via tributaries, shoreline erosion contributes to a portion of sediment deposition in the reservoir. Shoreline erosion is caused by seasonal changes in reservoir water levels and, to some extent, by recreational activities in and around the lake. The shoreline below full pool elevation is generally steep and devoid of vegetation that might otherwise help stabilize soils.

Shasta and Keswick dams have a significant influence on sediment transport in the upper Sacramento River because they block sediment that would normally have been transported downstream. The result has been a net loss of coarse sediment, including salmon spawning gravels, in the Sacramento River below Keswick Dam. In alluvial river sections, bank erosion and sediment deposition cause river channel migrations that are vital to maintaining instream and riparian habitats, but which can cause loss of agricultural lands and damage to roads and other structures. In the Sacramento River, these processes are most important in the major alluvial section of the river, which begins downstream from the RBDD. The river channel in the reach from Keswick Dam to RBDD is constrained by erosion-resistant formations and therefore is more stable.

Climate and Air Quality The northern half of the Central Valley is located in the Sacramento Valley Air Basin (SVAB). The Mediterranean climate of the SVAB is characterized by hot, dry summers and cool, rainy winters. Average temperatures range from about 60 degrees Fahrenheit (°F) in low valley regions to about 40°F in mountain areas. Characteristic of SVAB winters are periods of dense and persistent low-level fog, which are prevalent between storms. Precipitation on the valley floor occurs mostly during winter as rain. Average annual precipitation throughout the Sacramento River basin is 36 inches. Total annual precipitation at higher elevations is as much as 95 inches in the northern Sierra Nevada and the Cascade Range. In the primary study area, measurements recorded at the Shasta Dam station show that normal annual precipitation is approximately 61 inches. Summer air temperatures range from an average low of 62°F to an average high of 95°F. Winter air temperatures range from an average low of 39°F to an average high of 57°F.

In the SVAB, air pollutants can become concentrated during the summer because of inversion layers forming in the lower elevations, subsequently lowering air quality. Winter winds disperse pollutants, often resulting in clear weather and better air quality over most of the region. Much of the SVAB is designated as nonattainment with respect to the National and State ozone and particulate matter (PM) standards; the urban Sacramento and Marysville/Yuba City areas are designated as nonattainment for National and State carbon monoxide standards.

Hydrology Hydrologic features of the study area include perennial, intermittent, and ephemeral stream channels, and natural water bodies and wet meadowlands. The hydrology and climate of the primary study area make it

favorable to water resources development; consequently, streamflow hydrology on the upper Sacramento River and major tributaries to Shasta Lake has been significantly modified by the development of water management and hydropower facilities. The following subsections discuss historical flows and storage at Shasta Reservoir, historical flows in the Sacramento River below Keswick Dam, and flood control operations for Shasta Dam and Reservoir.

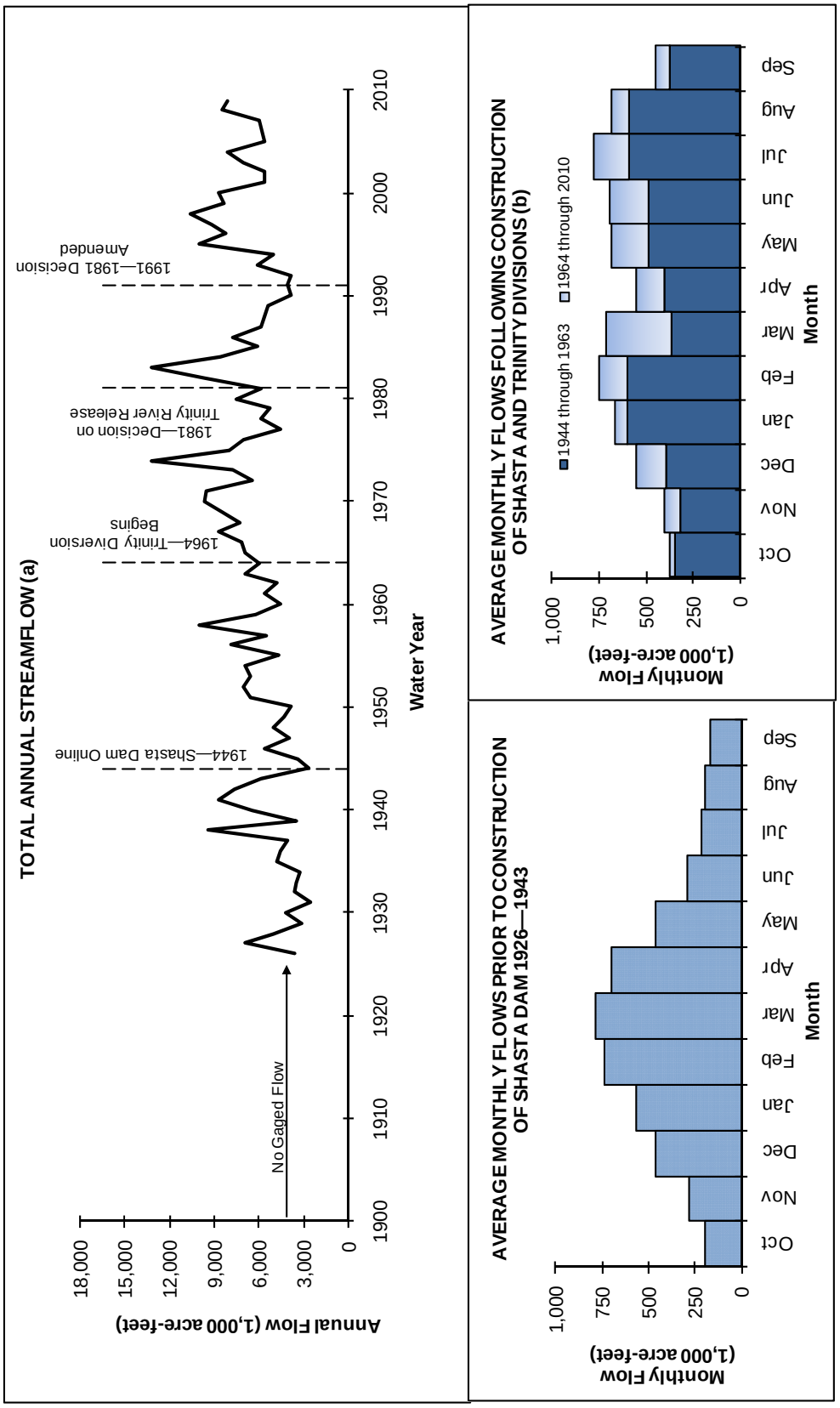
Historical Flows and Storage at Shasta Reservoir. Mean monthly inflow, outflow, and storage at Shasta Reservoir are shown in Table 2-6. The highest average monthly inflow period for Shasta is January through March. Winter and early spring inflows are stored for later release during the summer irrigation season.

Table 2-6. Mean Monthly Inflow, Outflow, and Storage at Shasta Reservoir

Month	Inflow[1] (TAF)	Outflow[2] (TAF)	Storage[3] (TAF)
January	799	587	3,143
February	836	628	3,366
March	889	511	3,732
April	693	421	3,981
May	537	524	3,965
June	339	536	3,730
July	247	615	3,326
August	223	571	2,967
September	220	377	2,808
October	263	301	2,770
November	365	331	2,793
December	585	465	2,911
Total	**5,991**	**5,868**	NA
Average	**499**	**489**	**3,291**

Notes:
[1] Computed data from 1944 through 2002.
[2] Recorded data from 1944 through 2002.
[3] Computed data from 1956 through 2005.
Key:
NA = not applicable
TAF = thousand acre-feet

Historical Flows in the Sacramento River. Historical streamflow in the Sacramento River below Keswick Dam is shown in Figure 2-4. Since 1964, an annual average of 1.27 MAF of Trinity River flow has been exported to the Sacramento River through CVP facilities, or approximately 17 percent of the flows measured in the Sacramento River at Keswick Dam. Trinity River diversions to the Sacramento River were reduced as part of the 2000 Trinity River ROD (as amended) to retain more flows in the Trinity River for fish and associated habitat restoration purposes (Reclamation 2000).



Source: California Data Exchange Center 2011

Notes:

(a) Full year of streamflow data for USGS Station 11370500 was 1939. Data for 1926--1963 are from USGS Station 1136950.

(b) Upper portion of bar represents incremental increase in average monthly flows since Water Year 1964, due to releases from the Trinity River Division.

Figure 2-4. Historical Streamflow in Sacramento River Below Keswick Dam

Flood Control. A storage space of up to 1.3 MAF is kept available for flood control purposes in Shasta Reservoir in accordance with the Shasta Dam and Lake Flood Control Diagram, as prescribed by USACE (1977). Under the diagram, flood storage space requirements increase from zero on October 1 to 1.3 MAF on December 1 and are maintained until December 23. From December 23 to June 15, the required flood storage space varies according to accumulation of seasonal inflow. This variable space allows water to be stored for conservation purposes, unless it is required for flood damage reduction purposes based on basin wetness parameters and the level of seasonal inflow.

Daily flood management operations consist of determining the required flood storage space reservation, and scheduling releases in accordance with flood operating criteria. This requires forecasting flood runoff both above and below the dam. Rapidly changing inflows are continually monitored, and forecasts of the various inflows are adjusted, as required. The large size of the flood pool at Shasta Reservoir can prolong flood release operations for many weeks as operators vacate the pool before the next storm event.

As indicated, a goal of existing operations is to have vacant flood storage space in excess of flood control requirements in the flood season and then fill the pool to the maximum extent possible for water supply and other needs in the remainder of the year. Figure 2-5 is a plot showing historical monthly storage in Shasta Reservoir for 1953 through 2008.

Table 2-7 shows the historical annual inflow, storage, and outflow history for Shasta Reservoir from 1945 through 2007. Releases for flood damage reduction purposes either occur in the fall, to reach the prescribed vacant flood space beginning in early October, or to evacuate space during or after a storm event to maintain the prescribed vacant flood space in the reservoir. Releases for flood management occur either over the spillway during large events or through river outlets for smaller events. As shown in Table 2-7, from about 1950 through 2007, flows over the spillway occurred in 12 years, or in 20 percent of post-1950 years. It is estimated that releases for flood management occurred in 49 years between 1950 and 2007, or nearly 90 percent of the years.

For flood events rarer than about 1 chance in 100 in any 1 year, inflows to Shasta Lake would exceed the ability of the reservoir to store the inflow volume and maintain the estimated safe channel-carrying capacity of 79,000 cfs. Under these circumstances, outflows would need to be increased to prevent uncontrolled conditions. Between Keswick Dam and the RBDD, intermittent levees help prevent flooding of low-lying lands along the Sacramento River.

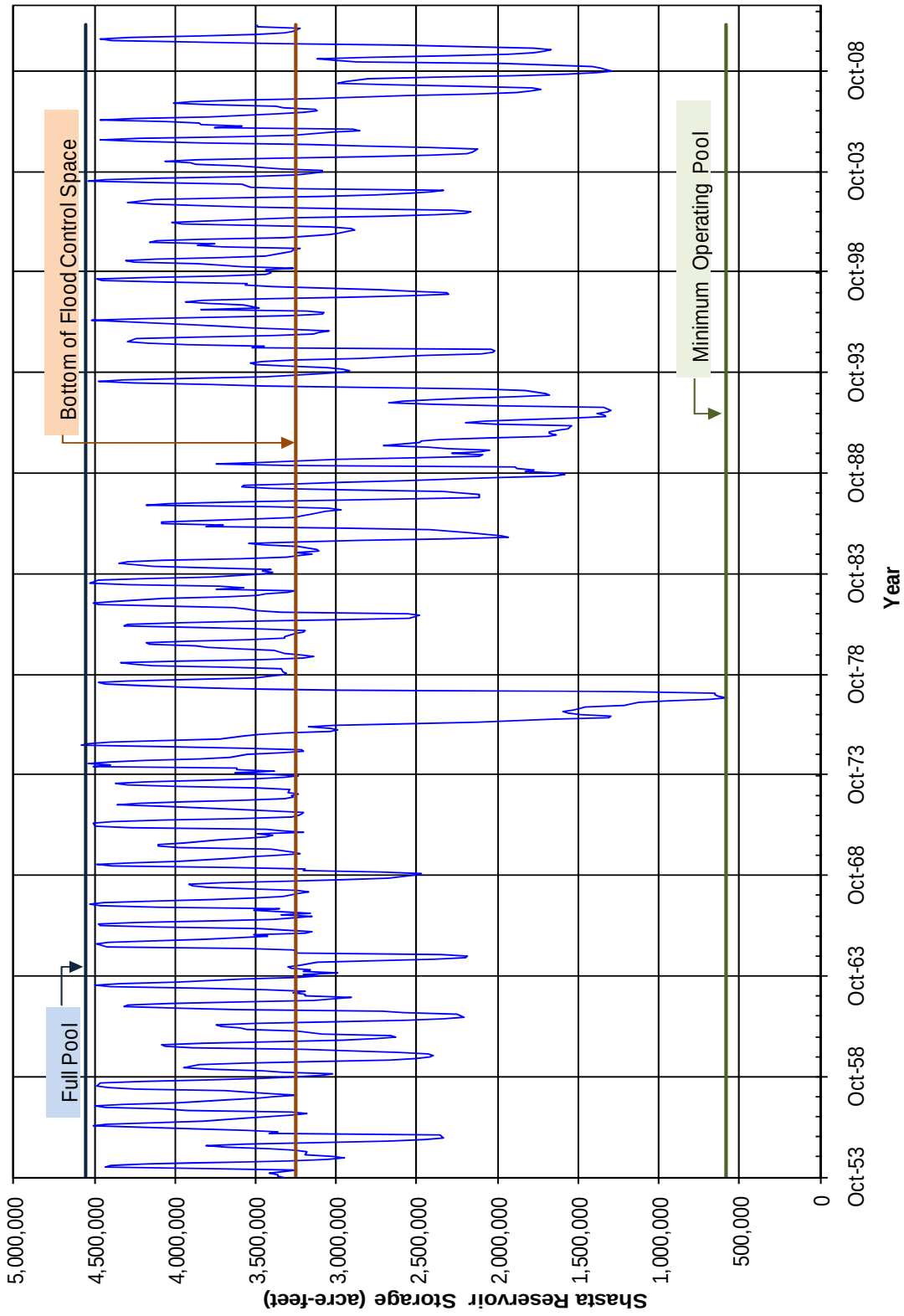


Figure 2-5. Monthly Average Storage in Shasta Reservoir

Table 2-7. Historical Shasta Dam and Reservoir Flood Management Releases

Water Year	Total Inflow (TAF)	End of Sept. Storage (TAF)	Outflows (TAF)				Water Year	Total Inflow (TAF)	End of Sept. Storage (TAF)	Outflows (TAF)			
			Total	Powerplant	Spillway	Outlets				Total	Powerplant	Spillway	Outlets
1945	4,858	*	3,462	2,624	0	839	1976	3,611	1,295	5,813	5,813	0	0
1946	5,906	*	5,599	3,898	0	1,700	1977	2,628	631	3,247	3,247	0	0
1947	3,908	*	3,964	3,571	0	393	1978	7,837	3,428	4,944	4,538	0	407
1948	5,416	*	4,958	4,244	0	714	1979	4,022	3,141	4,203	4,203	0	0
1949	4,318	*	4,303	4,303	0	0	1980	6,415	3,321	6,139	4,773	0	1,366
1950	4,133	*	3,784	3,781	1	2	1981	4,103	2,480	4,845	4,845	0	0
1951	6,316	*	6,486	5,696	0	790	1982	9,013	3,486	7,910	6,464	253	1,193
1952	7,785	*	6,800	5,625	9	1,166	1983	10,794	3,617	10,576	7,123	1	3,452
1953	6,540	3,300	6,408	5,067	0	1,341	1984	6,667	3,240	6,944	6,514	0	429
1954	6,541	3,059	6,826	5,941	0	885	1985	3,971	1,978	5,154	5,152	2	0
1955	4,112	2,455	4,612	4,612	0	0	1986	7,546	3,211	6,225	4,383	0	1,842
1956	8,834	3,569	7,606	4,926	12	2,668	1987	3,944	2,108	4,957	4,800	0	157
1957	5,368	3,485	5,341	4,841	17	483	1988	3,931	1,586	4,368	3,973	0	395
1958	9,698	3,473	9,610	6,672	13	2,924	1989	4,745	2,096	4,154	3,951	0	203
1959	5,086	2,504	5,952	5,631	0	321	1990	3,616	1,637	3,999	3,707	0	292
1960	4,733	2,756	4,380	4,380	0	0	1991	3,051	1,340	3,286	2,666	0	620
1961	5,071	2,333	5,402	5,402	0	0	1992	3,622	1,683	3,204	1,755	0	1,449
1962	5,262	2,908	4,582	4,582	0	0	1993	6,825	3,102	5,316	3,728	0	1,588
1963	7,003	3,242	6,575	6,077	13	485	1994	3,087	2,102	4,002	3,252	0	750
1964	3,905	2,202	4,849	4,849	0	0	1995	9,638	3,136	8,511	5,187	0	3,324
1965	6,983	3,612	5,475	4,581	0	894	1996	6,846	3,089	6,781	3,703	0	3,078
1966	5,299	3,263	5,544	5,544	0	0	1997	7,424	2,308	8,106	5,808	0	2,298
1967	7,404	3,506	7,066	6,131	0	935	1998	10,294	3,441	9,072	6,698	2	2,372
1968	4,772	2,670	5,515	5,138	0	377	1999	7,196	3,328	7,202	6,379	0	824
1969	7,668	3,528	6,714	5,421	0	1,293	2000	6,839	2,985	7,074	5,573	0	1,501
1970	7,902	3,440	7,885	5,477	4	2,404	2001	4,141	2,200	4,824	4,823	0	1
1971	7,328	3,275	7,402	6,824	1	578	2002	5,052	2,558	4,590	4,590	0	0
1972	5,078	3,267	5,000	5,000	0	0	2003	6363	3,159	5,659	5,409	0	250
1973	6,167	3,317	6,026	5,583	0	443	2004	5738	2,183	6,615	5,617	0	998
1974	10,796	3,658	10,364	6,796	0	3,568	2005	5639	3,035	4,692	4,475	0	217
1975	6,405	3,570	6,384	6,153	0	231	2006	9241	3,205	8,964	6,608	0	2,356
							2007	3,957	1,879	5,189	5,166	0	23
							Average	6,006	2,807	5,896	4,989	5	902

Source: Reclamation 2007b

Key:
* = reservoir filling
Sept. = September
TAF = thousand acre-feet

Shasta Lake collects flow in the upper Sacramento River watershed, but many uncontrolled tributaries, including Cow Creek, Battle Creek, Cottonwood Creek, and Thomes Creek, enter the Sacramento River downstream from the dam (USACE 1999). Stream gages located on various uncontrolled tributaries help the operators of Shasta Dam adjust releases to accommodate downstream peak flows. However, the influence of Shasta Dam's operation on reducing peak flood flows on the Sacramento River diminishes with distance downstream, largely because of these uncontrolled tributaries.

Downstream from the RBDD, flood management projects along the Sacramento River affect the flow and operation of facilities. Major reservoirs include Folsom Lake on the American River, Lake Oroville on the Feather River, and Black Butte Reservoir on Stony Creek. Levees associated with the Sacramento River Flood Control Project begin intermittently downstream from the RBDD and become continuous along both banks between Colusa and the Delta. Weirs located along the Sacramento River divert high flows to overflow basins and bypasses including Butte Basin, Sutter Bypass, and Yolo Bypass (Figure 2-6).

Water Quality Principal water quality issues in the primary study area include water temperatures in the Sacramento River between Keswick Dam and the RBDD, turbidity in Shasta Lake, and acid mine drainage and associated heavy metal contamination. The Central Valley Regional Water Quality Control Board (RWQCB) determined that the 25-mile-long reach of the Sacramento River from Keswick Dam downstream to Cottonwood Creek is impaired because levels of dissolved metals periodically exceed levels identified to protect aquatic organisms (CVRWQCB 2002a).

Water quality in the lower part of the Sacramento River and in the Delta may be affected by urban and agricultural runoff, acid mine drainage, stormwater discharges, and water project flows and diversions. The Sacramento River downstream from the RBDD was listed as an impaired water body under Section 303(d) of the Clean Water Act (CWA), and water quality was an identified objective of CALFED. Parameters of concern in this reach included diazinon, mercury, and unknown sources of toxicity (CVRWQCB 2002b). In the Delta, water quality can also be affected by saltwater intrusion. Water quality issues within the Delta, particularly those related to salinity, have resulted in significant declines in pelagic populations (California Water Boards, SWRCB, and Cal/EPA 2006). Potential changes in hydrology and sea levels due to climate change could further affect water quality within the Delta.

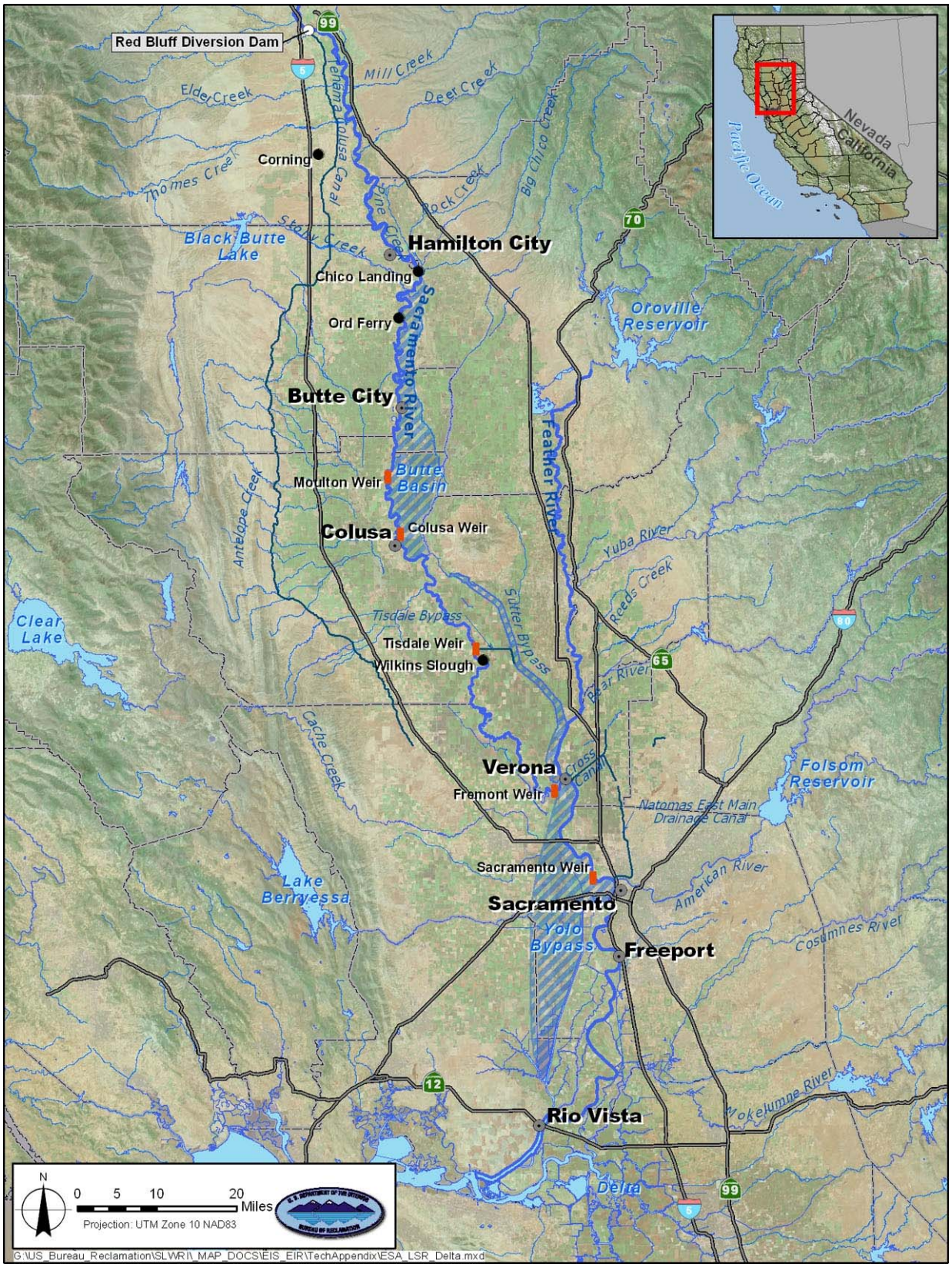


Figure 2-6. Sacramento River Overflow Basins and Bypasses South of the Red Bluff Diversion Dam

Noise and Vibration The area immediately surrounding Shasta Dam and Lake, where the majority of project construction would occur, is in an undeveloped canyon of the Sacramento River in Shasta County. Various recreational uses and sensitive receptors are present throughout the vicinity. Existing noise sources are associated with local roadway traffic, I-5 traffic, railway traffic, Redding Municipal Airport aircrafts, boats and personal watercraft on Shasta Lake, and stationary noise sources (e.g., mechanical equipment at the existing dam facility). Existing vibration sources in the SLWRI study area are primarily associated with local construction, roadway traffic, and trains.

Hazardous Materials Metals are present in inactive and abandoned mines around Shasta Lake and in the Sacramento River watershed. A records search for the primary study area identified one known contaminated site, which appears on the Federal National Priorities List/Superfund: the Iron Mountain Mine. The continuous release of metals from the Iron Mountain Mine since the 1940s is believed to have contributed to a steady decline in the fisheries population in the Sacramento River. In addition, several other former mining operations may currently impact environmental conditions in the primary study area. Of these, Bully Hill is the closest abandoned mine to the current shoreline; portions of mine tailings and a debris dam are periodically inundated by the reservoir.

Agricultural and Important Farmlands Within the primary study area, the valleys of the Sacramento River and its tributaries contain some of the most productive agricultural land in Shasta County. Many hundreds of acres of land in these valleys are classified as prime farmland, unique farmland, or farmland of statewide importance. Although there is little agricultural development immediately adjacent to Shasta Lake, agricultural lands are present in the upper watersheds of several tributaries, primarily to the east of the reservoir. In the extended study area, the Sacramento River basin downstream from the RBDD to the Delta, the Delta, the San Joaquin River basin to the Delta, portions of the American River basin, and the CVP and SWP water service areas are all rich in agricultural resources.

Biological Resources Environment

Biological resources in the region result from a wealth and diversity of climatic and vegetative associations within and adjacent to the study areas. Influences from the coastal mountains, southern Cascades, northern Sierra Nevada, Great Basin, and Central Valley provide for a unique mix of biota. The study area supports a variety of habitats, including riparian, grasslands, oak woodlands, chaparral, scrub, vernal pools, seasonal and permanent wetlands, estuaries, tidal sloughs, and marshes. Each of these habitats supports its own unique assemblage of vegetation and wildlife species.

Much of the area, especially within the Central Valley, has been modified by past and present land uses. Before human settlement, this region was dominated

by riparian vegetation within the annual floodplains, with stands of valley oak and interior live oak on higher ground. The extensive oak forests and riparian/wetland habitats hosted a diverse and abundant wildlife community. Deforestation, water development, flood protection, and expansion of agriculture onto the floodplains in the early to mid-1800s substantially altered the historical floodplain and channel vegetation.

Agriculture is currently the primary land use in the Central Valley; much of the remaining habitat exists as a mosaic of fragmented upland communities or narrow strips of riparian habitat along the Sacramento River and its tributary creeks and sloughs. Although the remaining riparian habitat along the Sacramento River corridor is limited, it supports wildlife, and also supplies shade, cover, and transported nonnative material to the adjacent streamside environment, benefiting the floral and faunal species that are closely associated with the riparian environment.

Fisheries and Aquatic Resources Shasta Lake and Keswick Reservoir fish species include native and introduced warm-water and cold-water species. Shasta Lake tributary species comprise planted and wild trout and several native species. Major nonfish aquatic animal species assemblages of the study area include the lake floor macroinvertebrates of Shasta Lake, the Sacramento River, and tributaries to Shasta Lake, and zooplankton of the reservoirs.

The Sacramento River between Keswick Dam and the RBDD has a stable, largely confined channel with little meander. Riffle habitat with gravel substrates and deep pool habitats are abundant compared to reaches downstream from the RBDD. Immediately below Keswick Dam, the river is deeply incised in bedrock with very limited riparian vegetation and no functioning riparian ecosystems. Water temperatures are generally cool, even in late summer, because of regulated releases from Shasta Reservoir and Keswick Reservoir. Near Redding, the river enters the valley and the floodplain broadens. Historically, this area appears to have had wide expanses of riparian forests, but much of the river's riparian zone is currently subject to urban encroachment, particularly in the Anderson/Redding area.

The Sacramento River supports a variety of anadromous fishes, including four runs of Chinook salmon, steelhead, green sturgeon, white sturgeon, striped bass, American shad, and Pacific lamprey. Resident species include rainbow trout, hardhead, California roach, Sacramento sucker, Sacramento pikeminnow, and various species of nonnative catfish, sunfish, and black bass. The population of the four runs of salmon and other important fish species (including steelhead) that also spawn upstream from Red Bluff have significantly declined since the 1950s.

Vegetation and Habitat Types Shasta Lake is surrounded by mountainous terrain forested primarily by brushy, hardwood stands, chaparral, oak woodlands, mixed conifer forests, and ponderosa-pine-dominated conifer

stands. Vegetation diversity tends to be high in the area, due largely to the favorable climate and varying geology. Elevation and sun exposure create variation in the forest stands around the lake. Shoreline vegetation around Shasta Lake provides important cover for aquatic species, and shade to maintain cooler water temperatures. The Shasta Lake area also supports nonnative plant species introduced to the region by early settlers. Some of the more invasive exotic species out-compete native vegetation.

Vegetation in the upper Sacramento River watershed upstream from Shasta Lake can be separated into seven basic vegetation types: Douglas fir-mixed conifer forest, mixed conifer, ponderosa pine, canyon oak woodland, black oak woodland, gray pine woodland, and chaparral. Lower elevation vegetation consists of a mix of chaparral and hardwoods; mid-elevation slopes are within a transitional zone that contains both the chaparral/hardwood mix and a mixed conifer component; and higher elevation sites are dominated by a mixed conifer overstory with brush species in the understory, primarily in open areas. An exception is in the riparian corridors, where conifers can span from lower to upper elevations.

Although the Central Valley historically contained an estimated 1,400,000 acres of wetlands, only about 123,000 acres remain today. Along most of the Sacramento River and its tributaries, the once productive and extensive riparian areas have been greatly reduced. Riparian and wetland habitats provide food and shelter to aquatic fauna and help attenuate high flows. Wetlands occupy many areas along Sacramento River waterways, and are extensive in the Delta. Grasslands and wooded upland communities are more abundant in this reach of the primary study area, which also includes some agricultural lands. Open-water areas occur mainly on the larger waterways, where waterways converge, and in reservoirs.

The Delta includes extensive areas of fresh and brackish tidal marsh, and submerged aquatic plant communities. Additional natural plant communities occur in the extended study area outside the Central Valley and adjacent foothills, but are not a focus of this study. Urban and agricultural and urban vegetation occupies nearly 70 percent of the Central Valley, and a larger portion of terrestrial habitats in the Delta. Urban area plant communities (landscaping) also occupy an increasingly greater portion of the extended study area.

Wildlife A variety of wildlife is present in the areas surrounding Shasta Lake and lower reaches of its tributaries, and includes black-tailed deer, elk, black bear, mountain lion, bobcat, gray squirrel, rabbit, and turkey. Avian species include quail, falcon, eagle, turkey, dove, pigeon, hawk, woodpecker, ash-throated flycatcher, Hutton's and warbling vireos, and house sparrow. The area provides excellent habitat for deer and elk, and suitable habitat for numerous bat species, although few bat sightings have been confirmed. Several other wildlife species inhabited this area before European settlement but were extirpated by over-hunting or because they were seen as threats; these species included

grizzly bear, wolf, and various species of elk. Shasta Lake is home to the largest concentration of nesting bald eagles in California.

The variety of habitats along the Sacramento River from Shasta Dam to the RBDD supports a wide range of wildlife species. Composition, abundance, and distribution of wildlife are directly related to the accessibility of these habitats. The range of wildlife species present includes a variety of waterfowl, raptors, and migratory and resident avian species, plus a variety of mammals, amphibians, and reptiles that inhabit both aquatic and upland habitats within the upper Sacramento River study area. Many of the wildlife species are unable to adapt to other habitat types or altered habitat conditions and are therefore most susceptible to habitat loss and degradation. Species that depend on riparian woodland, oak woodland, marsh, and grassland habitats have declined. The region also supports a variety of exotic species, some of which are detrimental to survival of native species.

Special-Status Species Special-status species primarily include plants and animals in the study area that are legally protected or are otherwise considered sensitive by Federal, State, or local resource conservation agencies and organizations. These include species that are Federally listed and/or State-listed as rare, threatened, or endangered; species considered as candidates or proposed for listing; species identified by DFG as species of special concern; species identified as species of concern by USFWS; plants considered by the California Native Plant Society (CNPS) to be rare, threatened, or endangered; and species afforded protection under local planning documents. Within the primary study area, 32 special-status species were identified for which generally suitable habitat was determined to be present.

Wild and Scenic Rivers The National Wild and Scenic Rivers Act of 1968, as amended (Public Law 90-542; 16 USC 1271 – 1287), established the National Wild and Scenic Rivers System, which identifies rivers of the Nation that possess outstandingly remarkable scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values. This act preserves the free-flowing condition of rivers that are designated, and protects their local environments. The California Wild and Scenic Rivers Act of 1972, as amended (Public Resources Code Section 5093.50 – 5093.70), aims to preserve designated rivers possessing extraordinary scenic, recreation, fishery, or wildlife values.

Although the McCloud River is not formally designated as a National or State wild and scenic river, Section 5093.542 of the California Public Resources Code specifies that the McCloud River should be maintained in its free-flowing condition, and its wild trout fishery protected from 0.25 miles below McCloud Dam downstream to the McCloud River Bridge.

Raising Shasta Dam would inundate portions of the lower McCloud River. Section 5093.542 (c) may limit assistance or cooperation from State

departments or agencies in planning or constructing any water impoundment facility that could adversely affect the free-flowing condition of the McCloud River or on its wild trout fishery, with the exception of participation by DWR in studies involving the feasibility of enlarging Shasta Dam. Section 5093.542(d) states, "All state agencies exercising powers under any other provision of law with respect to the protection and restoration of fishery resources shall continue to exercise those powers in a manner to protect and enhance the fishery" of the protected segments of the McCloud River. Participation by various State agencies in planning and potential construction activities associated with modifying Shasta Dam and Reservoir, including related permitting and approval processes, varies by an agency's mandate and California Public Resources Code (PRC) Section 5093.542. DFG has taken the position that it must participate in preparing the EIS to comply with Section 5093.542(d). Other State agencies, including DWR and the State Water Resources Control Board, have participated to a limited extent or expressed their intent to participate in the SLWRI. The CALFED Program Plan (CALFED 2000b) concluded that although Section 5093.542 sought to protect the free-flowing condition of the McCloud River, it also provided for investigations of enlarging Shasta Dam.

Cultural Resources Environment

Investigations have revealed repeated occupation of the Shasta Lake area as early as 8,000 years ago. From available information, it is believed that at least 118 archaeological sites are currently inundated by Shasta Reservoir at full pool elevation 1,076. Around the reservoir, above full pool to elevation 1,276, are an estimated additional 55 archaeological sites that have been identified in project-specific surveys.

Wintu people, who speak a Penutian language, are believed to have arrived in California around 1,000 B.C, and were the primary occupants of the Shasta area after 900 A.D. (Reclamation 2008d). Several local groups of Wintu lived within the Shasta Lake area, including the Nomtipom, Winnemem, and Waimuk. The Okwanuchu were a group related to the Hokan-speaking Shasta people of southern Oregon, and lived in the McCloud River drainage. The Madesi band of Achumawi lived farther east along the Pit River. In addition, the Central Yana people held territory in the Cow Creek drainage. Archaeological remains have been found that represent ancestors of the Yana people. Several sites of cultural and religious significance to the Winnemem Wintu are located within the study area, including burials and cemeteries, places of spiritual power, named villages, and other sites of special concern. The California Native American Heritage Commission has identified several locations of particular concern.

Settlement in the study area by whites began when trappers recognized the grazing potential of the land in the northern Sacramento River valley in the 1830s and 1840s. Mineral exploration, which included gold, silver, and, most influential to the region, copper, began with the Gold Rush of 1849. The lumber industry began in the region in the 1850s. Ranching (cattle and sheep)

and agriculture (grain and fruit) have been practiced from the mid-nineteenth century onward. Railroads and State highways cross the study area. National efforts to preserve forests and other natural resources began in the late nineteenth century and continue today. Historic-era structures in the study area include, among others, seven bridges, one dam, one railroad bridge and grade, and one aerial tramway.

Socioeconomic Resources Environment

The sections below describe socioeconomic resources in the SLWRI study area, including population, land use, employment and labor force, business and industrial activity, local government and finance, public health and safety, recreation and public access, aesthetics and visual resources, traffic and transportation, utilities and public services, and water supply.

Population California's population totaled an estimated 37 million in 2005 (California Department of Finance 2010). Approximately 2.9 million and 2.0 million of this population resided in the Sacramento River and San Joaquin River basins, respectively. The growth rate in the Sacramento River and San Joaquin River basins was over 11 and 14 percent from 2000 to 2005, respectively, significantly greater than the statewide rate of 8 percent for the same period. About three-fourths of the population in the Sacramento River basin resides in or near the City of Sacramento. The estimated population in the Sacramento River valley region in 2005 was approximately 2.6 million people with about three-fourths of this total residing in the greater Sacramento metropolitan area. Similarly, most of the population of the CVP service area is concentrated within urban areas. The CVP water service area includes various M&I water contractors and water districts that serve portions of the Sacramento, Stockton, and Bay Area metropolitan areas. Outside these population centers, most of the CVP water service area is rural, with irrigated agriculture the predominant land use and economic driver.

In Shasta County, Redding serves as the primary center for development and economic activity, while Red Bluff, although much smaller than Redding, plays that role in Tehama County. Because of the area's limited urbanization, residents live a more rural lifestyle than in many other areas of California. In total, the populations of Shasta and Tehama counties make up less than 1 percent of the total population in California. Although Shasta and Tehama counties are still comparatively small, both counties have grown substantially over the past 15 years.

Land Use Primary land uses in the vicinity of Shasta Lake include public and private lands managed for habitat and wildlife, residential, and some commercial industry uses. Portions of the STNF are located within Shasta County. Primary land uses along the Sacramento River between Shasta Dam and the RBDD include urban, residential, and agricultural. Land use in the extended study area varies greatly because of the differences in demographics and environment. Major urban development is concentrated in the Sacramento

River valley along the transportation corridor provided by I-5, State Route 99, and the UPRR. Within 5 to 8 miles to the east and west of this corridor, development is characterized by rural communities. Development in the upland areas consists of agriculture, grazing, and timber operations, with small rural community centers and individual homes dispersed throughout.

Employment and Labor Force Trends in employment and the labor force are key considerations for rural communities like those in the primary study area, and offer insight into the area economy. Trends in unemployment within Shasta and Tehama counties indicate the economy within the primary study area is in transition, with the economy shifting away from natural-resource-based industries and agriculture, and employment opportunities diminishing. At the same time, agriculture and its related support activities remain comparatively strong and provide employment opportunities in the remainder of the CVP water service area.

Business and Industrial Activity Established industries near the study area include the nonfarm industries of trade, transportation, and utilities, professional and business services, and government services. Tourism, recreation, and related hospitality industries are a major source of economic development in the primary study area. Shasta Lake and the Sacramento River play a central role in the tourism industry and the appeal of the region to prospective businesses and investors. The economy in the vicinity of Shasta Lake has historically depended on natural resources.

Local Government and Finance Rural jurisdictions generally dominate the primary study area. Local officials allocate financial resources for a diverse collection of activities, including providing police and public safety, reviewing development, and providing educational services within their jurisdictions. The two largest sources of revenue for most local jurisdictions are property taxes and funding received from the Federal and State governments. These two sources provide a relatively stable revenue base for funding local programs. Public health and safety, social services of various forms, and education represent the biggest expenditures at the local level. These activities serve as a safety net for the local population and are frequently the most visible local programs.

Public Health and Safety At Shasta Lake, water hazards are generally associated with recreational use; water management operations at a reservoir the size of Shasta Lake typically do not pose specific hazards to humans because water levels do not fluctuate rapidly. Downstream from Shasta Dam, water-related hazards may be associated with rapid increases in flow in the Sacramento River, as during flood events. Operations at Shasta and Keswick dams have historically helped to dampen rapid changes in flow in the Sacramento River, particularly in the reach between Shasta Dam and the RBDD. Downstream from the RBDD, Shasta Dam has a decreasing influence on flow conditions and associated water-related hazards.

Recreation and Public Access Much of the outdoor recreation and tourism in Shasta County is related to Shasta Lake. The Whiskeytown-Shasta-Trinity NRA was established by an Act of Congress in November 1965. The area comprises three separate units: Whiskeytown Lake, Shasta Lake, and Trinity Lake. The Shasta Lake and Trinity Lake units of the NRA are within the STNF, and recreation is managed by USFS; the Whiskeytown Lake Unit is administered by the National Park Service. Among the facilities that are administered by USFS within the Shasta Lake Unit of the NRA are 10 marinas with 1,075 houseboats; 625 are privately owned and 450 are owned by a marina and rented on a weekly or weekend basis. Also, 18 developed public campgrounds have a total of 246 sites. USFS maintains 11 group or boat-in campgrounds and also operates launching ramps and beach and picnic areas. A map with locations of the major recreation facilities in the Shasta Lake Unit of the Whiskeytown-Shasta-Trinity NRA is shown in Figure 2-7.

The area along the Sacramento River from Shasta Dam to the RBDD contains many recreation resources and public access sites. These include day use sites, boat launches, trail accesses, fishing accesses, recreational vehicle parks, wildlife areas, and undeveloped open space areas. Beyond Lake Red Bluff and the RBDD on the Sacramento River, it is not expected that recreation or public access would be affected by implementation of the project and, therefore, an in-depth review of recreation activities and facilities downstream is not presented in this analysis.

Aesthetics and Visual Resources Visual resources in the study area include views of and from Shasta Dam and Lake, and viewsheds or viewpoints along the Sacramento River downstream from Shasta Dam to the RBDD. Several highways located in the primary study area are designated, or are eligible for designation, as State or County Scenic Highways. California's Scenic Highway Program was created to preserve and protect scenic highway corridors from change that would diminish the aesthetic value of lands adjacent to the highways. Potential Class A visual features include Federal and State park and recreation areas, such as the Whiskeytown-Shasta-Trinity NRA and Lassen Volcanic National Park. Mount Shasta, Mount Lassen, and the Sutter Buttes are prominent mountains in the study area.

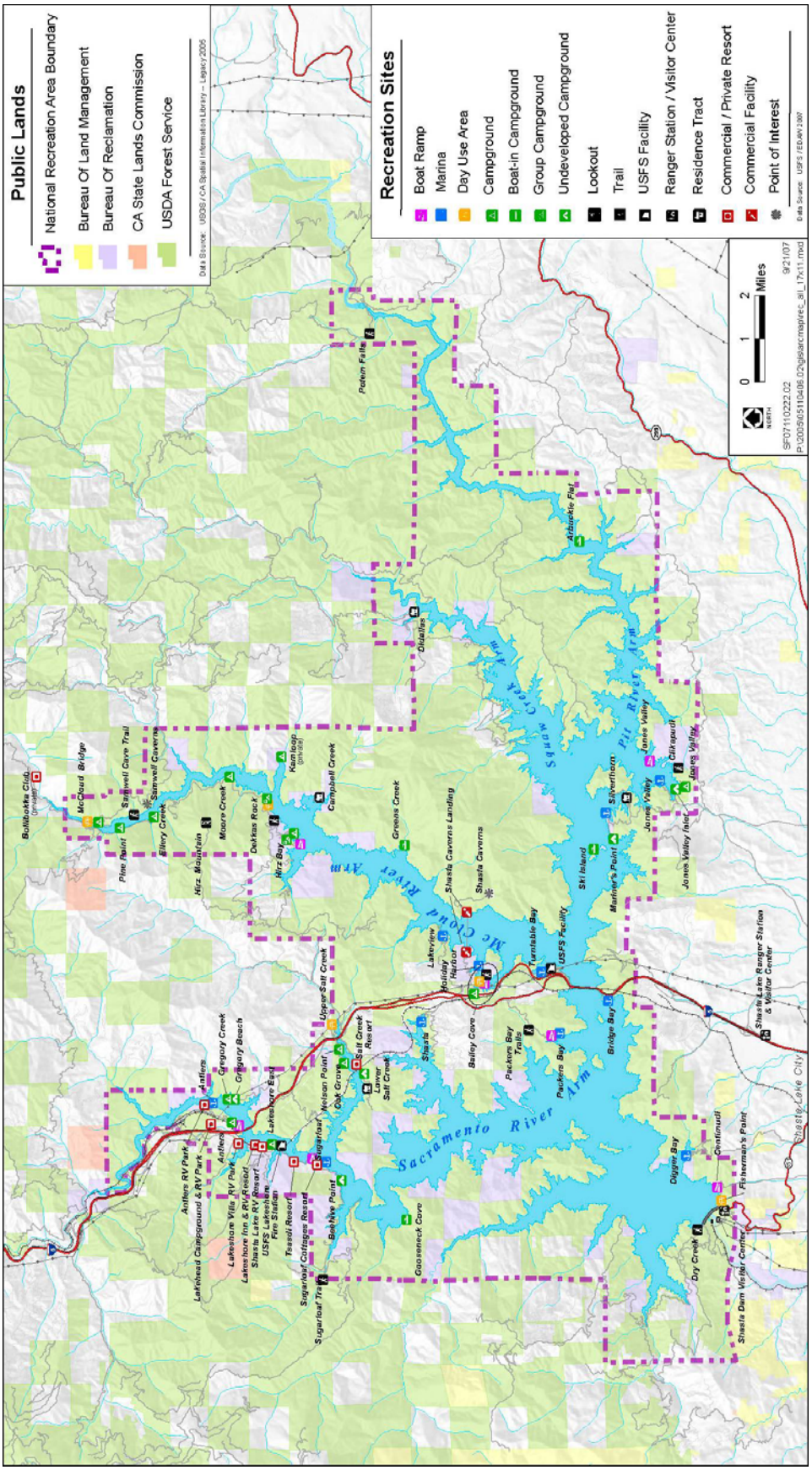


Figure 2-7. Shasta Lake Recreation Facilities

Traffic and Transportation Major transportation routes in the study area include I-5, and State Routes 20, 29, 36, 70, 99, 162, and 299. Excluding Chico, traffic within the central and northern portions of the Central Valley is usually moderate to light. Southern Pacific Railroad is the main rail line serving the Sacramento River basin area as a whole. The UPRR and Western Pacific Railroad both have rail lines serving the vicinity of Shasta Lake and the upper Sacramento River area. The UPRR main line follows the I-5 alignment and crosses Shasta Reservoir at the Pit River Bridge. Travel and navigation by water in the primary study area are primarily for recreational purposes. The extended study area includes numerous major and minor transportation features, including several rail lines, commercial and industrial ports, and a deep-water ship channel that runs from the Delta to the Port of Sacramento.

Utilities and Public Services Various county and local agencies provide the primary study area with solid waste and wastewater removal and management, emergency services, public safety, and law enforcement services. Pacific Gas and Electric Company (PG&E) is responsible for providing electrical and natural gas service to the primary study area. Gas is delivered to the study area through portions of PG&E's 40,000 miles of natural gas pipelines. Many areas scattered throughout Shasta and Tehama counties are served by individual septic systems.

Water Supply The CVP is the largest water storage and delivery system in California, covering 29 of 58 counties in the State. The CVP consists of 20 reservoirs capable of storing over 11 MAF of water, 11 powerplants, 500 miles of major canals and aqueducts, and many tunnels, conduits, and power transmission lines (Reclamation 2004b). CVP water is used to irrigate about 3 million acres of farmland and supplies water to more than 2.5 million people and businesses through more than 250 long-term water contracts (Reclamation 2008a, 2011a). Most of the CVP service area lies within the Central Valley. About 90 percent of south-of-Delta contractual delivery is for agricultural uses.

The SWP provides water to 25 million Californians and 750,000 acres of irrigated farmland (DWR 2010), with water deliveries allocated 70 percent to M&I use and 30 percent to agricultural use (DWR 2008). The SWP includes 34 storage facilities, reservoirs, and lakes; 20 pumping plants; four pumping-generating plants; five hydroelectric powerhouses; and about 700 miles of open canals and pipelines (DWR 2010). SWP water is delivered under long-term contracts to 29 public water agencies throughout the State, including the San Joaquin Valley, Tulare basin, and Southern California service areas (DWR 2010).

It is estimated that water demands (applied water) in the State in 2005 for urban, agricultural, and environmental purposes were about 83 MAF, including water dedicated to wild and scenic rivers (DWR 2009). Approximately 54 MAF of water was available in 2005 from statewide water management projects, including the CVP and SWP, as well as local projects Approximately 12 MAF

was available from groundwater. The remaining water supply came from reused or recycled water sources.

Future Conditions Summary

Identification of the magnitude of potential water resources and related problems, needs, and opportunities in the study area is based not only on the existing conditions highlighted above but also on an estimate of how these conditions may change in the future. Predicting future conditions is complicated by a variety of factors, including uncertainty regarding future regulatory requirements, and ongoing programs and projects affecting the study area, as described in the following sections.

Likely Future Conditions Without Project Implementation

Predicting future changes to the physical, biological, cultural, and socioeconomic environments in the primary and extended study areas is additionally complicated by ongoing programs and projects and potential changes in regulatory requirements. Several ecosystem restoration, water quality, water supply, and levee improvement projects are likely to be implemented in the future. Collectively, these efforts may improve ecosystem resources, Delta water quality, water supply, and levees. Much of this improvement would be based on separate opportunities that are not integrated in a single plan or part of an approved and funded program.

The baselines for analysis of future conditions without project implementation include reasonably foreseeable actions with current authorization, complete funding for design and construction, and complete environmental permitting and compliance. However, other programs currently in the planning phases could also potentially influence the SLWRI in the future. Prominent examples include the State of California's Delta Plan and the BDCP. These projects and programs have not been included in the evaluation of the alternative plans for the SLWRI because there has not been a specific decision to implement them at this.

The following sections summarize likely future conditions without project implementation for physical, biological, cultural, and socioeconomic resources within the study area. Additional, detailed information is included in the accompanying Preliminary Draft EIS and the Physical Resources Appendix, Biological Resources Appendix, Cultural Resources Appendix, and Socioeconomics Appendix.

Physical Resources Environment Basic physical conditions in the primary and extended study areas are expected to remain relatively unchanged in the future. Continued development in urban and suburban areas is expected. Ongoing restoration efforts along rivers are expected to marginally improve natural riverine processes. Without major physical changes to the river systems, hydrologic conditions may remain unchanged. However, the region's hydrology could be altered should there be significant changes in global

climatic conditions; scientific work in this field of study is continuing. Without major changes in hydrology, topography, or geology, sedimentation and erosion are also likely to remain unchanged.

Much effort has been expended to control the levels and types of herbicides, fungicides, and pesticides that can be used in the environment. Further, efforts are underway to better manage the quality of runoff from urban environments to the major stream systems. However, water quality conditions are expected to remain unchanged and similar to existing conditions.

It is unclear to what extent potential changes to the region's climate could occur in association with global climate change. As the population continues to grow and agricultural lands are converted to urban and industrial uses, a general degradation of air quality conditions could occur. However, because of technological innovation and stringent regulations, air quality could improve over time. While similar types and sources of hazardous materials and waste are likely to be present in the future, increasing population will likely increase the potential for hazardous waste issues. Similarly, increasing population will likely affect increases in environmental noise and vibration.

Biological Resources Environment Efforts are underway by numerous agencies and groups to restore various biological conditions throughout the primary and extended study areas. Accordingly, major areas of wildlife habitat, including wetlands and riparian vegetation areas, are expected to be protected and restored. However, as population and urban growth continues, and land uses are converted to urban centers, many wildlife and plant species especially dependent on woodland, oak woodland, and grassland habitats may be adversely affected.

Through the significant efforts of Federal and State wildlife agencies, populations of special-status species in the riverine and nearby areas are estimated to generally remain as under existing conditions. Although increases in anadromous and resident fish populations in the Sacramento River could continue through implementation of projects such as the Battle Creek Salmon and Steelhead Restoration Project, some degradation will likely occur through actions that reduce Sacramento River flows or elevate water temperatures such as implementation of the Trinity River ROD. Accordingly, populations of anadromous fish are expected to remain generally similar to existing conditions.

No rivers or streams in the primary study area are expected to be added to the list of Federal and/or State wild and scenic resources. The wild and scenic status of the McCloud River is expected to remain as under existing conditions.

Cultural Resources Environment In the vicinity of Shasta Lake, any archaeological, historic, or ethnographic resources currently affected by erosion due to reservoir fluctuations would continue to be impacted. Artifacts located around the perimeter of the existing reservoir will continue to be subject to

collection by recreationalists. Similarly, conditions related to the cultural environment downstream from Shasta Dam are unlikely to change significantly.

Socioeconomic Resources Environment The State's population is estimated to increase from approximately 37 million in 2005 to approximately 44 million by 2020, and to about 60 million by 2050. Between now and 2050, Shasta and Tehama counties are expected to continue their historic growth trends. According to the California Department of Finance (2007, 2010), Shasta County's population is expected to increase by approximately 86 percent by 2050 to a total of approximately 332,000 residents (2005 population was 179,000). This represents an expected increase in population that is almost 20 percent greater than for the State as a whole. The population of Tehama County is expected to more than double by 2050, with population increasing from approximately 60,000 (in 2005) to 124,000 (California Department of Finance 2007, 2010).

To support these expected increases in population, some conversion of agricultural and other rural land to urban uses is anticipated. More transportation routes are likely to be constructed to connect the anticipated population increase in the Central Valley to transportation infrastructure. Anticipated increases in population growth will also impact visual resources as areas of open space on the valley floor are converted to urban uses.

Increases in population will increase demands for electric, natural gas, and wastewater utilities; public services such as fire, police protection, and emergency services; and water-related and communication infrastructure. The increase in population and aging "baby boomer" generation will increase the need for health services. The region's superior outdoor recreational opportunities and moderate housing cost opportunities are expected to attract increasing numbers of retirees from outside the region and State. An increasing population will produce employment gains, particularly in retail sales, personal services, finance, insurance, and real estate. Recreation is expected to remain an important element of the community and economy in the region.

Anticipated increases in population growth in the Central Valley will also significantly increase demands on water resources systems for additional and reliable Central Valley water supplies, energy supplies, water-related facilities, recreational facilities, and flood management facilities.

Rationale for Use of 2004 Biological Assessment for Water Operation Models

Planning assumptions and information on water operations used to formulate comprehensive plans for the SLWRI were developed in 2006, and reflect the coordinated CVP and SWP operations described in the 2004 OCAP (Reclamation). In addition, the model package used to evaluate potential effects of the plans included in this Draft Feasibility Report and accompanying Preliminary Draft EIS was based on operations described in the 2004 OCAP BA (Reclamation) and the Coordinated Operations Agreement between

Reclamation and DWR for the CVP and SWP, as ratified by Congress. As Reclamation has proceeded with the SLWRI, essential environmental, hydrologic, and regulatory conditions in the Sacramento River basin and Delta have changed significantly, including substantial declines in key fish populations that use the Sacramento River basin waterways and Delta, such as the delta smelt and Chinook salmon. In addition, several key facility improvements have been made, including replacing the RBDD with screened pumping plants as well as constructing the Delta-Mendota Canal/California Aqueduct Intertie.

Since formulation and evaluation of SLWRI plans, new BOs have been issued on coordinated CVP and SWP operations, as described in Chapter 1, "Prior Studies, Projects, and Programs." In December 2008, USFWS issued a new BO, finding that the long-term operations of the CVP and SWP, as described in the 2004 OCAP BA, would jeopardize the continued existence of the delta smelt (USFWS 2008). In July 2009, NMFS issued a new BO finding that the same operations would jeopardize populations of listed salmonids, steelhead, green sturgeon, and orcas (NMFS 2009a). Because both agencies made jeopardy determinations, both agencies included an RPA in their respective BOs.

Several lawsuits were filed challenging the validity of the 2008 USFWS BO and 2009 NMFS BO and Reclamation's acceptance of the RPA included with each BO (Consolidated Salmonid Cases, Delta Smelt Consolidated Cases). On November 13, 2009, and March 5, 2010, the District Court concluded that Reclamation had violated NEPA by failing to perform a NEPA analysis before provisionally adopting the 2008 USFWS RPA and 2009 NMFS RPA. On December 14, 2010, the District Court found the 2008 USFWS BO to be unlawful and remanded the BO to USFWS. The District Court issued a similar ruling for the 2009 NMFS BO on September 20, 2011. On May 4, 2011, in the Delta Smelt Consolidated Cases, the District Court ordered USFWS to prepare a draft BO by October 1, 2011, which was subsequently extended to an unspecified date to be agreed upon by involved parties. USFWS and Reclamation must prepare a final BO and final NEPA document by November 1, 2013, and December 1, 2013, respectively.

In addition to changes in regulatory conditions, California experienced a severe drought from 2007 through 2009. Although the 2010-2011 water year brought water supplies to normal levels, California's complex water supply issues remain. Increased water needs for environmental purposes, regulatory cutbacks on water supplies, and population growth have created more serious water problems than the State faced in the early 1990s drought. In the future, impacts of climate change will further complicate California's water supply difficulties. In response to these issues, plans have been proposed to update California's water system by increasing storage, improving conveyance, protecting the Delta's ecosystem, and promoting greater water conservation, and planning

assumptions originally used to predict hydrologic conditions in the Sacramento River basin and Delta have changed.

Reclamation and DWR use CalSim-II to study operations, benefits, and effects of new facilities and operational parameters for the CVP and SWP. A set of operational assumptions was developed in 2006 based on water operations described in the 2004 OCAP BA and the Coordinated Operations Agreement between Reclamation and DWR for the CVP and SWP, as ratified by Congress. These assumptions were used to guide development, modeling, and evaluation of potential effects of the No-Action Alternative and comprehensive plans included in this Draft Feasibility Report and accompanying Preliminary Draft EIS. These existing evaluations were used as the basis of analysis in the Draft Feasibility Report and accompanying Preliminary Draft EIS.

The legal challenges and changing environmental conditions result in uncertainty with regard to both current and future operations. These operational uncertainties are likely to continue, and current and future water operation conditions may be different because operational constraints governing water operations are likely to change with release of revised USFWS and NMFS BOs. The existing SLWRI modeling analysis is being used for comparison purposes, and reflects expected variation among the plans, including the type and relative magnitude of anticipated impacts and benefits. Because of the lingering uncertainty about future water operations, the Draft Feasibility Report and Preliminary Draft EIS are based on existing studies.

Modeling studies will be updated to reflect changes in water operations resulting from ongoing OCAP reconsultation and other relevant water resources projects and programs, including, potentially, BDCP/DHCCP efforts. The results of these updated studies will be incorporated into future SLWRI documents.