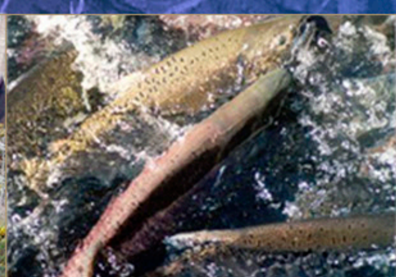
Department of the Interior Final

Shasta Lake Water Resources Investigation

Feasibility Report



July 2015

Mission Statements

Protecting America's Great Outdoors and Powering Our Future

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Feasibility Report

Shasta Lake Water Resources Investigation, California

Prepared by:

United States Department of the Interior
Bureau of Reclamation
Mid-Pacific Region

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Chapter 4 No-Action Alternative and Comprehensive Plans

This chapter describes the No-Action Alternative, representing a scenario in which a project is not implemented, and comprehensive plans developed as action alternatives for this Feasibility Report. This chapter concludes with an evaluation of the consistency of comprehensive plans with other programs, including the CVPIA and CALFED Bay-Delta Program, and consistency with Department of Interior climate change policy.

No-Action Alternative (No Additional Federal Action)

For all Federal feasibility studies of potential water resources projects, the No-Action Alternative is intended to account for existing facilities, conditions, land uses, and reasonably foreseeable actions expected to occur in the study area. 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 is considered to be the basis for comparison with potential action alternatives, consistent with the *Federal Water Resources Council Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC 1983) and NEPA guidelines.

For the SLWRI, the No-Action Alternative is based on CVP and SWP operational conditions described in the 2008 Long-Term Operation BA issued by Reclamation, and the Biological Opinions (BO) issued by USFWS and NMFS in 2008 and 2009, respectively. The No-Action Alternative also includes continued implementation of actions and programs identified under the CVPIA. In addition, the No-Action Alternative includes key projects assumed to be in place and operating in the future, including the Freeport Regional Water Project, Delta Water Supply Project, South Bay Aqueduct Improvement and Enlargement Project, a functional equivalent of the Vernalis Adaptive Management Plan, full restoration flows under the San Joaquin River Restoration Program, and full implementation of the Grassland Bypass Project. Table 2-1 of the EIS Modeling Appendix shows which actions were assumed to be part of the future condition (or No-Action Alternative) in the SLWRI 2012 Version CalSim-II model.

Under the No-Action Alternative, the Federal Government would continue to implement reasonably foreseeable actions, as defined above, 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, nor help address the growing water supply and reliability issues in California. The following discussions highlight the consequences of implementing the No-Action Alternative, as they relate to the planning objectives of the SLWRI.

Anadromous Fish Survival

Much has been done to address anadromous fish survival problems in the upper Sacramento River. Solutions have ranged from changes in the timing and magnitude of releases from Shasta Dam to constructing and operating the TCD at the dam. Actions also include site-specific projects, such as introducing spawning gravel to the Sacramento River, and work to improve or restore spawning habitat in tributary streams. However, to increase anadromous fish survival and reduce the risk of extinction, further water temperature improvements are needed in the Sacramento River, especially in dry and critical years. Increased demand for water for urban, agricultural, and environmental uses is also expected to reduce the reliability of cold water for anadromous fish. Prolonged drought, that depletes the cold-water pool in Shasta Reservoir, could put populations of anadromous fish at risk of severe population decline or extirpation in the long-term (NMFS 2009b). The risk associated with a prolonged drought is especially high in the Sacramento River because Shasta Reservoir is operated to maintain only 1 year of carryover storage. Under the No-Action Alternative, it is assumed that actions to protect fisheries and benefit aquatic environments would continue, including maintaining the TCD, ongoing spawning gravel augmentation programs, and satisfying other existing regulatory requirements.

Water Supply Reliability

Demands for water in the Central Valley and throughout California exceed available supplies, and the need for additional supplies is expected to grow. There is growing competition for limited system resources between various users and uses, including urban, agricultural, and environmental. Urban water demand and environmental water requirements have each increased, resulting in greater competition for limited water supplies. The population of California is expected to increase by more than 60 percent above 2005 levels by 2050. Significant increases in population also are expected to occur in the Central Valley, nearly 130 percent above 2005 levels by 2050 (California Department of Finance 2007). As these population increases occur, and are coupled with the need to maintain a healthy and vibrant industrial and agricultural economy, the demand for water would continue to significantly exceed available supplies. Competition for available water supplies would intensify as water demands increase to support this population growth.

Water conservation and reuse efforts are expected to significantly increase, and forced conservation resulting from increasing water shortages would continue. In the past, during drought years, many water conservation measures have been implemented to reduce the effects of the drought. In the future, as more water use efficiency actions become necessary to help meet even average year demands, the impacts of droughts will be much more severe. Besides forced conservation, without developing cost-effective new sources, the growing urban population would increasingly rely on shifting water supplies from such areas as agricultural production to satisfy M&I demands. In the urban sector, reduced supplies or increased supply uncertainty could cause water rates to increase as agencies seek to remedy supply shortfalls by implementing measures to reduce demand and/or augment supplies.

It is likely that with continued and deepening shortages in available water supplies, adverse economic and socioeconomic impacts would increase over time in the Central Valley and elsewhere in California. One example could include higher water costs, resulting in a further shift in agricultural production to areas outside California and/or outside the United States. Another example could include water supply shortages resulting in changes in land use patterns, loss and destruction of permanent crops, and/or decreased production of existing crops. In response to reduced water supplies, farmers may fallow fields, reducing agricultural productivity directly resulting in layoffs, reduced hours for agricultural employees, and increased unemployment in agricultural communities. Reduced water supplies and the resulting employment losses could also cause socioeconomic impacts in affected communities.

Under the No-Action Alternative, Shasta Dam would not be modified and the CVP would continue operating similarly to existing conditions. The No-Action Alternative would continue to meet water supply demands at levels similar to existing conditions, but would not be able to meet the expected increased demand in California.

Ecosystem Resources, Flood Management, Hydropower Generation, Recreation, and Water Quality

As opportunities arise, some locally sponsored efforts would likely continue to improve environmental conditions on tributaries to Shasta Lake and along the upper Sacramento River. However, overall, future environmental-related conditions in these areas would likely be similar to existing conditions. The quantity, quality, diversity, and connectivity of riparian, wetland, and riverine habitats along the Sacramento River have been limited by confinement of the river system by levees, reclamation of adjacent lands for farming, bank protection, channel stabilization, and land development.

Shasta Dam and Reservoir have greatly reduced flood damage along the Sacramento River. Shasta Dam and Reservoir were constructed at a total cost of about $36 million (in 1936 dollars). Shasta Dam, in combination with the Sacramento River Flood Control Project, protects about 1 million people and over $60 billion in assets. However, residual risks to human life, health, and safety along the Sacramento River remain. Development in flood-prone areas has exposed the public to the risk of flooding. Storms producing peak flows, and volumes greater than the existing flood management system was designed for, can occur, and result in extensive flooding along the upper Sacramento River. Under the No-Action Alternative, the threat of flooding would continue, and may increase as population growth increases.

California's demand for electricity is expected to significantly increase in the future. Under the No-Action Alternative, no actions would be taken to help meet this growing demand.

As California's population continues to grow, demands would grow 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.

To address the impact of water quality deterioration on the Sacramento River basin and Delta ecosystems and endangered and threatened fish populations, several environmental flow goals and objectives in the Central Valley (including the Delta) have been established through legal mandates aimed at maintaining and recovering endangered and threatened fish and wildlife, and protecting designated critical habitat. Despite these efforts, under the No-Action Alternative, these resources would continue to decline and ecosystems would continue to be impacted. In addition, Delta water quality may continue to decline.

Comprehensive Plans

The following sections describe the comprehensive plans developed as action alternatives for the SLWRI. Throughout this Feasibility Report, "comprehensive plan" is used synonymously with the NEPA terminology "action alternative." Management measures and environmental commitments common to all comprehensive plans are described first, followed by descriptions of major components, potential benefits, potential primary effects, mitigation measures, and estimated costs and economic benefits for each comprehensive plan. Quantification of potential benefits for each alternative plan is described in detail in the Modeling Appendix to the accompanying EIS. The Engineering Summary Appendix to the accompanying EIS provides additional information on the engineering designs and costs of each comprehensive plan. A detailed discussion of potential effects of all comprehensive plans is included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS. The Economic Valuation Appendix provides additional information on the economic valuation methods and analyses for the comprehensive plans.

Management Measures Common to All Comprehensive Plans

Eight of the management measures retained are included, to some degree, in all of the comprehensive plans. These measures were included because they (1) would either be incorporated or required with any dam raise, (2) were logical and convenient additions that would significantly improve any alternative, or (3) should be considered with any new water increment developed in California. The eight measures include enlarging the Shasta Lake cold-water pool, modifying the TCD, increasing conservation storage, reducing demand, modifying flood operations, modifying hydropower facilities, maintaining or increasing recreation opportunities, and maintaining or improving water quality.

Enlarge Shasta Lake Cold-Water Pool

Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. At a minimum, all comprehensive plans would include enlarging the cold-water pool by raising Shasta Dam to enlarge Shasta Reservoir. Some alternatives would also increase the seasonal carryover storage in Shasta Lake.

Modify Temperature Control Device

For all comprehensive plans, the TCD would be modified to account for an increased dam height and to reduce leakage of warm water into the structure. Minimum modifications to the TCD include raising the existing structure and modifying the shutter control. This measure would increase the ability of operators at Shasta Dam to meet downstream temperature requirements, and provide more operational flexibility to achieve desirable water temperatures during critical periods for anadromous fish.

Increase Conservation Storage

All comprehensive plans include increasing the amount of space available for water conservation storage in Shasta Reservoir by raising Shasta Dam. Conservation storage is the portion of the capacity of the reservoir available to store water for subsequent release to increase water supply reliability for M&I, agricultural, and environmental purposes. The comprehensive plans include a range of dam enlargements and various increases in conservation space.

Reduce Demand

All comprehensive plans would include an additional water conservation program for increased water deliveries created by the project, to augment current water use efficiency practices. The proposed program would consist of a 10-year initial program in which Reclamation would allocate approximately $2.3 million to $3.8 million, proportional to additional water supplies delivered, to fund water conservation efforts. Funding would focus on assisting project beneficiaries (agencies receiving increased water supplies because of the project), with developing new or expanded urban water conservation, agricultural water conservation, and water recycling programs. Program actions would be a combination of technical assistance, grants, and loans to support a variety of water conservation projects such as recycled wastewater projects, irrigation system retrofits, and urban utilities retrofit and replacement programs. Reclamation, in collaboration with project beneficiaries, would identify and develop water conservation projects for funding under the program. Reclamation would then implement an investment strategy, in coordination with project beneficiaries, to identify and prioritize projects which, in conjunction with other water conservation activities, would cost-effectively reduce water demand and increase water conservation. This process would result in developing, evaluating, and prioritizing projects for funding. The program could be established as an extension of existing Reclamation programs, or as a new program through teaming with SLWRI cost-sharing partners. Combinations and types of water use efficiency actions funded would be tailored to meet the needs of identified cost-sharing partners, including consideration of cost-effectiveness at a regional scale for agencies receiving funding.

Modify Flood Operations

Potential modification of flood operations would be considered for all comprehensive plans. Enlargement of Shasta Reservoir would require alterations to existing flood operation guidelines or rule curves, to reflect physical modifications, such as an increase in dam/spillway elevation. The rule curves would be revised with the goal of reducing flood damage and enhancing other objectives to the extent possible.

Modify Hydropower Facilities

Under each comprehensive plan, enlargement of Shasta Dam would likely require various minimum modifications, commensurate with the magnitude of the enlargement, to the existing hydropower facilities at the dam to enable their continued efficient use. These modifications, in conjunction with increased lake surface elevations, may provide incidental benefits to hydropower generation. Although modifications could also be included to further increase the power production capabilities of the reservoir (e.g., additional penstocks and generators), they are believed to be a detail beyond the scope of this investigation and are not considered further at this level of planning.

Maintain and Increase Recreation Opportunities

In addition to the measures described above, all comprehensive plans would address, to some extent, the secondary planning objective of maintaining and increasing recreation opportunities at Shasta Lake. Outdoor recreation, and especially recreation at Shasta Lake, represents a major source of enjoyment to millions of people annually and is a major source of income to the northern Sacramento Valley. Shasta Dam and Reservoir are within the Shasta Unit of the Whiskeytown-Shasta-Trinity NRA. Recreation within these lands is managed by USFS. As part of this administration, USFS either directly operates and maintains, or manages through leases, numerous public campgrounds, marinas, boat launching facilities, and related water-oriented recreation facilities. Enlarging Shasta Dam and Reservoir would affect some of these facilities. Consistent with the position of USFS, and planning conditions described in this chapter, all of the comprehensive plans would include features to, at a minimum, maintain the overall recreation capacity of the existing facilities. All comprehensive plans would also provide for modernization of relocated recreation facilities, including, at a minimum, modifications to comply with current standards for health and safety.

Maintain or Improve Water Quality

All alternatives could contribute to improved Delta water quality conditions and Delta emergency response. Additional storage in Shasta Reservoir would provide improved operational flexibility. Shasta Dam has the ability to provide increased releases and high-flow releases to reestablish Delta water quality. Improved Delta water quality conditions could provide benefits for both water supply reliability and ecosystem restoration by potentially increasing Delta outflow during drought years, and reducing salinity during critical periods.

Environmental Commitments Common to All Comprehensive Plans

Reclamation and/or its contractors would incorporate certain environmental commitments and best management practices (BMP) into all comprehensive plans, including any plan authorized for implementation, to avoid or minimize potential impacts. Reclamation would also coordinate planning, engineering, design and construction, operation, and maintenance phases of any authorized project modifications with applicable resource agencies.

The following environmental commitments would be incorporated into any comprehensive plan/action alternative for any project-related construction activities. This section does not include mitigation measures. Mitigation measures for each comprehensive plan are summarized later in this chapter. A mitigation plan to mitigate potential effects of comprehensive plans is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.

Develop and Implement Construction Management Plan

Reclamation would develop and implement a construction management plan to avoid or minimize potential impacts on public health and safety during project construction, to the extent feasible. The construction management plan would inform contractors and subcontractors of work hours, modes and locations of transportation and parking for construction workers; location of overhead and underground utilities; worker health and safety requirements; truck routes; stockpiling and staging procedures; public access routes; terms and conditions of all required project permits and approvals; and emergency response services contact information.

The construction management plan would also include construction notification procedures for the police, public works, and fire departments in the areas where construction would occur. In addition, the construction management plan would include similar procedures for Federal and State agencies with similar jurisdictions, including USFS. Notices would also be distributed to neighboring property owners. The health and safety component of the construction management plan would be monitored for the implementation of the plan on a day-to-day basis by a Certified Industrial Hygienist.

The construction management plan would include effort to notify businesses, residents, and visitors associated with recreation activities on and surrounding Shasta Lake. In addition to information available at the Shasta Lake Visitors Center, informational signs and booths would be placed at key locations to be identified by Reclamation in conjunction with agencies and local business organizations. Reclamation will also develop and maintain a project-specific website that will be used for a wide range of informational purposes.

Comply with Permit Terms and Conditions

If any action alternative is approved and authorized for construction, Reclamation would require its contractors and suppliers, its general contractor, and all of the general contractor's subcontractors and suppliers to comply with all of the terms and conditions of all required project permits, approvals, and conditions attached thereto. If necessary, additional information (e.g., detailed designs and additional documentation) would be prepared and provided for review by decision makers and the public. Reclamation would ultimately be responsible for the actions of its contractors in complying with permit conditions. Compliance with applicable laws, policies, and plans for this project is discussed in Section 26.6 of the accompanying EIS.

Provide Relocation Assistance Through Federal Relocation Assistance Program

All Federal, State, and local government agencies and others receiving Federal financial assistance for public programs and projects that require the acquisition of real property must comply with the policies and provisions set forth in the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, as amended (Uniform Act) (Title 49, Code of Federal Regulations (CFR), Part 24). All relocation and property acquisition activities would be performed in compliance with the Uniform Act. Any individual, family, or business displaced by implementation of any of the action alternatives would be offered relocation assistance services for the purpose of locating a suitable replacement property, to the extent consistent with the Uniform Act.

Under the Uniform Act, relocation services for residences would include providing a determination of the housing needs and desires, a list of comparable properties, transportation to inspect housing referrals, and reimbursement of moving costs and related expenses. For business relocation activities, relocation services would include providing a determination of the relocation needs and requirements; a determination of the need for outside specialists to plan, move, and reinstall personal property; advice as to possible sources of funding and assistance from other local, State, and Federal agencies; listings of commercial properties; and reimbursement for costs incurred in relocating and reestablishing the business. No relocation payment received would be considered as income for the purpose of the Internal Revenue Code.

Remain Consistent with USFS Built Environment Image Guide

Any facilities subject to USFS authorization that are constructed or reconstructed facilities would be consistent with USFS Built Environment Image Guide. The architectural character of facilities on National Forest System lands would be constructed using materials and design that keep with the visual and cultural identity of the landscape in which they are constructed. Reclamation would seek to maintain the quality of visitor experiences, affected facilities capacity will be replaced with facilities providing equivalent visual resource quality and amenities.

Protect Public Land Survey System Monuments and Property Corners

Reclamation would identify Public Land Survey System (PLSS) monuments or survey property corners affected by either inundation due to increased lake levels or construction activities. Reclamation or its contractors would protect all PLSS monuments and associated references and all property corners, either by positioning, or, where necessary, creating new references. The results will be filed with BLM and Shasta County.

Evaluate and Protect Paleontological Resources Discovered During Construction

If paleontological resources are discovered during construction activities, all work in the immediate vicinity of the discovery will stop immediately and Reclamation will be notified (as applicable). A qualified paleontologist will be retained to evaluate the find and recommend appropriate conservation measures, such as data recovery or protection in place. The conservation measures will be implemented before re-initiation of activities in the immediate vicinity of the discovery.

Develop and Implement Stormwater Pollution Prevention Plan

Any project authorized for construction would be subject to the construction-related stormwater permit requirements of the CWA National Pollutant Discharge Elimination System program. Reclamation would obtain any required permits through the Central Valley Regional Water Quality Control Board before any ground-disturbing construction activity. According to the requirements of Section 402 of the CWA, Reclamation and/or its contractors would prepare and implement a Stormwater Pollution Prevention Plan (SWPPP) before construction, identifying BMPs to prevent or minimize erosion and the discharge of sediments and other contaminants with the potential to affect beneficial uses of or lead to violations of water quality objectives for surface waters. The SWPPP would include site-specific structural and operational BMPs to prevent and control impacts on runoff quality, and procedures to be followed before each storm event. BMPs would control short-term and long-term erosion and sedimentation effects and stabilize soils and vegetation in areas affected by construction activities. The SWPPP would contain a site map that shows the construction-site perimeter; existing and proposed buildings, lots, roadways, and stormwater collection and discharge points; drainage patterns across the project; and general topography both before and after construction.

Additionally, the SWPPP would contain a visual monitoring program, a chemical monitoring program for “non-visible” pollutants that would be implemented if a BMP fails, and a sediment monitoring plan to be implemented if a particular site discharges directly to a water body listed on the CWA 303(d) list for sediment. BMPs for the project could include, but would not be limited to, silt fencing, straw bale barriers, fiber rolls, storm drain inlet protection, hydraulic mulch, and stabilized construction entrances.

Develop and Implement Erosion and Sediment Control Plan Reclamation would prepare and implement an erosion and sediment control plan to control short-term and long-term erosion and sedimentation effects, and to stabilize soils and vegetation in areas affected by construction activities. The plan would include all of the necessary local jurisdiction requirements regarding erosion control, and would implement BMPs for erosion and sediment control, as required. Types of BMPs may include, but would not be limited to, earth dikes and drainage swales, stream bank stabilization, and use of silt fencing, sediment basins, fiber rolls, and sandbag barriers.

Develop and Implement Feasible Spill Prevention and Hazardous Materials Management As part of the SWPPP, Reclamation and/or its contractors would develop and implement a spill prevention and control plan to minimize effects from spills of hazardous, toxic, or petroleum substances for project-related construction activities occurring in or near waterways. The accidental release of chemicals, fuels, lubricants, and nonstorm drainage water into water bodies would be prevented to the extent feasible. Spill prevention kits would always be close by when hazardous materials would be used (e.g., crew trucks and other logical locations). Feasible efforts would be implemented so that hazardous materials would be properly handled and the quality of aquatic resources would be protected by all reasonable means during work in or near any waterway. No fueling would be done within the ordinary high-water mark, immediate floodplain, or full pool inundation area, unless equipment stationed in these locations could not be readily relocated. Any equipment that could be readily moved out of the water body would not be fueled in the water body or immediate floodplain. For all fueling of stationary equipment done at the construction site, containments would be installed so that any spill would not enter the water, contaminate sediments that may come in contact with the water, or damage wetland or riparian vegetation. Any equipment that could be readily moved out of the water body would not be serviced within the ordinary high-water mark or immediate floodplain.

Additional BMPs designed to avoid spills from construction equipment and subsequent contamination of waterways would also be implemented. These could include, but would not be limited to, the following:

- Storage of hazardous materials in double-containment and, if possible, under a roof or other enclosure.
- Disposal of all hazardous and nonhazardous products in a proper manner.
- Monitoring of on-site vehicles for fluid leaks and regular maintenance to reduce the chance of leakage.
- Containment (using a prefabricated temporary containment mat, a temporary earthen berm, or other feature that can provide containment) of bulk storage tanks.

Haulers delivering materials to the project site would be required to comply with regulations for the transport of hazardous materials codified in Title 49, CFR Part 173; Title 49, CFR Part 177; and Title 26, California Code of Regulations (CCR) Division 6. These regulations provide specific packaging requirements, define unacceptable hazardous materials shipments, and prescribe safe-transit practices, including route restrictions, by carriers of hazardous materials.

Water Quality Protection for In-River Construction

The efforts discussed below would be implemented to minimize potential adverse effects to water quality.

Implement In-River Construction Work Windows All construction activities along the Sacramento River would be conducted during months when instream flows are managed outside the flood season (e.g., June to September). In-river work between Keswick Dam and the RBPP would be conducted mid-August through September to minimize impacts to Sacramento River winter-run Chinook salmon.

Comply with All Water Quality Permits and Regulations Project activities would be conducted to comply with all additional requirements specified in required permits relating to water quality protection. Relevant permits anticipated to be obtained for the proposed action include a CWA Section 401 certification, and CWA Section 404 compliance through the USACE.

Implement Water Quality Best Management Practices BMPs that would be implemented to avoid and/or minimize potential impacts associated with construction and the 10-year-long spawning gravel augmentation program are described below.

Handle Spawning Gravel to Minimize Potential Water Quality Impacts Gravel would be sorted and transported in a manner that minimizes potential water quality impacts (e.g., management of fine sediments). Gravel would be washed at least once and have a cleanliness value of 85 or higher based on California

Department of Transportation (Caltrans) Test No. 227. Gravel would also be completely free of oils, clay, debris, and organic material.

Minimize Potential Impacts Associated with Equipment Contaminants For in-river work, all equipment would be steam-cleaned every day to remove hazardous materials before the equipment entered the water. Biodegradable hydrocarbon products would be used in the heavy equipment in the stream channel.

Implement Feasible Spill Prevention and Hazardous Materials Management The accidental release of chemicals, fuels, lubricants, and non-storm drainage water into channels would be prevented to the extent feasible. Spill prevention kits would always be in close proximity when using hazardous materials (e.g., crew trucks and other logical locations). Feasible efforts would be implemented to ensure that hazardous materials are properly handled and the quality of aquatic resources is protected by all reasonable means. No fueling would be done within the ordinary high-water mark or immediate floodplain, unless equipment stationed in these locations was not readily relocated (i.e., pumps, generators). For stationary equipment that must be fueled on site, containments would be provided in such a manner that any accidental spill of fuel would not be able to enter the water or contaminate sediments that could come in contact with water. Any equipment that was readily moved out of the channel would not be fueled in the channel or immediate floodplain. All fueling done at the construction site would provide containment to the degree that any spill would be unable to enter the channel or damage wetland or riparian vegetation. No equipment servicing would be done within the ordinary high-water mark or immediate floodplain, unless equipment stationed in these locations could not be readily relocated (i.e., pumps, generators). Additional BMPs designed to avoid spills from construction equipment and subsequent contamination of waterways would also be implemented.

Minimize Potential Impacts Associated with Access and Staging Existing access roads would be used to the extent possible. Equipment staging areas would be located outside of the Sacramento River ordinary high water mark or the Shasta Dam full pool inundation area, and away from sensitive resources.

Remove Temporary Fills as Appropriate Temporary fill for access, side channel diversions, and/or side channel cofferdams, would be completely removed after completion of construction.

Remove Equipment from River Overnight and During High Flows Construction contractors would remove all equipment from the river on a daily basis at the end of the workday. Construction contractors would also monitor Reclamation's Central Valley Operations Office Web site daily for forecasted flows posted there to determine and anticipate any potential changes in releases. If flows were anticipated to inundate a work area that would normally be dry, the contractor would immediately remove all equipment from the work area.

Extend and Enhance Existing Fish Habitat Structures in Shasta Lake

Reclamation and USFS, in conjunction with resource management agencies would identify areas at appropriate elevations to replace, extend, and enhance existing structural fish habitat. The structures would be installed concurrently with construction activities in the vicinity of construction sites or at locations identified by resource agencies. These activities would include maintaining shallow water and transitional riverine habitat with the placement of manzanita brush structures, large woody debris, and rock-boulder clusters. To the extent feasible, vegetation cleared for construction and borrow pit areas would be used to extend and enhance fish habitat structures. Excess vegetative materials cleared from construction and borrow pit areas would be stockpiled for future fish habitat enhancement. Additionally, areas within the enlarged reservoir having appropriate conditions to establish living plants, including willow (Salix sp.), buttonbush (*Cephalanthus* sp.), and cottonwood (*Populus* sp.), would be identified for the purposes of providing structural fish habitat when the established plants are inundated.

Fisheries Conservation

The efforts discussed below would be implemented to minimize potential adverse effects on fish species.

Implement In-Water Construction Work Windows Reclamation would identify and implement feasible in-water construction work windows in consultation with NMFS, USFWS, and CDFW. In-water work windows would be timed to occur when sensitive fish species were not present or would be least susceptible to disturbance.

Monitor Construction Activities A qualified biologist would monitor potential impacts to important fishery resources throughout all phases of project construction. Monitoring may not be necessary during the entire duration of the project if, based on the monitor’s professional judgment (and with concurrence from Reclamation), a designated on-site contractor would suffice to monitor such activities and would agree to notify a biologist if aquatic organisms are in danger of harm. However, the qualified biologist would need to be available by phone and Internet and be able to respond promptly to any problems that arose.

Perform Fish Rescue/Salvage If spawning activities for sensitive fish species were encountered during construction activities, the biologist would be authorized to stop construction activities until appropriate corrective activities were completed or it was determined that the fish would not be harmed.

A qualified biologist would identify any fish species that may be affected by the project. The biologist would facilitate rescue and salvage of fish and other aquatic organisms that become entrapped within construction structures and cofferdam enclosures in the construction area. Any rescue, salvage, and handling of listed species would be conducted under appropriate authorization (i.e., incidental take statement/permit for the project, Federal Endangered

Species Act Section 4(d) scientific collection take permit, or a Memorandum of Understanding).

If fish were identified as threatened with entrapment in construction structures, construction would be stopped and efforts made to allow fish to leave the project area before resuming work. If fish were unable to leave the project area of their own volition, then fish would be collected and released outside the work area. Fish entrapped in cofferdam enclosures would be rescued and salvaged before the cofferdam area was completely dewatered. Appropriately sized fish screens would be installed on the suction side of any pumps used to dewater in-water enclosures.

Reporting A qualified biologist would prepare a letter report detailing the methodologies used and the findings of fish monitoring and rescue efforts. Monitoring logs would be maintained and provided, with monitoring reports. The reports would contain, but not be limited to, the following: summary of activities; methodology for fish capture and release; table with dates, numbers, and species captured and released; photographs of the enclosure structure and project site conditions affecting fish; and recommendations for limiting impacts during subsequent construction phases, if appropriate.

Survey and Monitor Fish Migration between Shasta Lake and Squaw Creek

Reclamation would fund and implement an adaptive management effort to survey and monitor fish migration between Shasta Lake and Squaw Creek, within and immediately upstream from the new inundation zone, before and immediately after project completion, to determine if warm-water fish (bass) actively migrated into and cause adverse effects on native fish, amphibians, and mollusks. These study and monitoring activities would be warranted due to uncertainties associated with the potential for warm-water fish accessing tributary stream reaches currently isolated by passage barriers near the head of the existing reservoir. The surveys would document occurrences and abundances of warm-water fish species and USFS special-status species in lower Squaw Creek before and immediately after project completion to evaluate if reservoir enlargement coincides with increases in warm-water predator species and declines of special-status indicator species. If warm-water fish abundance increases or adverse effects attributed to warm-water fish predation on native fish, amphibians or mollusks is documented within 3-5 years after the project was completed, a fish barrier or other acceptable feature would be implemented to prevent or minimize further invasions and colonization by warm-water fish.

Revegetation Plan

Reclamation, in conjunction with cooperating agencies and private landowners, would prepare a comprehensive revegetation plan to be implemented in conjunction with other management plans (e.g., SWPPP). This plan would apply to any area included as part of an action alternative, such as inundation, relocation, or mitigation activities. Overall objectives of the revegetation plan would be to reestablish native vegetation to control erosion, provide effective ground cover, minimize opportunities for nonnative plant species to establish or expand; and provide habitat diversity over time. Reclamation would work closely with cooperating agencies, private landowners, and revegetation specialists to develop the sources of native vegetation, site-specific planting patterns and species assemblages necessary for a revegetation effort of this magnitude.

Invasive Species Management

Reclamation would develop and implement a control plan to prevent the introduction of zebra/quagga mussels, invasive plants, and other invasive species to project areas. The control plan would cover all workers, vehicles, watercraft, and equipment (both land and aquatic) that would come into contact with Shasta Reservoir, the shoreline of Shasta Reservoir, the Sacramento River, and any riverbanks, floodplains, or riparian areas. Plan activities could include, but would not be limited to, the following:

- Preinspection and cleaning of all construction vehicles, watercraft, and equipment before being shipped to project areas
- Reinspection of all construction vehicles, watercraft, and equipment on arrival at project areas
- Inspection and cleaning of all personnel before work in project areas

All inspections would be conducted by trained personnel and would include both visual and hands-on inspection methods of all vehicle and equipment surfaces, up to and including internal surfaces that have contacted raw water.

Approved cleaning methods would include a combination of the following:

- **Precleaning –** Draining, brushing, vacuuming, high-pressure water treatment, thermal treatment
- **Cleaning –** Freezing, desiccation, thermal treatment, high-pressure water treatment, chemical treatment

On-site cleanings would require capture, treatment, and/or disposal of any and all water needed to conduct cleaning activities.

Fire Protection and Prevention Plan

Reclamation would prepare and implement a fire protection and prevention plan to minimize the risk of wildfire or threat to workers, property, and the public. The USFS will maintain a plan similar to this Fire Protection and Prevention Plan which addresses preventing and controlling wildfires in the NRA as described by the interagency agreement with the California Department of

Forestry and Fire Protection (CAL FIRE) and other associated entities. Reclamation's contractors would follow relevant safety standards/procedures related to fire prevention would be incorporated into the project design, and would be used during construction activities and project operation and maintenance. Safety standards and procedures include the California Building Code; the Shasta County Fire Plan; USFS safety requirements regarding fire hazards; CAL FIRE requirements for private lands; and California Public Utilities Code General Order 95, which provides procedures for proper removal, disposal, and placement of poles, wires, and associated infrastructure; and the National Electric Safety Code (a voluntary code that provides safety procedures for electric utility installation and operation). Precautionary activities to prevent construction-related fires would include locating utilities a safe distance from vegetation and structures, proper construction of power lines, and construction worker safety training. Post-construction infrastructure operation and maintenance would follow current safety practices associated with fire prevention and would include clearing vegetation from power utility facilities and other sources using combustion engines (e.g., water pumps) on a regular basis.

Construction Material Disposal

Reclamation's contractors would recycle or reuse demolished materials, such as steel or copper wire, concrete, asphalt, and reinforcing steel, as required and where practical. Other demolished materials would be disposed of in local or other identified permitted landfills in compliance with applicable requirements.

To reduce the risk to construction workers, the public, and the environment associated with exposure to hazardous materials and waste, Reclamation would implement the following:

- A Hazardous Materials Business Plan (HMBP) would be developed and implemented to provide information regarding hazardous materials to be used for project implementation and hazardous waste that would be generated. The HMBP would also define employee training, use of protective equipment, and other procedures that provide an adequate basis for proper handling of hazardous materials to limit the potential for accidental releases of and exposure to hazardous materials. All procedures for handling hazardous materials would comply with all Federal, State, and local regulations.

- Soil to be disposed of at a landfill or recycling facility would be transported by a licensed waste hauler.

- All relevant available asbestos survey and abatement reports and supplemental asbestos surveys would be reviewed. Removal and disposal of asbestos-containing materials would be performed in accordance with applicable Federal, State, and local regulations.

A lead-based paint survey would be conducted to determine areas where lead-based paint is present and the possible need for abatement before construction.

Asphalt Removal

Per California Fish and Game Code 5650 Section (a), all asphaltic roadways and parking lots inundated by project implementation would be demolished and removed according to Shasta County standards. Asphalt would be disposed of at an approved and permitted waste facility. Dirt roads inundated by project implementation would remain in place.

Major Components of Comprehensive Plans

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 constructing a common set of features, as shown in Table 4-1. Features and related construction activities under all comprehensive plans would include the following:

- Clearing vegetation from portions of the inundated reservoir area
- Constructing the dam raise, appurtenant structures, reservoir area dikes, and railroad embankments
- Relocating roadways, bridges, recreation facilities, utilities, and miscellaneous minor infrastructure

Figure 4-1 illustrates major features in the Shasta Lake area common to all comprehensive plans.

In addition, as described in the Preliminary Environmental Commitments and Mitigation Measures Appendix to the accompanying EIS, environmental commitments and mitigation measures have been identified for and included in all comprehensive plans.

CP4, CP4A, and CP5 would also include features and related construction activities associated with gravel augmentation and restoring riparian, floodplain, and side channel habitat along the upper Sacramento River. Additional features and related construction activities associated with Shasta Lake and tributary shoreline enhancements and features to increase Shasta Lake recreation opportunities are included under CP5.

Table 4-1. Summary of Physical Features of Comprehensive Plans

Main Features		Comprehensive Plans				
	CP1	**CP2**	**CP3**	**CP4**	**CP4A**	**CP5**
Dam and Appurtenant Structures						
Shasta Dam						
Crest Raise (feet)	6.5	12.5	18.5	18.5	18.5	18.5
Full Pool Height Increase (feet)	8.5	14.5	20.5	20.5	20.5	20.5
Elevation of Dam Crest (feet)[1]	1084.0	1090.0	1096.0	1096.0	1096.0	1096.0
Elevation of Full Pool (feet)[2]	1,078.2	1,084.2	1,090.2	1,090.2	1,090.2	1,090.2
Capacity Increase (acre-feet)	256,000	443,000	634,000	634,000	634,000	634,000
Main Dam	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.	Raise dam crest. Construct new parapets and utility gallery. Raise existing elevator tower and hoist tower.
Wing Dams	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.	Raise to meet dam crest. Build new visitor center along left wing dam. Relocate gantry crane on right wing dam.
Spillway	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.	Raise crest and extend piers. Replace 3 drum gates with 6 sloping fixed-wheel gates.
River Outlets	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.	Replace 4 lower-tier tube valves with jet flow gates.
Temperature Control Device	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.	Raise/modify controls.
Shasta Powerplant/Penstocks	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.	Raise penstock hoists.

Table 4-1. Summary of Physical Features of Comprehensive Plans (contd.)

Main Features	Comprehensive Plans					
	CP1	CP2	CP3	CP4	CP4A	CP5
Pit 7 Dam/Powerhouse	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.	Increase height of training walls on dam spillway. Install a tailwater depression system. Modify other Pit 7ancillary facilities.
Reservoir Area Clearing	Clear 150 acres completely and 220 acres with overstory removal.	Clear 240 acres completely and 350 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.	Clear 340 acres completely and 500 acres with overstory removal.
Reservoir Area Dikes and Railroad Embankments	Construct 3 railroad embankments and 2 new dikes.	Construct 3 railroad embankments and 3 new dikes.	Construct 3 railroad embankments and 4 new dikes.	Construct 3 railroad embankments and 4 new dikes.	Construct 3 railroad embankments and 4 new dikes.	Construct 3 railroad embankments and 4 new dikes.
Relocations						
Roadways	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.	Match replacement widths to existing paved roads to be replaced.
Length of Relocated Roadway (linear feet)	16,700	28,400	33,100	33,100	33,100	33,100
Number of Road Segments Affected	10	21	30	30	30	30
Vehicle Bridges	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.	Relocate 4 bridges, modify 1 bridge.
Railroad	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge	Relocate 2 bridges and realign track in-between, modify 1 bridge
Recreation Facilities	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 202 campsites/day-use sites/RV sites, 2 USFS facilities, 8.1 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 261 campsites/ day-use sites/RV sites, 2 USFS facilities, 9.9 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads.	Modify or replace 9 marinas, 6 public boat ramps, 6 resorts, 328 campgrounds/day-use areas/RV sites, 2 USFS facilities, 11.6 miles of trail, and 2 trailheads. Add 6 trailheads and18 miles of new hiking trails.

Table 4-1. Summary of Physical Features of Comprehensive Plans (contd.)

Main Features	Comprehensive Plans					
	CP1	CP2	CP3	CP4	CP4A	CP5
Utilities	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.	Relocate inundated utilities. Construct wastewater treatment facilities.
Ecosystem Enhancements	None	None	None	Reserve 378 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River.	Reserve 191 TAF of the additional storage for cold-water supply for anadromous fish. Implement adaptive management plan to benefit anadromous fish. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River.	Construct shoreline fish habitat around Shasta Lake. Enhance aquatic habitat in tributaries to Shasta Lake to improve fish passage. Augment spawning gravel in the upper Sacramento River at the rate of up to 10,000 tons per year. Restore riparian, floodplain, and side channel habitat along the upper Sacramento River.

Notes:

[1] Dam crest elevations are based on the National Geodetic Vertical Datum of 1929 (NGVD29). All designs and figures for Shasta Dam and appurtenant structures are based on NGVD29.

[2] Full pool elevations are based on the North American Vertical Datum of 1988 (NAVD88), which is 2.66 feet higher than NGVD29. All designs and figures for reservoir area infrastructure modifications and relocations to accommodate increased water levels are based on a 2001 aerial survey of the reservoir using NAVD88.

Key:

CP = comprehensive plan

RV = recreational vehicle

TAF = thousand acre-feet

USFS = U.S. Department of Agriculture, Forest Service

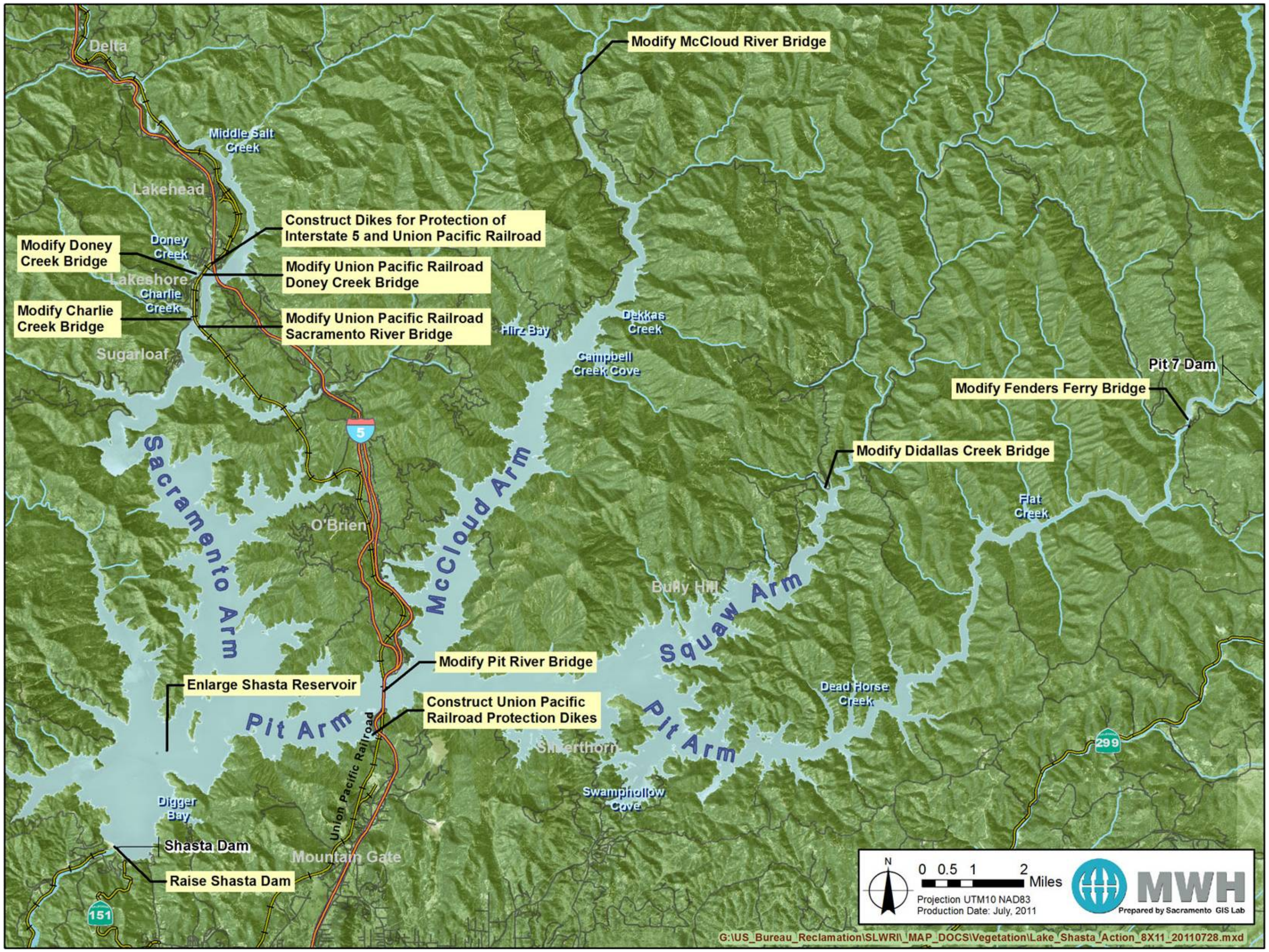


Figure 4-1. Major Features Common to All Comprehensive Plans in Shasta Lake Area

CP1 – 6.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP1 consists primarily of enlarging Shasta Dam by raising the crest 6.5 feet and enlarging the reservoir by 256,000 acre-feet. Major features of CP1 in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

Major Components of CP1

CP1 includes the following major components:

- Raising Shasta Dam and appurtenant facilities by 6.5 feet.
- Implementing the set of eight common management measures described above.
- Implementing the common environmental commitments described above.

As shown in Table 4-1, by raising Shasta Dam 6.5 feet, from a crest elevation of 1,077.5 feet to 1,084.0 feet (based on NGVD29),[1] CP1 would increase the height of the reservoir full pool by 8.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications, including replacing the three drum gates with six sloping, fixed-wheel gates. This increase in full pool height would add approximately 256,000 acre-feet of additional storage to the overall reservoir capacity. Accordingly, the overall full pool storage would increase from 4.55 MAF to 4.81 MAF. Figure 2-3 shows the increase in surface area and storage capacity for each dam raise.

Under CP1, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. This alternative (and all comprehensive plans) involves extending the existing TCD for efficient use of the expanded cold-water pool. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage capacity in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 70,000 acre-feet of the 256,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 35,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

CP1 would also include the potential to revise the operational rules for flood control at Shasta Dam and Reservoir, which could reduce the potential for flood damage, and benefit recreation. Although the volume of the flood control pool would remain the same as under existing operations (1.3 MAF), the bottom of the flood control pool elevation would likely be increased based on increased

[1] Dam crest elevations are based on NGVD29. All designs and figures for Shasta Dam and appurtenant structures are based on NGVD29.

dam height and reservoir capacity. Because of reservoir geometry, this would decrease the depth of the flood control pool, allowing higher winter and spring water levels. Increased reservoir capacity could have further flood damage reduction benefits in years when water levels are below the new flood control pool elevation.

A limited potential also exists for changes in flood control rules to allow more operational flexibility in reservoir drawdown requirements in response to storms, resulting in a net increase in the rate of spring reservoir filling during some years. The ability to revise the operational rules might result from using advanced weather forecasting tools and enhanced basin monitoring, which may be included during refinement of operational parameters after authorization. Higher spring water levels and associated increases in reservoir surface area would benefit recreation.

Potential Benefits of CP1

Major potential benefits of CP1, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below. In addition, Table 4-4 qualitatively compares the benefits and effects of each of the comprehensive plans relative to the beneficial water uses recognized by the State Water Board.

Table 4-2. Summary of Potential Features and Benefits of Comprehensive Plans (Compared to No-Action Alternative)

Item	CP1	CP2	CP3	CP4	CP4A	CP5
Shasta Dam Raise (feet)	6.5	12.5	18.5	18.5	18.5	18.5
Total Increased Storage (TAF)	256	443	634	634	634	634
Benefits						
Increase Anadromous Fish Survival						
Dedicated Storage (TAF)	-	-	-	378	191	-
Production Increase (thousand fish)[1]	61	379	207	813	710	378
Spawning Gravel Augmentation (tons)[2]				10,000	10,000	10,000
Side Channel Rearing Habitat Restoration				Yes	Yes	Yes
Increase Water Supply Reliability						
Total Increased Dry and Critical Year Water Supplies (TAF/year)[3]	47.3	77.8	63.1	47.3	77.8	113.5
Increased NOD Dry and Critical Year Water Supplies (TAF/year)[3]	4.5	10.7	35.2	4.5	10.7	25.2
Increased SOD Dry and Critical Year Water Supplies (TAF/year)[3]	42.7	67.1	28.0	42.7	67.1	88.3
Increased Water Use Efficiency Funding	Yes	Yes	Yes	Yes	Yes	Yes
Increased Emergency Water Supply Response Capability	Yes	Yes	Yes	Yes	Yes	Yes
Reduce Flood Damage						
Increased Reservoir Storage Capacity	Yes	Yes	Yes	Yes	Yes	Yes
Additional Hydropower Generation[4]						
Increased Hydropower Generation (GWh/year)[5]	52 - 54	87 - 90	86 - 90	127 - 133	125 - 130	112 - 117

Table 4-2. Summary of Potential Features and Benefits of Comprehensive Plans (Compared to No-Action Alternative) (contd.)

Item	CP1	CP2	CP3	CP4	CP4A	CP5
Conserve, Restore, and Enhance Ecosystem Resources						
Shoreline Enhancement (acres)	-	-	-	-	-	130
Tributary Aquatic Habitat Enhancement (miles)[6]	-	-	-	-	-	6
Riparian, Floodplain, and Side Channel Restoration Habitat	-	-	-	Yes	Yes	Yes
Increased Ability to Meet Flow and Temperature Requirements Along Upper Sacramento River	Yes	Yes	Yes	Yes	Yes	Yes
Improve Water Quality						
Improved Delta Water Quality	Yes	Yes	Yes	Yes	Yes	Yes
Increased Delta Emergency Response Capability	Yes	Yes	Yes	Yes	Yes	Yes
Increase Recreation						
Recreation (user days, thousands)[7]	85 - 89	116 - 134	201 - 205	307 - 370	246 - 259	142 - 175
Modernization of Recreation Facilities	Yes	Yes	Yes	Yes	Yes	Yes

Notes:

1 Numbers were derived from SALMOD and represent an index of production increase, based on the estimated average annual increase in juvenile Chinook salmon surviving to migrate downstream from the RBPP.

2 Average amount per year for 10-year period.

3 Total increased dry and critical year reliability for Central Valley Project and State Water Project deliveries estimated using the SLWRI 2012 Version CalSim-II model. Does not reflect benefits related to water use efficiency actions included in all comprehensive plans.

4 In addition to increased hydropower generation, all comprehensive plans provide increased capacity benefits (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

5 Annual increases in hydropower generation were estimated using two methodologies – at load center (accounting for transmission losses) and at-plant (no transmission losses). To provide a more conservative estimate of potential hydropower benefits, load center generation values were used to estimate potential benefits of increased hydropower generation under comprehensive plans. However, increased generation values reported in Chapter 23 of the EIS are based on at-plant generation values to capture the largest potential effects from changes in hydropower generation and pumping.

6 Tributary aquatic enhancement provides for the connectivity of native fish species and other aquatic organisms between Shasta Lake and its tributaries. Estimates of benefits reflect only connectivity with perennial streams and do not reflect additional miles of connectivity with intermittent streams.

7 Annual recreation visitor user days were estimated using two methodologies. The minimum user day value was used to estimate potential recreation benefits to provide a more conservative estimate of the potential benefits of increased recreation under comprehensive plans. However, the maximum user value was used for direct and indirect effects evaluations in each resource area chapter to capture the largest potential effects from increased visitation. These values do not account for increased visitation due to modernization of recreation facilities associated with all comprehensive plans. For more detailed information related to estimated recreation user days, please see Chapter 10 of the Modeling Appendix.

Key:
- = not applicable
CP = comprehensive plan
Delta = Sacramento-San Joaquin Delta
GWh/year = gigawatt-hours per year
NOD = north of Delta
SOD = south of Delta
SLWRI = Shasta Lake Water Resources Investigation
RBPP = Red Bluff Pumping Plant
TAF = thousand acre feet

Table 4-3. Summary of Additional Broad Public Benefits

Category	Benefit Description
System-Wide Water Management Flexibility	All CPs improve system-wide water management flexibility for storage and operations to meet multiple competing public needs
Air Quality	All CPs provide for increased clean energy generation, potentially reducing GHG emissions
Groundwater	All CPs allow for decreased groundwater pumping and related groundwater overdraft conditions in CVP/SWP water service areas
Reservoir Water Quality	All CPs replace reservoir area septic systems with centralized wastewater treatment plants
Shasta Lake Cold-Water Fisheries	All CPs improve Shasta Lake cold-water fisheries conditions through increasing the cold-water pool
Traffic and Transportation	All CPs modernize relocated roadways and bridges with facilities designed to meet current public safety standards
Public Services	All CPs relocate USFS emergency response facilities to a more centralized location adjacent to major transportation corridors

Note:
[1] Broad public benefits above are additional to benefits associated with project planning objectives.

Key:
CP = Comprehensive Plan
CVP = Central Valley Project
GHG = greenhouse gas
SWP = State Water Project
USFS = U.S. Forest Service

Table 4-4. Comparison of Comprehensive Plans Relative to Beneficial Uses of Water in California

State Water Board Recognized Beneficial Use[1]	CP1	CP2	CP3	CP4	CP4A	CP5
Agricultural Supply	+++	++++	++++++	+++	++++	+++++
Municipal and Industrial Supply[2]	+	++	0	+	++	+++
Groundwater Recharge[3]	+	++	+++	+		++++
Freshwater Replenishment	+	++	+++	+++	+++	+++
Navigation	0	0	0	0		0
Hydropower Generation	+	++	++	++++	++++	+++
Water Contact Recreation	+	++	+++	+++++	++++	++
Noncontact Water Recreation	+	++	+++	+++++	++++	++
Ocean, Commercial, and Sport Fishing	+	+++	++	++++++	++++++	+++
Aquaculture	0	0	0	0	0	0
Warm Freshwater Habitat	+	+	+	+	+	+++
Cold Freshwater Habitat	+	+++	++	++++++	++++++	+++
Inland Saline Water Habitat	0	0	0	0		0
Estuarine Habitat	+	++	+++	+++	+++	+++

Table 4-4. Comparison of Comprehensive Plans Relative to Beneficial Uses of Water in California (contd.)

State Water Board Recognized Beneficial Use[1]	CP1	CP2	CP3	CP4	CP4A	CP5
Marine Habitat	+	++	++	++++	++++	++
Preservation of Biological Habitats of Special Significance	+	+++	++	++++++	++++++	++++
Rare, Threatened, or Endangered Species – Aquatic	+	+++	++	++++++	++++++	+++
Rare, Threatened, or Endangered Species – Terrestrial	–	–	–	–	–	–
Migration of Aquatic Organisms	+	+++	++	++++++	++++++	++++
Spawning, Reproduction, and/or Early Development	+	+++	++	++++++	++++++	++++
Shellfish Harvesting	0	0	0	0	0	0

Notes:

[1] Listed beneficial use categories are those officially recognized by the State Water Resources Control Board, as described in the *2002 California 305(b) Report on Water Quality* State Water Board 2003).

[2] "Municipal and Industrial Supply" combines the State Water Board "Municipal and Domestic Supply," "Industrial Process Supply," and "Industrial Service Supply" beneficial use categories.

[3] Although the SLWRI comprehensive plans do not include specific features to fund or assist groundwater storage, enlarging Shasta Reservoir could allow for additional system flexibility for surface water deliveries, decreasing reliance on groundwater pumping and reducing groundwater overdraft conditions in Central Valley Project and State Water Project service areas.

Key:
– = net negative effect (net impact)
\+ = net positive effect (net benefit)
0 = minimal anticipated effect
CP = comprehensive plan
SLWRI = Shasta Lake Water Resources Investigation

Increase Anadromous Fish Survival Water temperature is one of the most important factors affecting anadromous fish survival in the Sacramento River (NMFS 2009a, 2009b, 2014). CP1 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critical water years. This would be accomplished by raising Shasta Dam 6.5 feet, thus increasing the depth of the cold-water pool in Shasta Reservoir and resulting in an increase in seasonal cold-water volume below the thermocline (layer of greatest water temperature and density change). Cold water released from Shasta Dam significantly influences water temperature conditions in the Sacramento River between Keswick Dam and the RBPP. Hence, the most significant benefits to anadromous fish would occur upstream from the RBPP. It is estimated that under CP1, improved water temperature and flow conditions could result in an average annual increase in the salmon population of about 61,300 outmigrating juvenile Chinook salmon.

Figure 4-2 shows an exceedence probability relationship of maximum annual storage in Shasta Lake for CP1 and other comprehensive plans compared to the No-Action Alternative, illustrating expected increases in storage volumes under each comprehensive plan. Storage volumes for Figure 4-2 were simulated with the CalSim-II model as discussed in detail in the EIS Modeling Appendix. Figure 4-3 shows simulated reservoir storage fluctuations for the No-Action Alternative and CP1 for a representative period of 1972 through 2003.

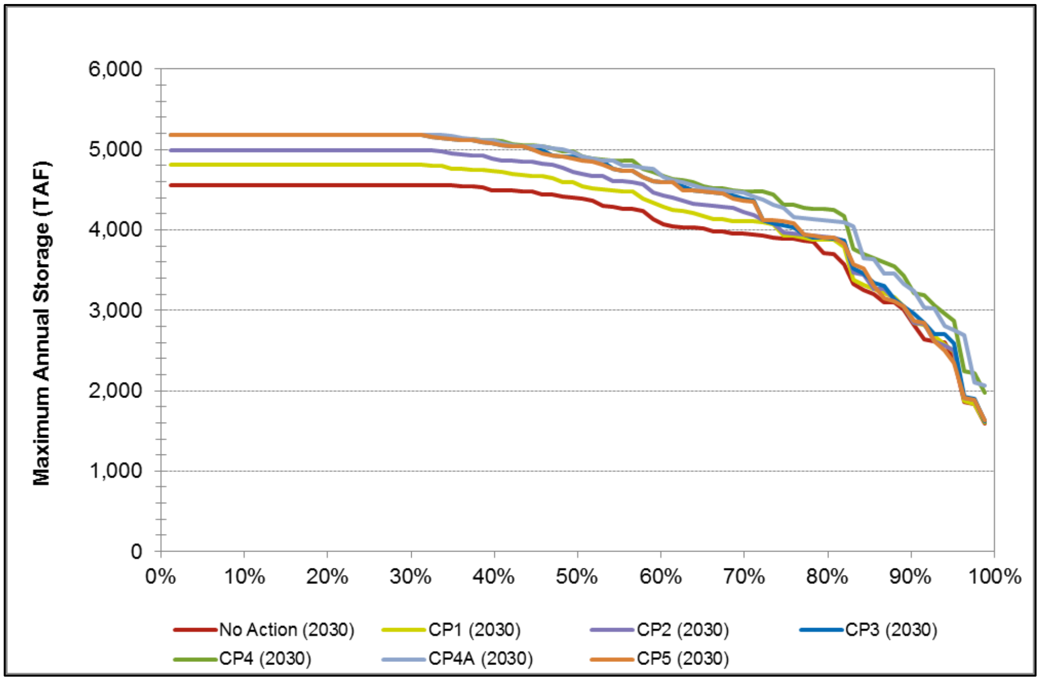


Figure 4-2. Simulated Exceedence Probability Relationship of Maximum Annual Storage in Shasta Lake for Future Level of Development (2030)

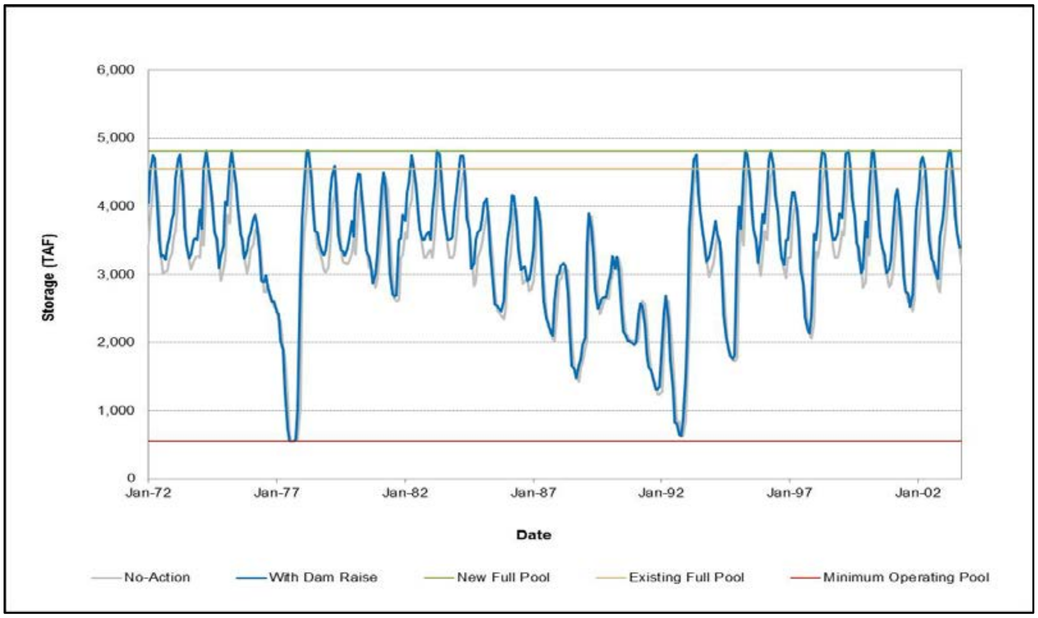
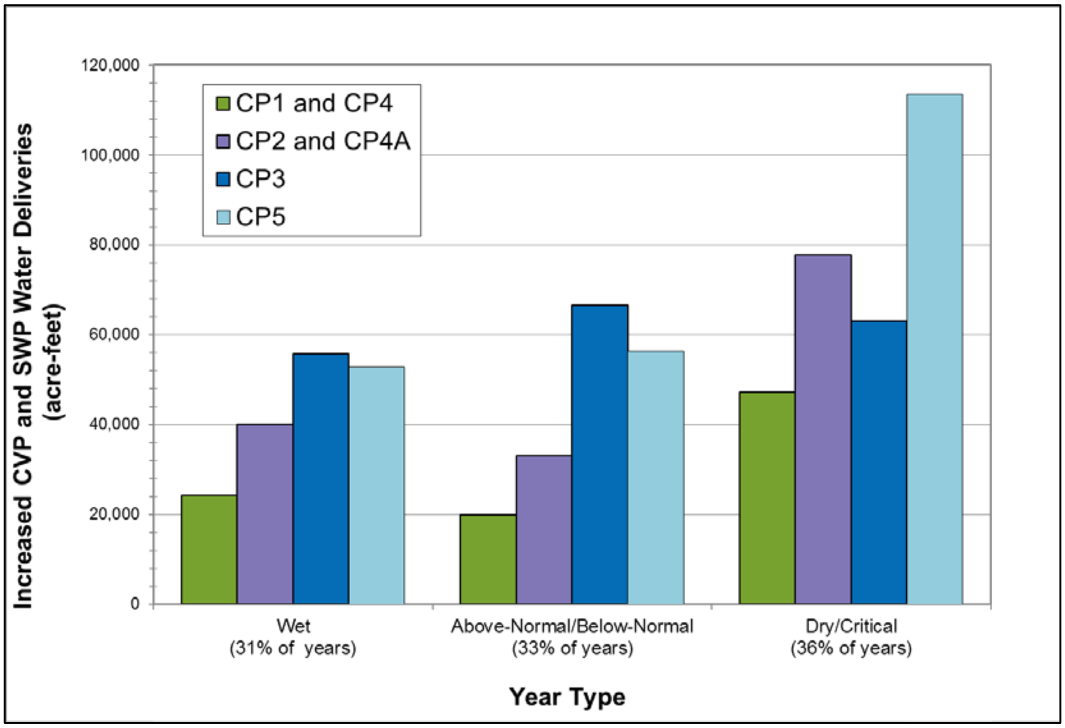


Figure 4-3. Simulated Shasta Reservoir Storage from 1972 to 2003 for the No-Action Alternative and CP1

Increase Water Supply Reliability CP1 would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries primarily during drought periods. Resulting increases in deliveries, based on CalSim-II modeling results, are shown in Figure 4-4 and Tables 4-2 and 4-5. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. As shown in Table 4-5, CP1 would help reduce estimated future water shortages by increasing dry and critical year water supplies for agricultural and M&I deliveries by at least 47,300 acre-feet per year and average annual deliveries by about 31,000 acre-feet per year. The majority of increased dry and critical year water supplies, 42,700 acre-feet, would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. As population and resulting water demands continue to grow and available supplies continue to remain relatively static, more effectively using these supplies could reduce potential critical impacts to agricultural and urban areas resulting from water shortages. Under CP1, approximately $1.6 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.



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

Figure 4-4. Comparison of Increased CVP and SWP Water Deliveries by Year Type for Comprehensive Plans

Table 4-5. Increases in CVP and SWP Water Deliveries for Comprehensive Plans

CVP and SWP Deliveries	Average All Years						Dry and Critical Years[2]					
	CP1 (acre-feet)	CP2 (acre-feet)	CP3 (acre-feet)	CP4 (acre-feet)	CP4A (acre-feet)	CP5 (acre-feet)	CP1 (acre-feet)	CP2 (acre-feet)	CP3 (acre-feet)	CP4 (acre-feet)	CP4A (acre-feet)	CP5 (acre-feet)
Agriculture												
CVP Agriculture	16,300	25,600	64,400	16,300	25,600	44,300	13,500	23,500	77,300	13,500	23,500	51,200
SWP Agriculture	4,000	5,900	(2,200)	4,000	5,900	6,500	9,000	14,100	(6,700)	9,000	14,100	14,900
M&I												
CVP M&I	30	1,300	5,500	30	1,300	3,300	100	1,200	8,000	100	1,200	4,000
SWP M&I	10,700	18,600	(6,000)	10,700	18,600	21,700	24,500	39,000	(15,500)	24,500	39,000	43,400
Combined CVP and SWP												
Agriculture[1]	20,300	31,400	62,200	20,300	31,400	50,900	22,500	37,600	70,600	22,500	37,600	66,100
M&I[1]	10,700	19,900	(500)	10,700	19,900	25,000	24,700	40,200	(7,500)	24,700	40,200	47,400
Total[1]	***31,000***	***51,300***	***61,700***	***31,000***	***51,300***	***75,900***	***47,300***	***77,800***	***63,100***	***47,300***	***77,800***	***113,500***

Notes:
[1] Totals may not sum due to rounding.
[2] Based on the Sacramento Valley Water Year Hydrologic Classification

Key:
CP = Comprehensive Plan
CVP = Central Valley Project
M&I = Municipal and Industrial
SWP = State Water Project

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in an increase in power generation of about 52 gigawatt-hours (GWh) per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Maintain and Increase Recreation Opportunities CP1 includes features to at least maintain the existing recreation capacity at Shasta Lake. Although CP1 does not include specific features to further increase recreation capacity, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. The maximum surface area of the lake would increase by about 1,110 acres (4 percent), from 29,700 to about 30,800 acres. The average surface area of the lake during the recreation season from May through September would increase by about 800 acres (3 percent), from 23,900 acres to 24,700 acres. There is also limited potential to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Planning Objectives CP1 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality. Enlarging Shasta Dam would provide for incidental increased reservoir capacity to capture flood flows, which could reduce flood damage along the upper Sacramento River. Improved fisheries conditions as a result of CP1, as described above, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River. Furthermore, CP1 could potentially benefit ecosystem restoration through improved Delta water quality conditions by increasing Delta outflow during drought years and reducing salinity during critical periods. CP1 may also contribute to improving Delta water quality through increased Delta emergency response capabilities. When Delta emergencies occur, additional water in Shasta Reservoir could improve operational flexibility for increasing releases to supplement existing water sources to reestablish Delta water quality. In addition to Delta emergency response, increased storage in Shasta Reservoir could increase emergency response capability for CVP/SWP water supply deliveries.

Additional Broad Public Benefits Additional broad public benefits of CP1 obtained through pursuing project objectives are summarized in Table 4-3. These include benefits to reservoir water quality, traffic and transportation, and public services from modernization and upgrades of relocated facilities. Long-term benefits to air quality, groundwater, Shasta Lake fisheries, and system-wide operations are due to increased overall system capacity, allowing for increases in clean energy production, surface water deliveries, and storage capacity in Shasta Reservoir.

Potential Primary Effects of CP1

Following is a summary of potential environmental consequences and proposed mitigation measures for this comprehensive plan. A detailed discussion of potential effects of all comprehensive plans is included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS. Proposed mitigation measures to address potential adverse impacts of CP1 are summarized below in Table 4-6.

Shasta Lake Area Within the reservoir area, the primary long-term impacts of this and other comprehensive plans would be due to the increased water surface elevations and inundation area and/or indirect effects related to facility modifications and relocations. Raising the full pool of the lake would cause direct impacts due to higher water surface elevations and inundation area. General types of impacts would include potential inundation of terrestrial and aquatic habitat, inundation of cultural resources, and inundation and resulting relocation of buildings, sections of paved and nonpaved roads, campground facilities (such as parking areas and restrooms), and low-lying bridges. Use of, and access to, recreation facilities also would be impacted, including trails, day-use picnic areas, boat ramps, marinas, campgrounds, resorts, and beaches. Several of the main buildings associated with Bridge Bay Resort and Marina, the largest resort and marina complex on Shasta Lake, are located within a few feet of the existing full pool elevation. Any potential real estate acquisition, or necessary relocations of displaced parties, would be accomplished under Public Law 91-646.

The future without-project and future with-project relationship of water stored in Shasta Reservoir is shown in Figure 4-3. Figure 4-2 shows the exceedence probability of maximum annual storages in Shasta Reservoir. From these graphics, it can be seen that Shasta Reservoir fills to (or near) full pool levels in the without-project condition about once every 3 years (about 35 percent of the years). In addition, on the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. With this plan, Shasta would fill to the new full pool storage of 4.81 MAF at about the same frequency as under without-project conditions – about once every 3 years. Further, Shasta Lake would also fill to 80 percent of the new capacity in about 81 percent of the years. Accordingly, annual operations in the reservoir generally would mirror existing operations except the water surface in the lake would be about 8.5 feet higher. The primary difference in additional reservoir area exposed under without-project versus with-project conditions would be that during extended drought periods, the reservoir would be drawn down to without-project minimum levels.

Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans

Resource Topic/Impact	Alternative	Mitigation Measure
Geology, Geomorphology, Minerals, and Soils		
Impact Geo-2: Alteration of Fluvial Geomorphology and Hydrology of Aquatic Habitats	CP1 – CP5	Mitigation Measure Geo-2: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.
Impact Geo-9: Substantial Increase in Channel Erosion and Meander Migration	CP1 – CP5	Mitigation Measure Geo-9: Modification of Flow Releases in Response to River Management and Habitat Restoration Efforts between Keswick Dam and Red Bluff.
Air Quality and Climate		
Impact AQ-1: Short-Term Emissions of Criteria Air Pollutants and Precursors at Shasta Lake and Vicinity During Project Construction	CP1 – CP5	Mitigation Measure AQ-1: Implement Standard Measures and Best Available Mitigation Measures to Reduce Emissions Levels.
Hydrology, Hydraulics, and Water Management		
No mitigation measures proposed.		
Water Quality		
Impact WQ-1: Temporary Construction-Related Sediment Effects on Shasta Lake and Its Tributaries that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	CP1 – CP5	Mitigation Measure WQ-1: Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.
Impact WQ-4: Long-Term Sediment Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries	CP1 – CP5	Mitigation Measure WQ-4: Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.
WQ-6: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in Shasta Lake or Its Tributaries	CP1 – CP5	Mitigation Measure WQ-6: Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines.
Impact WQ-7: Temporary Construction-Related Sediment Effects on the Upper Sacramento River that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses	CP1 – CP5	Mitigation Measure WQ-7: Implement Mitigation Measure WQ-1 (CP1): Develop and Implement a Comprehensive Multi-scale Sediment Reduction and Water Quality Improvement Program Within Watersheds Tributary to the Primary Study Area.
Impact WQ-12: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Upper Sacramento River	CP1 – CP5	Mitigation Measure WQ-12: Implement Mitigation Measure WQ-6 (CP1): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines

Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)

Resource Topic/Impact	Alternative	Mitigation Measure
Impact WQ-18: Long-Term Metals Effects that Would Cause Violations of Water Quality Standards or Adversely Affect Beneficial Uses in the Extended Study Area	CP1 – CP5	Mitigation Measure WQ-18: Implement Mitigation Measure WQ-6 (CP1): Prepare and Implement a Site-Specific Remediation Plan for Historic Mine Features Subject to Inundation in the Vicinity of the Bully Hill and Rising Star Mines.
Noise and Vibration		
Impact Noise-1: Exposure of Sensitive Receptors in the Primary Study Area to Project-Generated Construction Noise	CP1 – CP5	Mitigation Measure Noise-1: Implement Measures to Prevent Exposure of Sensitive Receptors to Temporary Construction Noise at Project Construction Sites.
Hazards and Hazardous Materials and Waste		
Impact Haz-1: Wildland Fire Risk (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure Haz-1: Coordinate and Assist Public Services Agencies to Reduce Fire Hazards.
Impact Haz-2: Release of Potentially Hazardous Materials or Hazardous Waste (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure Haz-2: Reduce Potential for Release of Hazardous Materials and Waste.
Impact Haz-4: Exposure of Sensitive Receptors to Hazardous Materials (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure Haz-4: Reduce Potential for Exposure of Sensitive Receptors to Hazardous Materials or Waste.
Agriculture and Important Farmlands		
No mitigation measures proposed.		
Fisheries and Aquatic Ecosystems		
Impact Aqua-4: Effects on Special-Status Aquatic Mollusks	CP1 – CP5	Mitigation Measure Aqua-4: Implement Mitigation Measure Geo-2: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.
Impact Aqua-7: Effects on Spawning and Rearing Habitat of Adfluvial Salmonids in Low-Gradient Tributaries to Shasta Lake	CP1 – CP5	Mitigation Measure Aqua-7: Implement Mitigation Measure Aqua-4: Replace Lost Ecological Functions of Aquatic Habitats by Restoring Existing Degraded Aquatic Habitats in the Vicinity of the Impact.
Impact Aqua-14: Reduction in Ecologically Important Geomorphic Processes in the Upper Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows	CP1 – CP5	Mitigation Measure Aqua-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.
Impact Aqua-15: Changes in Flow and Water Temperatures in the Lower Sacramento River and Tributaries and Trinity River Resulting from Project Operation – Fish Species of Primary Management Concern	CP1 – CP5	Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements.

Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)

Resource Topic/Impact	Alternative	Mitigation Measure
Impact Aqua-16: Reduction in Ecologically Important Geomorphic Processes in the Lower Sacramento River Resulting from Reduced Frequency and Magnitude of Intermediate to High Flows	CP1 – CP5	Mitigation Measure Aqua-16: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.
Botanical Resources and Wetlands		
Impact Bot-2: Loss of MSCS Covered Species	CP1 – CP5	Mitigation Measure Bot-2: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate MSCS Plants; and Revegetate Affected Areas.
Impact Bot-3: Loss of USFS Sensitive, BLM Sensitive, or CRPR Species	CP1 – CP5	Mitigation Measure Bot-3: Acquire and Preserve Mitigation Lands; Avoid Populations; Relocate USFS Sensitive, BLM Sensitive, and CRPR Plants and Revegetate Affected Areas.
Impact Bot-4: Loss of Jurisdictional Waters	CP1 – CP5	Mitigation Measure Bot-4: Mitigate Loss of Jurisdictional Waters.
Impact Bot-5: Loss of General Vegetation Habitats	CP1 – CP5	Mitigation Measure Bot-5: Acquire and Preserve Mitigation Lands for Loss of General Vegetation Habitats.
Impact Bot-6: Spread of Noxious and Invasive Weeds	CP1 – CP5	Mitigation Measure Bot-6: Develop and Implement a Weed Management Plan In Conjunction with Stakeholders.
Impact Bot-7: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes	CP1 – CP5	Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.
Impact Bot-8: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management	CP1 – CP5	Mitigation Measure Bot-8: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.
Impact Bot-11: Loss of Sensitive Natural Communities or Habitats Resulting from Implementing the Gravel Augmentation Program or Restoring Riparian, Floodplain, and Side Channel Habitats	CP4 – CP5	Mitigation Measure Bot-11: Revegetate Disturbed Areas, Consult with CDFW, and Mitigate Loss of Jurisdictional Waters.
Impact Bot-12: Loss of Special-Status Plants Resulting from Implementing the Gravel Augmentation Program, or Restoring Riparian, Floodplain, and Side Channel Habitats	CP4 – CP5	Mitigation Measure Bot-12: Conduct Preconstruction Surveys for Special-Status Plants and Avoid Special-Status Plant Populations During Construction.

Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)

Resource Topic/Impact	Alternative	Mitigation Measure
Impact Bot-13: Spread of Noxious and Invasive Weeds Resulting from Implementing the Gravel Augmentation Program, Restoring Riparian, Floodplain, and Side Channel Habitats	CP4 – CP5	Mitigation Measure Bot-13: Implement Weed Management Measures and Revegetation.
Impact Bot-14: Altered Structure and Species Composition and Loss of Sensitive Plant Communities and Special-Status Plant Species Resulting from Altered Flow Regimes on the Lower Sacramento River	CP1 – CP5	Mitigation Measure Bot-14: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.
Impact Bot-15: Conflict with Approved Local or Regional Plans with Objectives of Riparian Habitat Protection or Watershed Management Along the Lower Sacramento River	CP1 – CP5	Mitigation Measure Bot-15: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.
Wildlife Resources		
Impact Wild-1: Take and Loss of Habitat for the Shasta Salamander	CP1 – CP5	Mitigation Measure Wild-1: Avoid, Relocate, and Acquire Mitigation Lands for Shasta Salamander.
Impact Wild-2: Impact on the Foothill Yellow-Legged Frog and Tailed Frog and Their Habitat	CP1 – CP5	Mitigation Measure Wild-2: Avoid, Relocate, and Acquire Mitigation Lands for Foothill Yellow-Legged Frog and Tailed Frog.
Impact Wild-3: Impact on the Northwestern Pond Turtle and Its Habitat	CP1 – CP5	Mitigation Measure Wild-3: Avoid, Relocate, and Acquire Mitigation Lands for Northwestern Pond Turtle.
Impact Wild-4: Impact on the American Peregrine Falcon	CP1 – CP5	Mitigation Measure Wild-4: Conduct Preconstruction Surveys for the American Peregrine Falcon and Establish Buffers.
Impact Wild-5: Take and Loss of Habitat for the Bald Eagle	CP1 – CP5	Mitigation Measure Wild-5: Acquire and Preserve Mitigation Lands; Conduct Protocol-Level Surveys for the Bald Eagle and Establish Buffers.
Impact Wild-6: Loss of Dispersal Habitat for the Northern Spotted Owl	CP1 – CP5	Mitigation Measure Wild-6: Acquire and Preserve Mitigation Lands, Habitat Enhancement.
Impact Wild-7: Impact on the Purple Martin and Its Habitat	CP1 – CP5	Mitigation Measure Wild-7: Conduct a Preconstruction Survey for Purple Martin and Establish Buffers.
Impact Wild-8: Impacts on the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Their Foraging and Nesting Habitat	CP1 – CP5	Mitigation Measure Wild-8: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Willow Flycatcher, Vaux's Swift, Yellow Warbler, and Yellow-Breasted Chat and Establish Buffers.

Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)

Resource Topic/Impact	Alternative	Mitigation Measure
Impact Wild-9: Impacts on the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Their Foraging and Nesting Habitat	CP1 – CP5	Mitigation Measure Wild-9: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for the Long-Eared Owl, Northern Goshawk, Cooper's Hawk, Great Blue Heron, and Osprey and Establish Buffers.
Impact Wild-10: Take and Loss of Habitat for the Pacific Fisher	CP1 – CP5	Mitigation Measure Wild-10: Acquire and Preserve Mitigation Lands; Conduct Preconstruction Surveys for the Pacific Fisher and Establish Buffers.
Impact Wild-11: Impacts on Special-Status Bats (Pallid Bat, Spotted Bat, Western Red Bat, Western Mastiff Bat, Townsend's Big-Eared Bat, Long-Eared Myotis, and Yuma Myotis), the American Marten, and Ringtails and Their Habitat	CP1 – CP5	Mitigation Measure Wild-11: Acquire and Preserve Mitigation Lands; Conduct a Preconstruction Survey for Special-Status Bats, American Marten, and Ringtails and Establish Buffers.
Impact Wild-12: Impacts on Special-Status Terrestrial Mollusks (Shasta Sideband, Wintu Sideband, Shasta Chaparral, and Shasta Hesperian) and Their Habitat	CP1 – CP5	Mitigation Measure Wild-12: Avoid Suitable Habitat; Acquire and Preserve Mitigation Lands for Special-Status Terrestrial Mollusks.
Impact Wild-13: Permanent Loss of General Wildlife Habitat	CP1 – CP5	Mitigation Measure Wild-13: Acquire and Preserve Mitigation Lands for Permanent Loss of General Wildlife Habitat.
Impact Wild-14: Impacts on Other Birds of Prey (Red-Tailed Hawk and Red-Shouldered Hawk) and Migratory Bird Species (American Robin, Anna's Hummingbird) and Their Foraging and Nesting Habitat	CP1 – CP5	Mitigation Measure Wild-14: Acquire and Preserve Mitigation Lands and Conduct Preconstruction Surveys for Other Nesting Raptors and Migratory Birds and Establish Buffers.
Impact Wild-15: Loss of Critical Deer Winter and Fawning Range	CP1 – CP5	Mitigation Measure Wild-15: Acquire and Preserve Mitigation Lands for Permanent Loss of Critical Deer Wintering and Fawning Range.
Impact Wild-16: Take and Loss of California Red-Legged Frog	CP1 – CP5	TBD
Impact Wild-17: Impacts on Riparian-Associated Special-Status Wildlife Resulting from Modifications to the Existing Flow Regime in the Primary Study Area	CP1 – CP5	Mitigation Measure Wild-17: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.
Impact Wild-20: Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat in the Primary Study Area	CP1 – CP5	Mitigation Measure Wild-20: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.

Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)

Resource Topic/Impact	Alternative	Mitigation Measure
Impact Wild-21: Impacts on Riparian-Associated Special-Status Wildlife Resulting from the Gravel Augmentation Program	CP4 – CP5	Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Northwestern Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds. Avoid Removal or Degradation of Elderberry Shrubs and Avoid Vegetation Removal near Active Nest Sites.
Impact Wild-22: Impacts on Riparian-Associated Special-Status Wildlife Species Resulting from Restoration Projects	CP4 – CP5	Mitigation Measure Wild-22: Implement Mitigation Measure Wild-21: Conduct Preconstruction Surveys for Elderberry Shrubs, Northwestern Pond Turtle, and Nesting Riparian Raptors and Other Nesting Birds. Avoid Removal or Degradation of Elderberry Shrubs and Avoid Vegetation Removal near Active Nest Sites.
Impact Wild-23: Impacts on Riparian-Associated and Aquatic Special-Status Wildlife Resulting from Modifications to Existing Flow Regimes in the Lower Sacramento River and Delta	CP1 – CP5	Mitigation Measure Wild-23: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.
Impact Wild-26: Consistency with Local and Regional Plans with Goals of Promoting Riparian Habitat along the Lower Sacramento River and in the Delta	CP1 – CP5	Mitigation Measure Wild-26: Implement Mitigation Measure Bot-7: Implement a Riverine Ecosystem Mitigation and Adaptive Management Plan to Avoid and Compensate for the Impact of Altered Flow Regimes on Riparian and Wetland Communities.
Cultural Resources		
Impact Culture-1: Disturbance or Destruction of Archaeological and Historical Resources Due to Construction or Inundation	CP1 – CP5	Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA.
Impact Culture-2: Inundation of Traditional Cultural Properties	CP4 – CP5	Mitigation Measure Culture-2: Adverse effects will be avoided, minimized, or mitigated through project redesign, when warranted, or through the development and implementation of an MOA or PA.
Impact Culture-3: Disturbance or Destruction of Archaeological and Historical Resources near the Upper Sacramento River Due to Construction	CP4 – CP5	Mitigation Measure Culture-3: Implement Mitigation Measure Culture-1: Develop and Implement measures identified in an NHPA Section 106 MOA or PA.
Indian Trust Assets		
No mitigation measures proposed.		

Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)

Resource Topic/Impact	Alternative	Mitigation Measure
Socioeconomics, Population, and Housing		
Impact Socio-14: Potential Temporary Reduction in Shasta Project Water or Hydropower Supplied to the CVP and SWP Service Areas During Construction	CP1 – CP5	Mitigation Measure Socio-14: Secure Replacement Water or Hydropower During Project Construction.
Land Use Planning		
Impact LU-1: Disruption of Existing Land Uses (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure LU-1: Minimize and/or Avoid Temporary Disruptions to Local Communities.
Impact LU-2: Conflict with Existing Land Use Goals and Policies of Affected Jurisdictions (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure LU-2: Minimize and/or Avoid Conflicts with Land Use Goals and Policies.
Recreation and Public Access		
Impact Rec-2: Temporary Construction-Related Disruption of Recreation Access and Activities at and near Shasta Dam	CP1 – CP5	Mitigation Measure Rec-2: Provide Information About and Improve Alternate Recreation Access and Opportunities to Mitigate the Temporary Loss of Recreation Access and Opportunities During Construction at Shasta Dam.
Impact Rec-4: Increased Hazards to Boaters and Other Recreationists at Shasta Lake from Standing Timber and Stumps Remaining in Untreated Areas of the Inundation Zone	CP1 – CP5	Mitigation Measure Rec-4: Provide Information to Shasta Lake Visitors About Potential Safety Hazards in Newly Inundated Areas from Standing Timber and Stumps.
Impact Rec-15: Increased Difficulty for Boaters and Anglers in Using the Sacramento River and Rivers Below CVP and SWP Reservoirs as a Result of Decreased River Flows	CP1 – CP5	Mitigation Measure Rec-15: Implement Mitigation Measure Aqua-15: Maintain Flows in the Feather River, American River, and Trinity River Consistent with Existing Regulatory and Operational Requirements and Agreements.
Aesthetics and Visual Resources		
Impact Vis-1: Consistency with Guidelines for Visual Resources in the STNF LRMP (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure Vis-1: Amend the STNF LRMP to Include Revised VQOs for developments at Turntable Bay area.
Impact Vis-2: Degradation and/or Obstruction of a Scenic View from Key Observation Points (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure Vis-2: Minimize Construction-Related Visual Impacts on Scenic Views From Key Observation Points.
Impact Vis-3: Generation of Increased Daytime Glare and/or Nighttime Lighting (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure Vis-3: Minimize or Avoid Visual Impacts of Daytime Glare and Nighttime Lighting.

Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)

Resource Topic/Impact	Alternative	Mitigation Measure
Transportation and Traffic		
Impact Trans-1: Short-Term and Long-Term Increases in Traffic in the Primary Study Area in Relation to the Existing Traffic Load and Capacity of the Street System	CP1 – CP5	Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan.
Impact Trans-2: Adverse Effects on Access to Local Streets or Adjacent Uses in the Primary Study Area	CP1 – CP5	Mitigation Measure Trans-2: To Reduce Effects on Local Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan.
Impact Trans-4: Adverse Effects on Emergency Access in the Primary Study Area	CP1 – CP5	Mitigation Measure Trans-4: To Reduce Effects on Emergency Access, Implement Mitigation Measure Trans-1: Prepare and Implement a Traffic Control and Safety Assurance Plan.
Impact Trans-5: Accelerated Degradation of Surface Transportation Facilities in the Primary Study Area	CP1 – CP5	Mitigation Measure Trans-5: Identify and Repair Roadway Segments Damaged by the Project.
Utilities and Service Systems		
Impact Util-1: Damage to or Disruption of Public Utility and Service Systems Infrastructure (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure Util-1: Implement Procedures to Avoid Damage to or Temporary Disruption of Service.
Impact Util-2: Utility Infrastructure Relocation or Modification (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure Util-2: Adopt Measures to Minimize Infrastructure Relocation Impacts.
Public Services		
Impact PS-1: Disruption of Public Services (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure PS-1: Coordinate and Assist Public Services Agencies.
Impact PS-2: Degraded Level of Public Services (Shasta Lake and Vicinity and Upper Sacramento River)	CP1 – CP5	Mitigation Measure PS-2: Provide Support to Public Services Agencies.
Power and Energy		
No mitigation measures proposed.		
Environmental Justice		
No mitigation measures proposed.		

Table 4-6. Summary of Proposed Mitigation Measures for Comprehensive Plans (contd.)

Resource Topic/Impact	Alternative	Mitigation Measure
Wild and Scenic Rivers Considerations for McCloud River		
Impact WASR-3: Effects to McCloud River Wild Trout Fishery, as Identified in the California Public Resources Code, Section 5093.542	CP1 – CP5	Mitigation Measure WASR-3: Develop and Implement a Comprehensive Multi-scale Fishery Protection, Restoration and Improvement Program for the Lower McCloud River Watershed.
Impact WASR-4: Effects to McCloud River Free-Flowing Conditions, as Identified in the California Public Resources Code, Section 5093.542	CP1 – CP5	Mitigation Measure WASR-4: Implement Protection, Restoration, and Improvement Measures to Benefit Hydrologic Functions Within the Lower McCloud River Watershed.

Key:
Ag = Agriculture and Important Farmlands
AQ = Air Quality and Climate
Aqua = Fisheries and Aquatic Ecosystems
BLM = U.S. Bureau of Land Management
BMP = best management practice
Bot = Botanical Resources and Wetlands
CDFW = California Department of Fish and Wildlife
CP – Comprehensive Plan
CRPR = California Rare Plant Rank
Culture = Cultural Resources
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
Geo = Geology, Geomorphology, Minerals, and Soils
Haz = Hazards and Hazardous Materials and Waste
LU = Land Use Planning
MSCS = Multi-Species Conservation Strategy
MOA = Memorandum of Understanding
NHPA = National Historic Preservation Act
Noise = Noise and Vibration
PA = Programmatic Agreement
PS = Public Services
Rec = Recreation and Public Access
Socio = Socioeconomics, Population, and Housing
SWP = State Water Project
TBD = to be determined
Trans = Transportation and Traffic
USFS = U.S. Forest Service
Util = Utilities and Service Systems
Vis = Aesthetics and Visual Resources
Wild = Wildlife Resources
WQ = Water Quality

The increased area of inundation for CP1 is about 1,110 acres. This equates to an average increase in the lateral zone of about 21 feet. An example of the extent of inundation for the 6.5-foot dam raise (as well as 12.5-foot and 18.5-foot dam raises) is shown in Figure 4-5. The figure shows increased inundation of the Sacramento River arm at the community of Lakeshore, considering proposed protective dikes and embankments. Lakeshore is the most populated area around the lake. Because of the gently sloping shoreline adjacent to Lakeshore, this area is representative of the maximum lateral increase in inundation that could be expected with dam raises up to 18.5 feet. The community of Sugarloaf would also be impacted.

The duration of inundation at given drawdown levels (e.g., 10 feet from top of full pool) would be similar to existing conditions. Water would inundate the highest levels of the reservoir for periods ranging from several days to about 1 month. Much of the vegetation in the enlarged drawdown zone on steeper lands would be removed during construction. In addition, much of the remaining vegetation in the expanded drawdown zone would eventually be lost over time. However, it is expected that significant amounts of vegetation could remain on the flatter slopes because of the infrequent inundation.

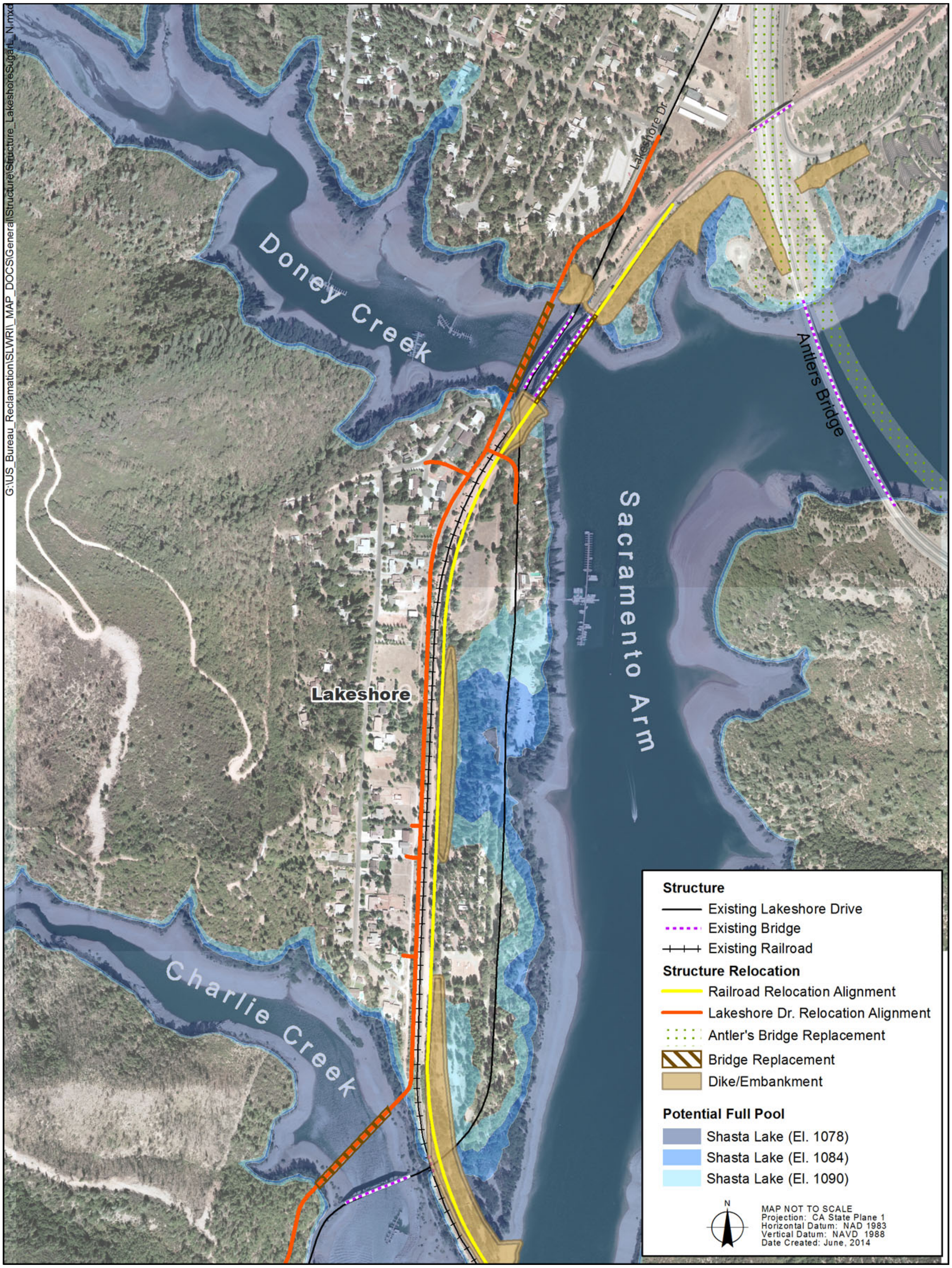


Figure 4-5. Estimated Maximum Inundation in the Lakeshore Area for 6.5-foot, 12.5-foot, and 18.5-foot Dam Raises

The McCloud River is of specific interest. PRC 5093.542 (c) and (d) may limit State involvement in studies to enlarge Shasta Dam and Reservoir if that action could have an adverse effect on the free-flowing conditions of the McCloud River or its wild trout fishery. Figure 4-6 illustrates the estimated increase in area of inundation on the McCloud River upstream from the McCloud Bridge for the 6.5-foot (and 18.5-foot) dam raise. As shown in Figure 4-6, raising Shasta Dam 6.5 feet would result in inundating an additional 1,470 lineal feet (about 9 acres) of the lower McCloud River, compared to existing conditions. Raising Shasta Dam 18.5 feet would result in inundating an additional 3,550 lineal feet (about 27 acres) of the lower McCloud River, compared to existing conditions. This represents a maximum of about 3 percent of the 24-mile-reach of river between the McCloud Bridge and McCloud Dam, which controls flows on the river.

Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

Upper Sacramento River Potential effects on flow and stages of the upper Sacramento River from this plan and other comprehensive plans would be minimal. Figure 4-7 shows Sacramento River flows above RBPP, simulated using CalSim-II, under wet, above- and below-normal, and dry and critical year conditions for the No-Action Alternative, and CP1 and CP4. Additional figures are included in the EIS Plan Formulation Appendix that show simulated Sacramento River flows below Keswick Dam and Stony Creek, under wet, above- and below-normal, and dry and critical year conditions for all of the alternatives. As shown in Figure 4-7, during most years, annual operations of Shasta Reservoir, and subsequent flows and stages in the Sacramento River, would be relatively unchanged. Also, flows and stages would increase slightly from June through November. Although small, this increase would be most pronounced during dry periods as more water is released from Shasta Dam for water supply reliability purposes. During dry periods, however, there are few to no changes in water flows or changes during the winter and spring periods. Potential noticeable changes in flows and stages would diminish rapidly downstream from the RBPP. This is primarily because of the significant amount of tributary inflows, especially from the Feather River system.

Changes in river flows and stages may impact geomorphic conditions along the river, existing riparian vegetation, and other wildlife resources. As described above, the changes in temperatures and flows are expected to have a beneficial impact on anadromous fish resources. A possibility exists, however, that by benefiting anadromous fish, a slightly altered temperature and flow regime may adversely impact warm-water species in the Sacramento River. This impact is not expected to be significant.

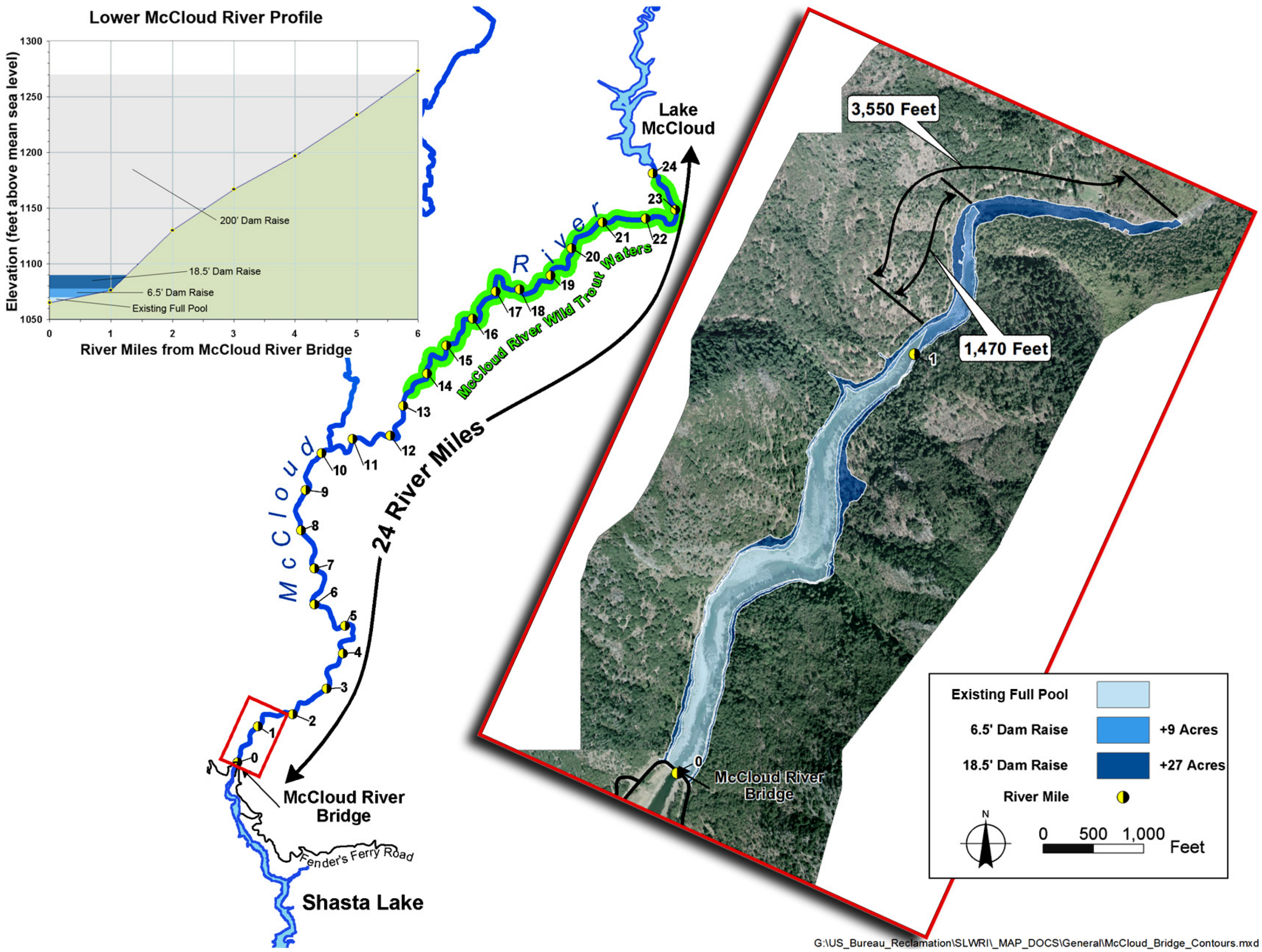
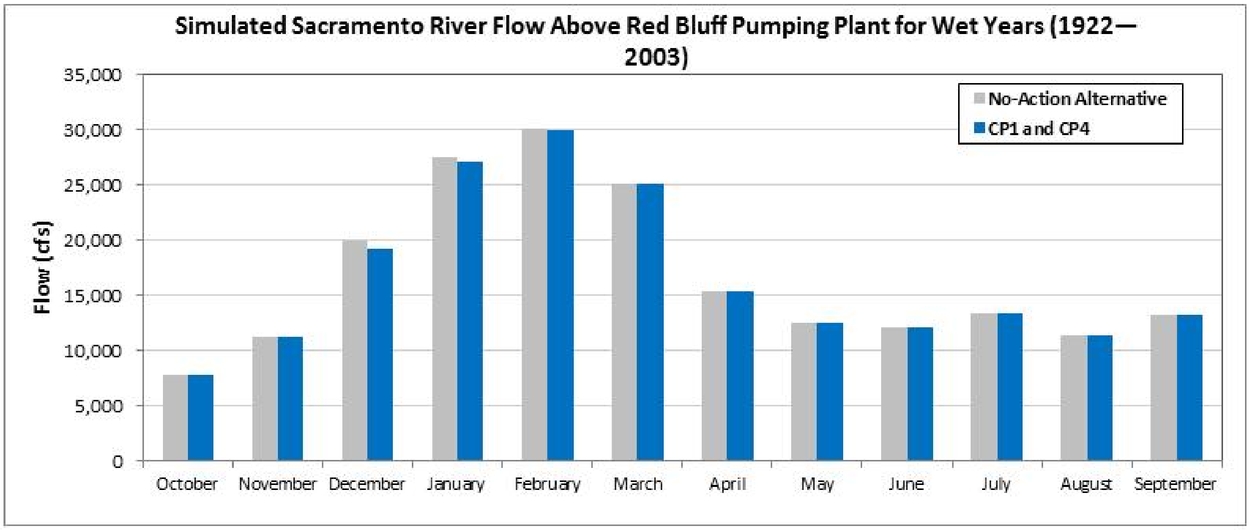
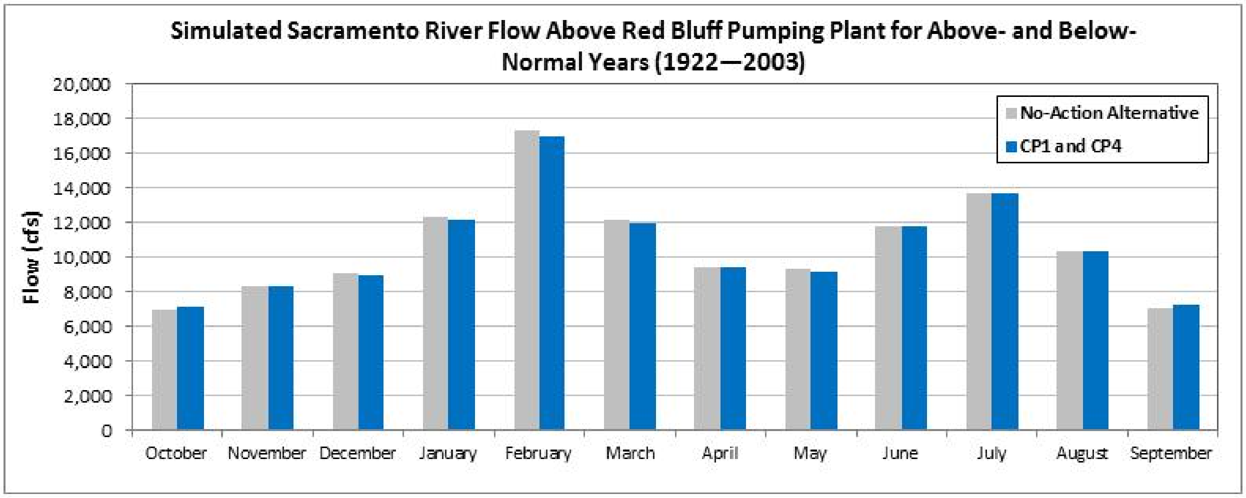
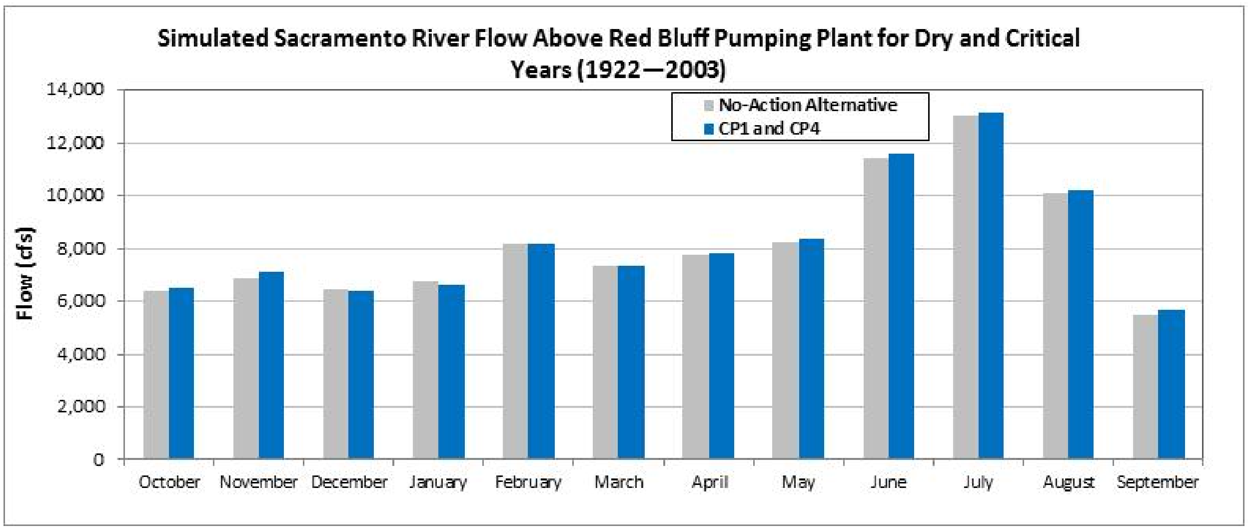


Figure 4-6. McCloud River Extent of Maximum Inundation for 6.5-foot Raise and 18.5-foot Raise







Note: Water year types based on the Sacramento Valley Water Year Hydrologic Classification.

Figure 4-7. Simulated Sacramento River Flow Above Red Bluff Pumping Plant in Wet, Above- and Below-Normal, and Dry and Critical Years for No-Action and CP1 and CP4

Preliminary Economics Assessment of CP1

Estimated Costs Estimated construction cost and annual cost of CP1 are included in Table 4-7. As shown, the estimated construction cost for CP1 is about $990 million. The estimated total annual cost of CP1 is $45.1 million.

Table 4-7. Estimated Construction and Annual Costs of the Comprehensive Plans

Item	CP1 6.5 ft ($ millions)	CP2 12.5 ft ($ millions)	CP3 18.5 ft ($ millions)	CP4 18.5 ft ($ millions)	CP4A 18.5 ft ($ millions)	CP5 18.5 ft ($ millions)
Construction Costs[1,2]						
Field Costs						
Relocations						
Vehicular Bridges	$34	$34	$54	$54	$54	$54
Doney Creek Railroad Bridge	$56	$56	$56	$56	$56	$56
Sacramento River Railroad Bridge, Second Crossing	$116	$116	$116	$116	$116	$116
Pit River Bridge Modifications	$17	$23	$31	$31	$31	$31
Railroad Realignment	$8.2	$8.2	$8.2	$8.2	$8.2	$8.2
Roads	$17	$26	$37	$37	$37	$37
Local Utilities	$24	$24	$30	$30	$30	$30
Transmission Lines	$19	$19	$19	$19	$19	$19
Buildings/Facilities – Recreation	$133	$150	$166	$166	$166	$166
Dams and Reservoirs						
Main Dam	$54	$64	$76	$76	$76	$76
Outlet Works	$27	$27	$27	$27	$27	$27
Spillway	$126	$131	$131	$131	$131	$131
Temperature Control Device	$28	$30	$31	$31	$31	$31
Powerhouse and Penstocks	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3
Right Wing Dam	$4.6	$5.7	$6.9	$6.9	$6.9	$6.9
Left Wing Dam	$13	$18	$26	$26	$26	$26
Visitor Center	$8.4	$8.8	$9.1	$9.1	$9.1	$9.1
Dikes	$14	$16	$27	$27	$27	$27
Reservoir Clearing	$4.5	$7.2	$21	$21	$21	$21
Pit 7 Dam and Powerhouse Modifications	$8.2	$8.2	$8.2	$8.2	$8.2	$8.2
Environmental Restoration	-	-	-	$6.2	$6.2	$18.2
Recreation Enhancement	-	-	-	-	-	$1.3
Total Field Costs	**$713**	**$773**	**$881**	**$887**	**$887**	**$901**
Planning, Engineering, Design, and Construction Management	$160	$174	$198	$200	$200	$203
Lands	$30	$47	$69	$70	$70	$70
Environmental Mitigation	$71	$77	$88	$88	$88	$88
Cultural Resource Mitigation	$14	$15	$18	$18	$18	$18
Water Use Efficiency Actions	$1.6	$2.6	$3.1	$1.6	$2.6	$3.8
Total Construction Cost	**$990**	**$1,089**	**$1,257**	**$1,264**	**$1,265**	**$1,283**
Interest During Construction	$83	$91	$105	$105	$105	$108
Total Capital Cost	**$1,073**	**$1,180**	**$1,362**	**$1,370**	**$1,371**	**$1,391**

Table 4-7. Estimated Construction and Annual Costs of the Comprehensive Plans (contd.)

Item	CP1 6.5 ft ($ millions)	CP2 12.5 ft ($ millions)	CP3 18.5 ft ($ millions)	CP4 18.5 ft ($ millions)	CP4A 18.5 ft ($ millions)	CP5 18.5 ft ($ millions)
Annual Cost[1,2]						
Interest and Amortization	$39	$43	$49	$50	$50	$50
Operations and Maintenance	$6.3	$8.5	$4.6	$7.5	$9.4	$10.7
Total Annual Cost	**$45.1**	**$51.2**	**$53.8**	**$57.1**	**$59.0**	**$61.0**

Notes:
[1] Based on January 2014 price levels, 100-year period of analysis, and 3-1/2 percent interest rate.
[2] Totals may not sum due to rounding.
Key:
- = not applicable
CP = Comprehensive Plan
ft = feet

Estimated Economic Benefits As shown in Table 4-8, the estimated average annual monetary benefit of CP1, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $29.7 million. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, the average annual benefit could exceed about $48.4 million per year.

Table 4-8. Average Annual Economic Benefit Summary[1]

Economic Benefit Category[2,3]	CP1 ($ millions)	CP2 ($ millions)	CP3 ($ millions)	CP4 ($ millions)	CP4A ($ millions)	CP5 ($ millions)
Anadromous Fish	2.9	17.8	9.7	38.1	33.3	17.7
Water Supply Reliability[4]	15.2	26.9	10.2	15.2	26.9	34.8
Hydropower[5]	6.8	10.3	11.1	14.9	14.4	13.4
Recreation[6]	4.9	6.7	11.6	17.8	14.3	8.2
Total Benefits						
Estimated Value (At Inflation)[7,8]	29.7	61.6	42.6	86.0	88.9	74.2
Estimated Value (2% Above Inflation)[9]	48.4	93.3	60.7	111.6	124.1	115.2

Notes:
[1] Based on Central Valley Project and State Water Project operational conditions described in the 2008 and 2009 Biological Opinions released by the National Marine Fisheries Service and the U.S. Fish and Wildlife Service, respectively.
[2] Economic benefits have not been monetized for ecosystem restoration, including (1) restoring resident fish habitat in Shasta Lake, (2) restoring fisheries and riparian habitat at several locations along the lower reaches of the upper Sacramento River and tributaries to Shasta Lake, (3) augmenting spawning gravel in the upper Sacramento River, and (4) restoring riparian, floodplain, and side channel habitat along the upper Sacramento River.
[3] Benefits for flood control and water quality have not been monetized.
[4] Includes irrigation and municipal and industrial water supply. Does not reflect benefits related to water use efficiency actions included in all comprehensive plans.
[5] Economic benefits for hydropower include ancillary services and capacity benefits in addition to increased hydropower generation.
[6] These values do not account for increased visitation due to modernization of recreation facilities associated with all comprehensive plans.
[7] Assumes the costs of water supplies and hydropower increase at the same rate as inflation.
[8] All numbers are rounded for display purposes; therefore, line items may not sum to totals.
[9] Includes increase of water supply and hydropower costs at 2 percent above inflation to account for growing scarcity in the future.
Key:
CP = comprehensive plan

CP2 – 12.5-Foot Dam Raise, Anadromous Fish Survival and Water Supply Reliability

CP2 consists primarily of enlarging Shasta Dam by raising the crest 12.5 feet and enlarging the reservoir by 443,000 acre-feet. Major features of CP2 in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

Major Components of CP2

- Raising Shasta Dam and appurtenant facilities by 12.5 feet.
- Implementing the set of eight common management measures previously described.
- Implementing the common environmental commitments described above.

A dam raise of 12.5 feet was chosen because it represents a midpoint between the likely smallest dam raise considered and the largest practical dam raise that would not require relocating the Pit River Bridge. By raising Shasta Dam from a crest elevation of 1,077.5 feet to 1,090.0 feet (based on NGVD29), CP2 would increase the height of the reservoir's full pool by 14.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to the modifications proposed under CP1. This increase in full pool height would add approximately 443,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would increase from 4.55 MAF to 5.0 MAF. Figure 2-3 shows the increase in surface area and storage capacity for CP2.

Under CP2, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. The existing TCD would also be extended for efficient use of the expanded cold-water pool. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 120,000 acre-feet of the 443,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 60,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

As described for CP1, this plan would include the potential to revise flood control operational rules, which could potentially reduce flood damage and benefit recreation.

Potential Benefits of CP2

Major potential benefits of CP2, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below.

Increase Anadromous Fish Survival Similar to CP1, raising Shasta Dam by 12.5 feet would increase the cold-water pool and increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critical water years. It is estimated that improved water temperature and flow conditions under CP2 could result in an average annual increase in the Chinook salmon population of about 379,200 outmigrating juvenile Chinook salmon.

Increase Water Supply Reliability CP2 would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. As shown in Table 4-5, CP2 would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural and M&I deliveries by at least 77,800 acre-feet per year and average annual deliveries by about 51,300 acre-feet per year. The majority of increased dry and critical year water supplies, 67,100 acre-feet, would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. Under CP2, approximately $2.6 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 87 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Maintain and Increase Recreation Opportunities CP2 includes features to, at minimum, maintain the existing recreation capacity at Shasta Lake. Although CP2 does not have specific features to further benefit recreation resources, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. The maximum surface area of the lake would increase by about 1,900 acres (6 percent), from 29,700 acres to about 31,600 acres. The average surface area of the lake during the recreation season from May through September would increase by about 1,300 acres (5 percent), from 23,900 acres to 25,200 acres. There is also limited potential to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Planning Objectives CP2 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality, as described for CP1, but to a greater extent because of increased capacity and associated overall system flexibility.

Additional Broad Public Benefits Additional broad public benefits of CP2 obtained through pursuing project objectives are summarized in Table 4-3. Broad public benefits for CP2 are similar to those for CP1 but amplified because of increased system capacity and the facility upgrades associated with additional relocations.

Potential Primary Effects of CP2

Following is a summary of potential environmental effects of CP2. Potential environmental effects are generally comparable between comprehensive plans; some adverse impacts would be exacerbated by larger dam raises and the associated scale of those effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Proposed mitigation measures to address potential adverse impacts of CP2 are summarized in Table 4-6. A detailed discussion of potential effects and proposed mitigation measures are included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan.

Shasta Lake Area As with CP1, the primary long-term effects of this comprehensive plan would be due to the direct effects from increased water surface elevations and inundation area and/or indirect effects related to facility modifications and relocations. The dam raise scenario under CP2 is greater than under CP1; therefore, anticipated effects under CP2 are expected to be slightly greater.

CP2 includes modifying two bridges and replacing six other bridges, inundating a number of small segments of existing paved and nonpaved roads, and relocating a number of potable water facilities, wastewater facilities, gas and petroleum facilities, and power distribution and telecommunications facilities. A number of recreation facilities would also be impacted, including campgrounds, marinas, resorts, boat ramps, day-use areas, and trails. Approximately 21 segments of roadway would be relocated, including portions of Lakeshore Drive, Fenders Ferry Road, Gilman Road, and Silverthorn Road. Embankments would be constructed to protect I-5 at Lakeshore and the UPRR at Bridge Bay. Any potential real estate acquisitions or necessary relocations of displaced parties would be accomplished under Public Law 91-646.

With CP2, Shasta Reservoir would fill to the new full pool storage of 5.0 MAF at a frequency similar to existing and future conditions. On the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent or its current capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. Figure 4-2 shows an exceedence probability relationship of maximum annual storage in Shasta Reservoir for this and other dam raises. Under CP2, Shasta Reservoir would fill to 80 percent of the new capacity in about 74 percent of the years. Accordingly, annual operations in the reservoir would generally mirror existing operations, but the water surface in the reservoir would be about 12.5 feet higher. The primary difference in the reservoir area would be that during extended drought periods, the reservoir would be drawn down to without-project minimum levels. Figure 4-8 shows the changes from without-project conditions for CP2 for a representative period of 1972 through 2003.

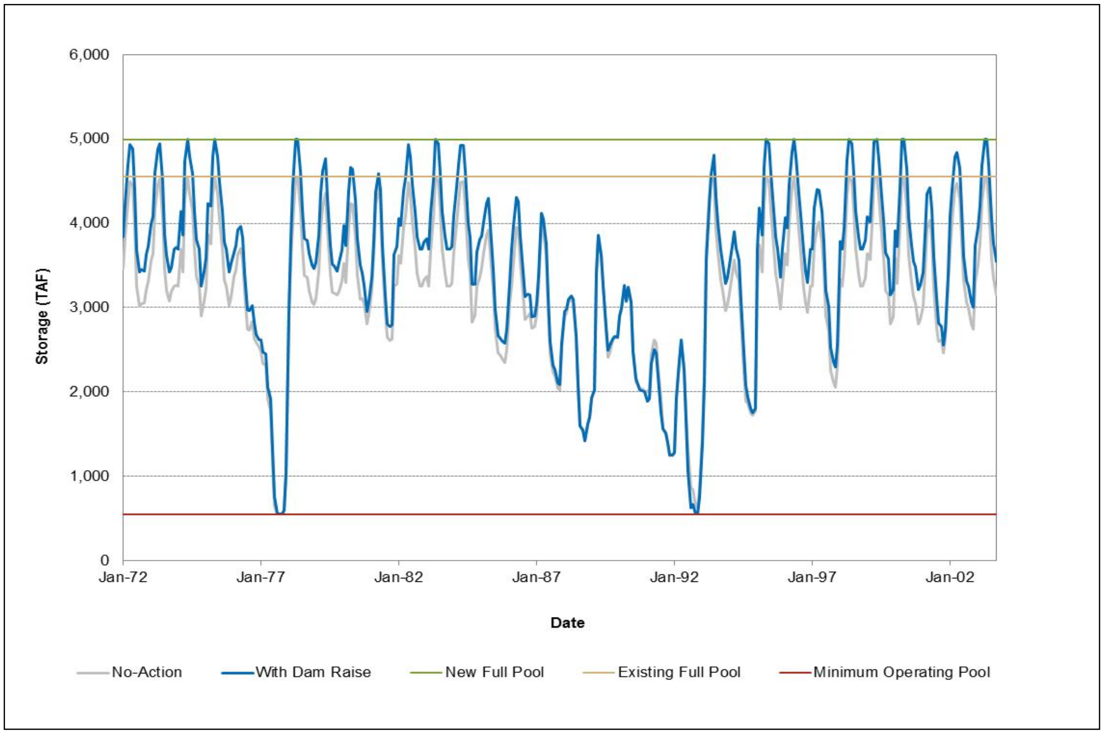


Figure 4-8. Simulated Shasta Reservoir Storage from 1972 to 2003 for the No-Action Alternative and CP2

The increased area of inundation for CP2 is about 1,900 acres. As with CP1, much of the vegetation in the enlarged drawdown zone on steeper lands would be removed during construction. In addition, some vegetation in the expanded drawdown zone would eventually be lost over time. However, it is expected that significant amounts of vegetation could remain on the flatter slopes because of infrequent inundation. The lower reaches of tributaries to Shasta Lake also would experience increased inundation.

Raising Shasta Dam 12.5 feet would result in inundating an additional 2,740 lineal feet (about 18 acres) of the lower McCloud River. This represents about 2 percent of the 24-mile-reach of river between the McCloud Bridge and McCloud Dam, which controls flows on the river.

Although recreation would generally improve under this plan, water in the reservoir would be drawn down to without-project conditions during the late fall and winter periods of some dry years, representing a drawdown 14.5 feet greater than under without-project conditions. In addition, clearances for boat traffic under the Pit River Bridge would be restricted to the north end of the bridge during periods of high reservoir levels (at or near full pool). This condition would typically occur in the late spring (May to June) in about 1 out of 3 years, and could last several days to a week. The estimated minimum clearance at the new full pool would be about 20 feet between Piers 6 and 7. This would not be expected to significantly impact boating on the lake.

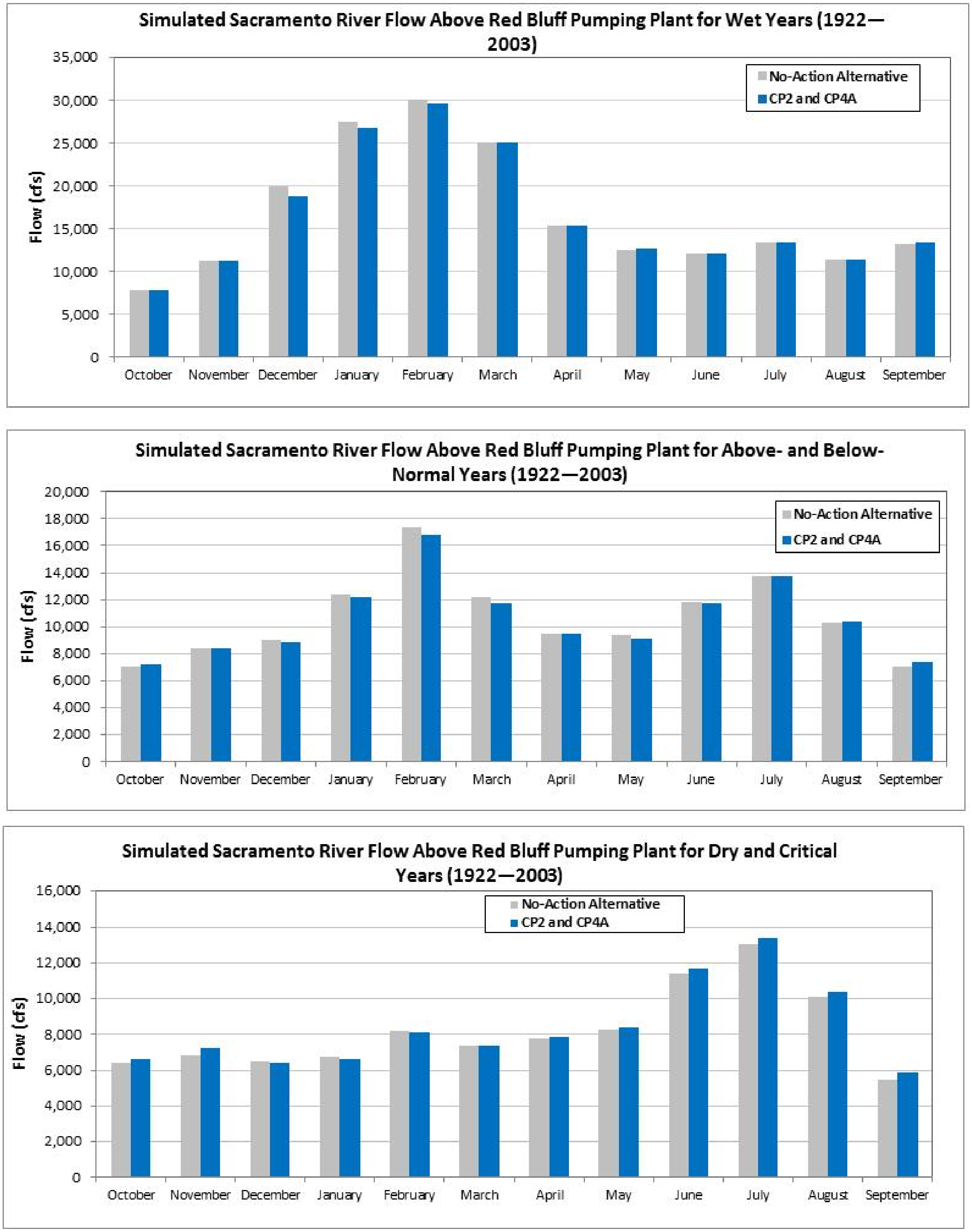
Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

Upper Sacramento River As with the previous plan, potential effects on flow and stages of the upper Sacramento River from this plan and other comprehensive plans would be minimal. Figure 4-9 shows Sacramento River flows above RBPP, simulated using CalSim-II, under above- and below-normal, and dry and critical year conditions for the No-Action Alternative, and CP2. Additional figures are included in the EIS Plan Formulation Appendix that show simulated Sacramento River flows below Keswick Dam and Stony Creek under wet, above- and below-normal, and dry and critical year conditions for all of the alternatives. As shown in Figure 4-9, during most years, annual operations of Shasta Reservoir, and subsequent flows and stages in the Sacramento River, would be relatively unchanged. Also, flows and stages would increase slightly from June through November. Although small, this increase would be most pronounced during dry periods as more water is released from Shasta Dam for water supply reliability purposes. During dry periods, however, there are few to no changes in water flows or changes during the winter and spring periods. All potential noticeable changes in flows and stages would diminish rapidly downstream from the RBPP.

Similar to CP1, changes in river flows and stages may impact geomorphic conditions, existing riparian vegetation, and other wildlife resources of the upper Sacramento River. As described above, the changes in temperatures and flows are expected to have a beneficial impact on anadromous fish resources. A possibility exists, however, that by benefiting anadromous fish, a slightly altered temperature and flow regime may adversely impact warm-water species in the Sacramento River. This effect is not expected to be significant.

Preliminary Economics Assessment of CP2

Estimated Costs Estimated construction cost and annual cost of CP2 are included in Table 4-7. As shown, the estimated construction cost is about $1,089 million. The estimated total annual cost of this plan is $51.2 million.



Note: Water year types based on the Sacramento Valley Water Year Hydrologic Classification.

Figure 4-9. Simulated Sacramento River Flow Above Red Bluff Pumping Plant in Wet, Above- and Below-Normal, and Dry and Critical Years for No-Action, CP2, and CP4A

Estimated Economic Benefits As shown in Table 4-8, the estimated average annual monetary benefit of this plan, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $61.6 million. The largest monetary benefit is increased dry year water supply reliability. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, the average annual benefit could exceed about $93.3 million per year.

CP3 – 18.5-Foot Dam Raise, Agricultural Water Supply Reliability and Anadromous Fish Survival

CP3 consists primarily of enlarging Shasta Dam and Reservoir by raising the dam crest 18.5 feet and enlarging the reservoir by 634,000 acre-feet. Major features of CP3 in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

Major Components of CP3

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Implementing the set of eight common management measures previously described.
- Implementing the common environmental commitments described above

As shown in Table 4-1, by raising Shasta Dam 18.5 feet, from a crest elevation of 1,077.5 feet to 1,096.0 feet (based on NGVD29), CP3 would increase the height of the reservoir's full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to modification proposed under CP1. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would increase from 4.55 MAF to 5.19 MAF. Although higher dam raises are technically and physically feasible, 18.5 feet is the largest dam raise that would not require extensive and costly reservoir area relocations such as relocating the Pit River Bridge, I-5, and the UPRR tunnels, as shown in Figure 4-10. Raising the dam 18.5 feet would provide the minimum clearance required (4 feet) at the south end of the Pit River Bridge, while still providing more than 14 feet of clearance at the north end of the bridge. Figure 2-3 shows the increase in surface area and storage capacity for CP3.

Because CP3 focuses on increasing agricultural water supply reliability and anadromous fish survival, none of the increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations. The additional storage would be retained for water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. The existing TCD would also be extended for efficient use of the expanded cold-water pool.

As described for the above plans, this plan would include the potential to revise flood control operational rules, which could reduce the potential for flood damage and benefit recreation.

Potential Benefits of CP3

Major potential benefits of CP3, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below.

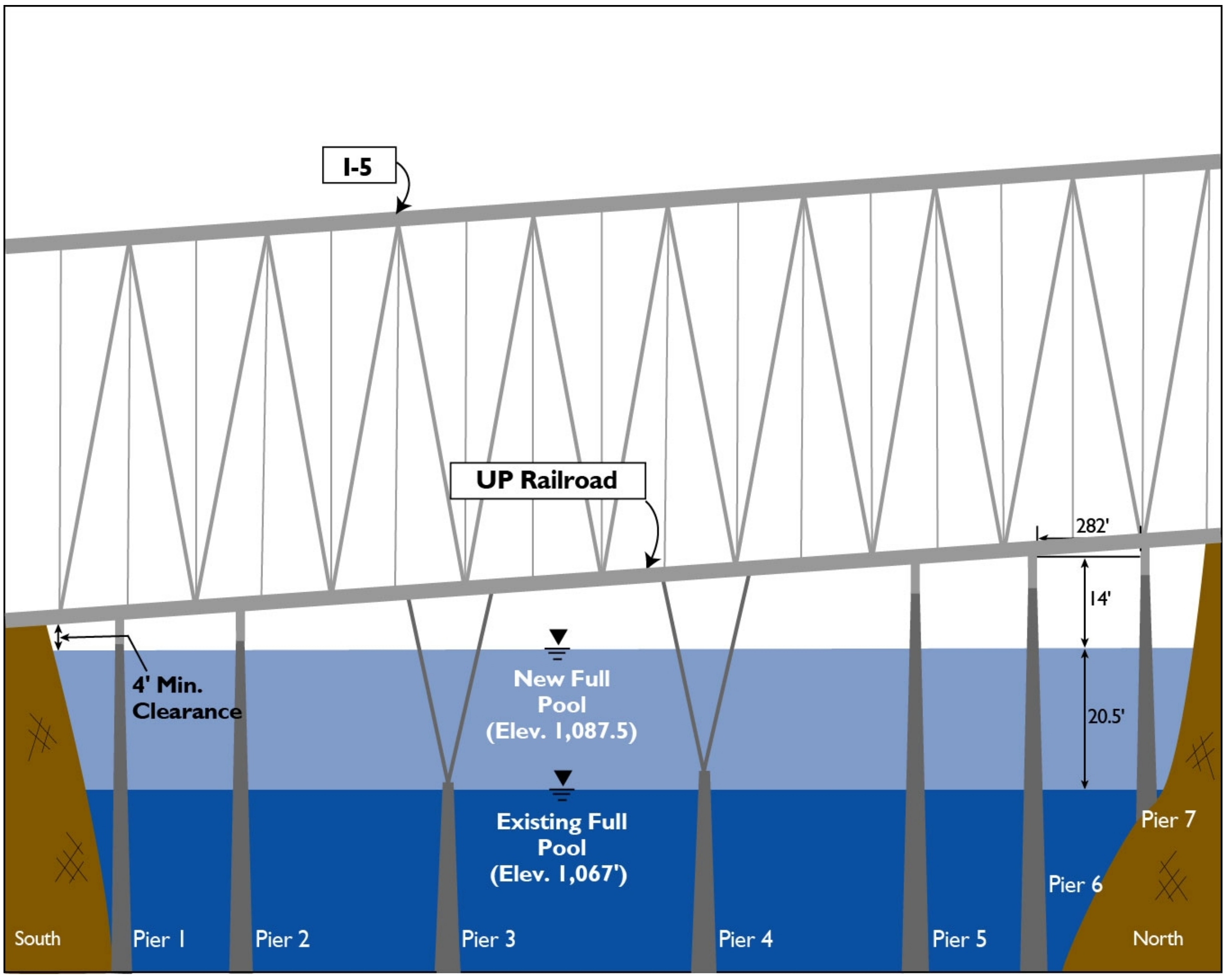


Figure 4-10. Minimum Clearance for Boat Traffic at Pit River Bridge, Full Pool with 18.5-foot Dam Raise

Increase Anadromous Fish Survival Similar to the above comprehensive plans, raising Shasta Dam by 18.5 feet would increase the ability of Shasta Dam to make cold-water releases and regulate water temperatures for fish in the upper Sacramento River, primarily in dry and critical water years. It is estimated that improved water temperature and flow conditions under CP3 could result in an average annual increase in the Chinook salmon population of about 207,400 outmigrating juvenile Chinook salmon.

Increase Water Supply Reliability CP3 would increase water supply reliability by increasing water supplies for CVP irrigation deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. As shown in Table 4-5, CP3 would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural deliveries by at least 63,100 acre-feet per year, and average annual deliveries by about 61,700 acre-feet per year**.** Almost half of the increased dry and critical year water supplies, 28,000 acre-feet, would be for south-of-Delta agricultural deliveries, with the remainder for north-of-Delta agricultural deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. Under CP3, approximately $3.1 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 86 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Maintain and Increase Recreation Opportunities CP3 includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. Although CP3 does not include specific features to further increase recreation capacity, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. The maximum surface area of the lake would increase by about 2,600 acres (9 percent), from 29,700 acres to about 32,300 acres. The average surface area of the lake during the recreation season from May through September would increase by about 2,000 acres (8 percent), from 23,900 acres to 25,900 acres. There is also limited potential for reservoir reoperation to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Planning Objectives CP3 could also provide benefits related to flood damage reduction, ecosystem restoration, and water quality, as described for CP1, but to a greater extent because of increased capacity and associated overall system flexibility.

Additional Broad Public Benefits Additional broad public benefits of CP3 obtained through pursuing project objectives are summarized in Table 4-3. Broad public benefits for CP3 are similar to CP1 and CP2, but amplified because of increased system capacity and facility upgrades associated with additional relocations.

Potential Primary Effects of CP3

Following is a summary of potential environmental effects of CP3. Environmental effects are generally comparable between comprehensive plans; some adverse effects would be exacerbated by larger dam raises and the associated scale of those effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Proposed mitigation measures to address potential adverse impacts of CP3 are summarized in Table 4-6. A detailed discussion of potential effects and proposed mitigation measures are included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.

Shasta Lake Area As with the other comprehensive plans, the primary long-term effects of CP3 would be due to the increased water surface elevations and inundation area. The dam raise scenario under CP3 is greater than under CP1 or CP2; therefore, anticipated effects under CP3 are expected to be slightly greater. As with the above plan, raising the full pool of the lake would cause direct effects due to higher water levels, and/or indirect impacts related to facility modifications and relocations.

CP3 includes modifying two bridges and replacing six other bridges, inundating a number of small segments of existing paved and nonpaved roads, and relocating a number of potable water facilities, wastewater facilities, gas and petroleum facilities, and power distribution and telecommunications facilities. A number of recreation facilities would also be impacted, including campgrounds, marinas, resorts, boat ramps, day-use areas, and trails. Approximately 30 segments of roadway would be relocated, including portions of Lakeshore Drive, Fenders Ferry Road, Gilman Road, and Silverthorn Road. Embankments would be constructed to protect I-5 at Lakeshore and the UPRR at Bridge Bay. Any potential real estate acquisitions or necessary relocations of displaced parties would be accomplished under Public Law 91-646.

With CP3, Shasta Reservoir would fill to the new full pool storage of 5.19 MAF at a frequency similar to without-project conditions (see Figure 4-1). On the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent or its current capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. Under CP3, Shasta Reservoir would fill to 80 percent of the new capacity in about 76 percent of the years (see Figure 4-2). Figure 4-2 shows an exceedence probability relationship of maximum annual storage in Shasta Reservoir for this and other dam raises.

Under CP3, Shasta Reservoir would also fill to 80 percent of the new capacity in about 72 percent of the years. Accordingly, annual operations in the reservoir would generally mirror existing operations, but the water surface in the reservoir would be about 18.5 feet higher. The primary difference in the reservoir area would be that during extended drought periods, the reservoir would be drawn down to without-project minimum levels. Figure 4-11 shows the changes from without-project conditions for CP3 feet for a representative period of 1972 through 2003.

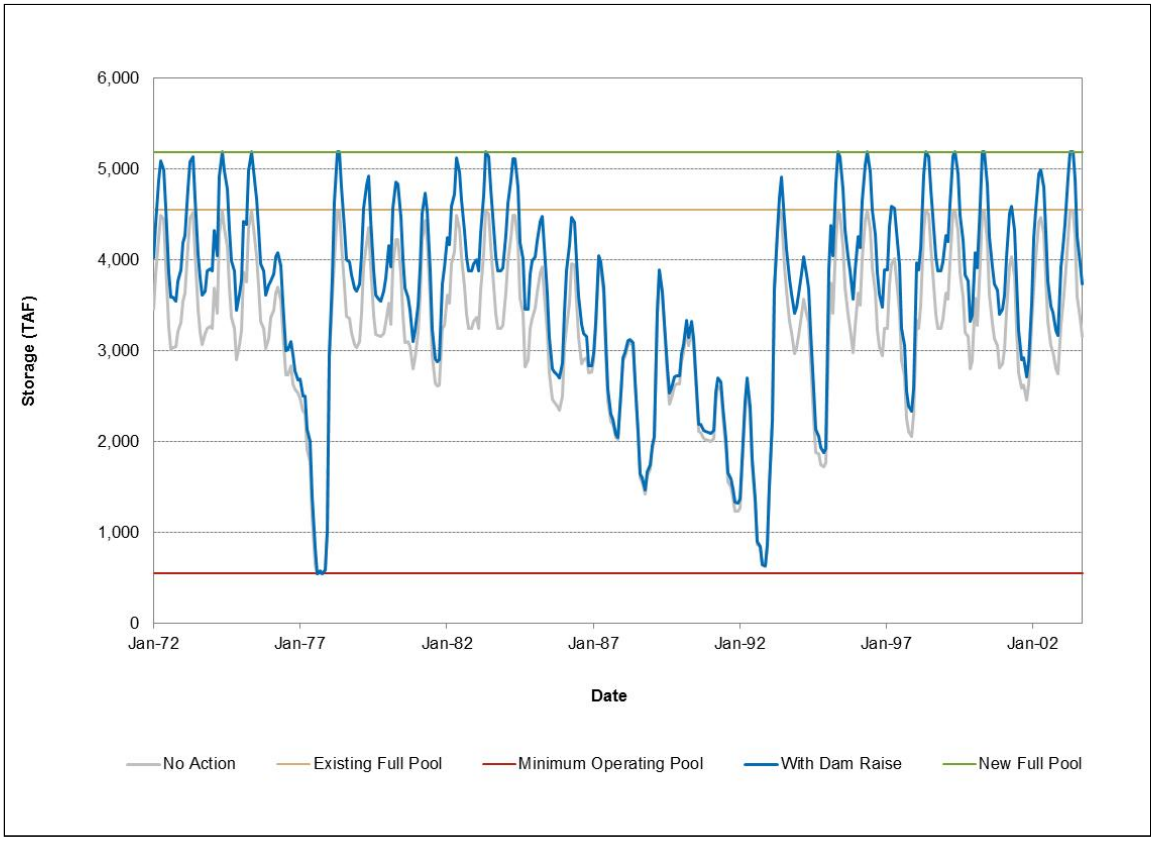


Figure 4-11. Simulated Shasta Reservoir Storage from 1972 to 2003 for the No-Action Alternative and CP3

The increased area of inundation for this plan is about 2,600 acres. As with the previous plans, much of the vegetation in the enlarged drawdown zone on steeper lands would be removed during construction. In addition, some vegetation in the expanded drawdown zone would eventually be lost over time. However, it is expected that significant amounts of vegetation could remain on the flatter slopes because of infrequent inundation. The lower reaches of tributaries to Shasta Lake would also experience increased inundation.

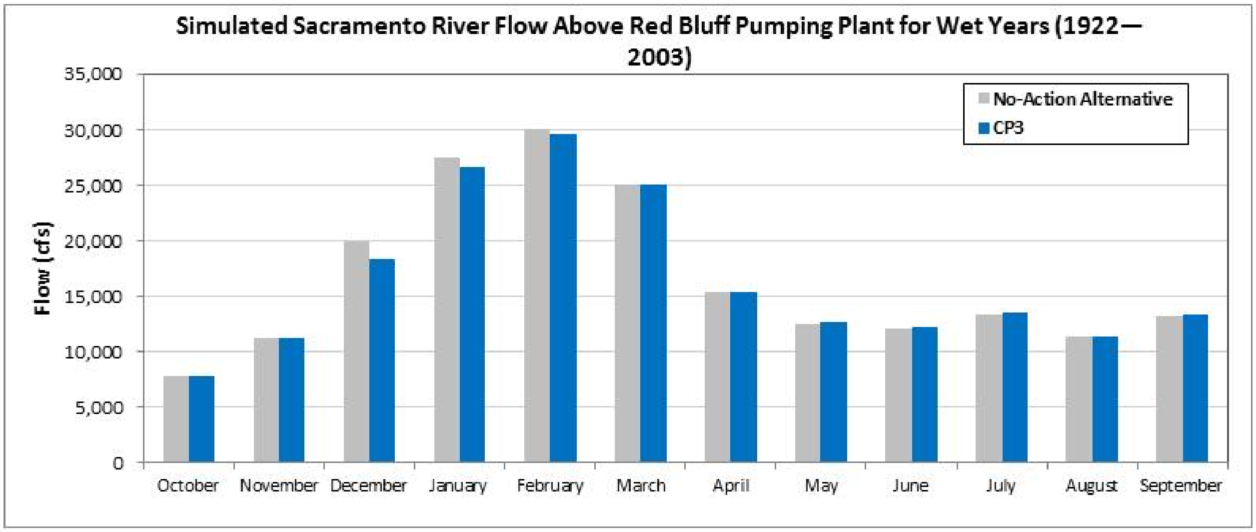
Raising Shasta Dam 18.5 feet would result in inundating an additional 3,550 lineal feet (about 27 acres) of the lower McCloud River (see Figure 4-4). This represents about 3 percent of the 24-mile-reach of river between the McCloud

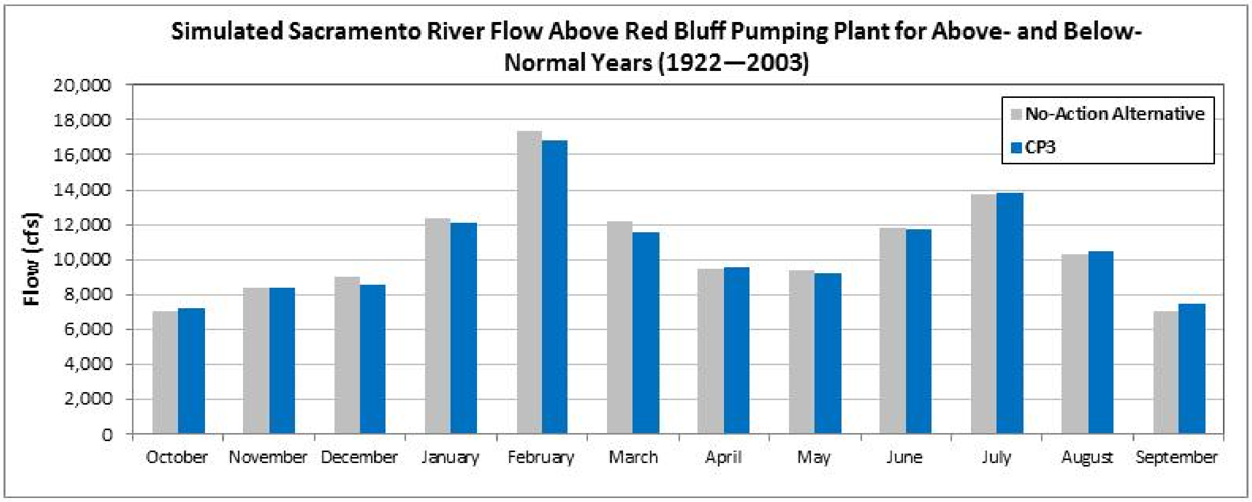
Bridge and McCloud Dam, which controls flows on the river. Although it is believed that recreation use would generally improve under this plan, water in the lake would be drawn down to without-project conditions during the late fall and winter periods of some dry years, representing a drawdown 20.5 feet greater than under without-project conditions. During these periods, the drawdown zone could increase by about 50 lineal feet. In addition, clearances for boat traffic under the Pit River Bridge would be restricted to the north end of the bridge during periods of high reservoir levels (at or near full pool). This condition would typically occur in the late spring (May to June) in about 1 out of 3 years, and could last several days to 1 or 2 weeks. Figure 4-10 illustrates that the minimum clearance at the new full pool would be about 14 feet between Piers 6 and 7. This could impact boating on the lake, as some houseboats exceed 16 feet in height. Since houseboating is a major recreational experience on Shasta Lake, especially around Memorial Day, restrictions on large boat traffic under the Pit River Bridge during maximum pool levels could adversely impact lake area boat rentals, marinas, and other recreation-dependent businesses.

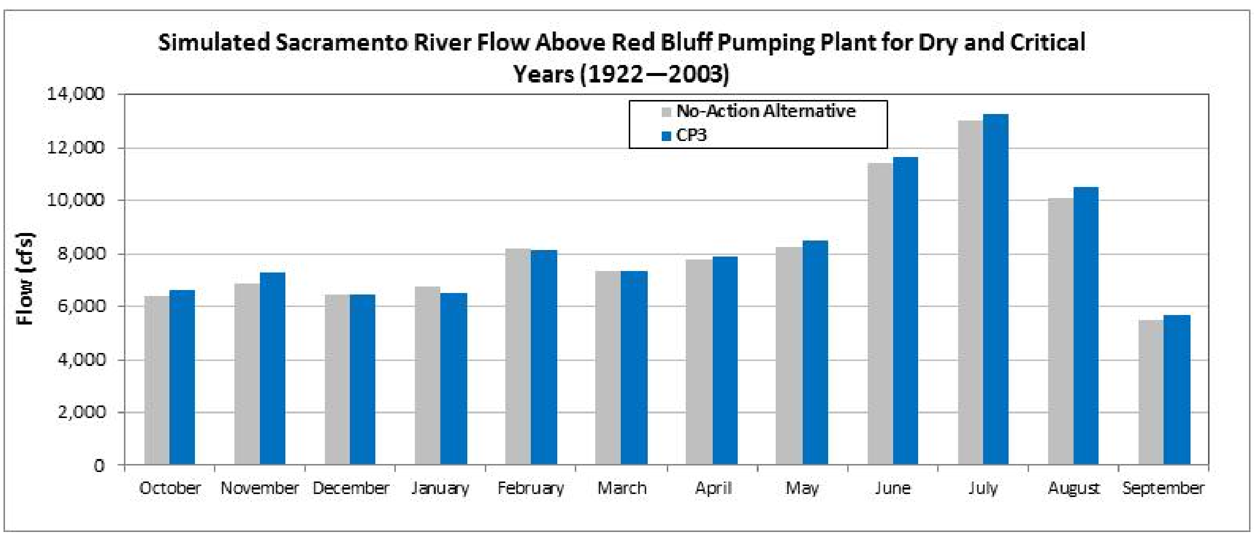
Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

Upper Sacramento River Potential effects on flow and stages of the upper Sacramento River from this plan and other comprehensive plans would be minimal. Figure 4-12 shows Sacramento River flows above RBPP, simulated using CalSim-II, under wet, above- and below-normal, and dry and critical year conditions for the No-Action Alternative and CP3. Additional figures are included in the EIS Plan Formulation Appendix that show simulated Sacramento River flows below Keswick Dam and Stony Creek, under wet, above- and below-normal, and dry and critical year conditions for all of the alternatives. As shown in Figure 4-12, during most years, annual operations of Shasta Reservoir, and subsequent flows and stages in the Sacramento River, would be relatively unchanged. Also, flows and stages would increase slightly from June through November. Although small, this increase would be most pronounced during dry periods as more water is released from Shasta Dam for water supply reliability purposes. During dry periods, however, there are few to no changes in water flows or changes during the winter and spring periods. All potential noticeable changes in flows and stages would diminish rapidly downstream from the RBPP.

Similar to other comprehensive plans, changes in river flow and stages may impact geomorphic conditions, existing riparian vegetation, and wildlife resources of the upper Sacramento River. As described above, the changes in temperature and flows are expected to have a beneficial effect on anadromous fish resources. A possibility exists, however, that by benefiting anadromous fish, a slightly altered temperature and flow regime may adversely impact warm-water species in the Sacramento River. This effect is not expected to be significant.







Note: Water year types based on the Sacramento Valley Water Year Hydrologic Classification.

Figure 4-12. Simulated Sacramento River Flow Above Red Bluff Pumping Plant in Wet, Above- and Below- Normal, and Dry and Critical Years for No-Action and CP3

Preliminary Economics Assessment of CP3

Estimated Costs Estimated construction cost and annual costs of CP3 are included in Table 4-7. As shown, the estimated construction cost is about $1,257 million. The estimated total annual cost of this plan is $53.8 million.

Estimated Economic Benefits As shown in Table 4-8, the estimated average annual monetary benefit of CP3, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $42.6 million. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, the average annual benefit could exceed about $60.7 million per year.

CP4 and CP4A– 18.5-Foot Dam Raise, Anadromous Fish Focus with Water Supply Reliability

CP4 and CP4A focus on increasing anadromous fish survival by raising Shasta Dam 18.5 feet while also increasing water supply reliability. CP4 and CP4A are identical except for Shasta Dam and reservoir operations. CP4 and CP4A have similar reservoir operations in that they each dedicate a portion of the new storage in Shasta Lake for fisheries purposes, however, the portion of this dedicated storage varies. Major features of CP4 and CP4A in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

Major Components of CP4 and CP4A

Major components CP4 and CP4A include the following:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Reserving a portion of the increased storage in Shasta Lake for maintaining cold-water volume or augmenting flows as part of an adaptive management plan for anadromous fish survival (378,000 acre-feet for CP4, 191,000 acre-feet for CP4A)
- Augmenting spawning gravel in the upper Sacramento River.
- Restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.
- Implementing the set of eight common management measures previously described.
- Implementing the common environmental commitments described above.

As shown in Table 4-1, by raising Shasta Dam 18.5 feet, from a crest at 1,077.5 feet to 1,096.0 feet (based on NGVD29), CP4 would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to the modifications proposed under CP1. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF.

The additional storage created by the 18.5-foot dam raise would be used to improve the ability to meet temperature objectives and habitat requirements for anadromous fish during drought years, while also increasing water supply reliability. Of the increased reservoir storage space of CP4, about 378,000 acre-feet would be dedicated to increasing the cold-water supply for anadromous fish survival purposes. Of the increased storage space of CP4A, about 191,000 acre-feet would be dedicated to increasing the supply of cold water for anadromous fish survival purposes. Figure 2-3 shows the increase in surface area and storage capacity for CP4.

For CP4, operations for the remaining portion of increased storage (approximately 256,000 acre-feet) would be the same as in CP1, with 70,000 acre-feet reserved in dry years and 35,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries. For CP4A, operations for the remaining portion of increased storage (approximately 443,000 acre-feet) would be the same as in CP2, with 120,000 acre-feet reserved in dry years and 60,000 acre-feet reserved in critical years to specifically focus on increasing M&I deliveries. The existing TCD would also be extended to achieve efficient use of the expanded cold-water pool for CP4 or CP4A.

As described for the above comprehensive plans, both CP4 and CP4A would include the potential to revise operational rules for flood control for Shasta Dam and Reservoir, which could reduce the potential for flood damage and benefit recreation.

Both CP4 and CP4A also include an adaptive management plan for the cold-water pool, augmenting spawning gravel, and restoring riparian, floodplain, and side channel habitat in the upper Sacramento River.

Adaptive Management of Cold-Water Pool Both CP4 and CP4A may also include development of an adaptive management plan for the storage capacity dedicated to increasing the supply of cold water for anadromous fish survival (378,000 acre-feet for CP4, 191,000 acre-feet for CP4A). The adaptive management plan may include operational changes to the timing and magnitude of releases from Shasta Dam to benefit anadromous fish, as long as there are no conflicts with current operational guidelines or adverse impacts to water supply reliability. These changes may include increasing minimum flows, timing releases from Shasta Dam to mimic more natural seasonal flows, meeting flow targets for side channels, or retaining the additional water in storage to meet temperature requirements. Reclamation would manage the cold-water pool each year in cooperation with the SRTTG. Because adaptive management is predicated on using best available science and new information to make decisions, a monitoring program would be implemented as part of the adaptive management plan. SRTTG would conduct monitoring, develop monitoring protocols, and set performance standards to determine the success of adaptive management actions.

Augment Spawning Gravel in Upper Sacramento River Gravel suitable for spawning has been identified as a significant influencing factor in the recovery of anadromous fish populations in the Sacramento River (USFWS 2001, NMFS 2009b). Under CP4 and CP4A, spawning-sized gravel would be injected at multiple locations along the Sacramento River between Keswick Dam and the RBPP.

Gravel augmentation would occur at one to three locations every year, for a period of 10 years, unless unusual conditions or agency requests precluded placement during a single year. This program, in addition to the ongoing CVPIA gravel augmentation program, would help address the gravel debt in the upper Sacramento River, but this reach may continue to be gravel-limited in the future. Therefore, the gravel augmentation program proposed herein would be reevaluated after the 10-year period to assess the need for continued spawning gravel augmentation, and to identify opportunities for future gravel augmentation actions.

On average, 5,000 to 10,000 tons of gravel would be placed each year, although the specific quantity of gravel placed in a given year may vary from that range. Gravel would be washed and sorted to meet specific size criteria, and would be applied to active river channels between August and September each year, consistent with the time frame for the ongoing CVPIA gravel augmentation program.

Fifteen preliminary locations for spawning gravel augmentation were identified in the Sacramento River between Keswick Dam and Shea Island. Each site would be eligible for gravel placement one or more times during the 10-year program. Selection of these locations was based on potential benefits to anadromous fish and site accessibility. Gravel placement would provide either immediate spawning habitat or long-term recruitment.

Although preliminary sites have been identified, specific gravel augmentation site(s) and volume(s) would be selected each year in the spring or early summer through discussions among Reclamation, USFWS, CDFW, and NMFS. The discussions would include topics such as avoiding redundancy with planned CVPIA gravel augmentation activities in a given year; identifying hydrology or morphology issues that could impact the potential benefit of placing gravel at any particular site; identifying changes in spawning trends based on ongoing CVPIA monitoring efforts; evaluating potential new sites; and appropriately distributing selected gravel sites along the river reach(es).

Restore Riparian, Floodplain, and Side Channel Habitat Under CP4 and CP4A, riparian, floodplain, and side channel habitat restoration would occur at one or a combination of potential locations along the upper Sacramento River. Restoration measures for six potential sites, referred to collectively as "upper Sacramento River restoration sites", are described below. The sites under consideration for habitat restoration are shown in Figure 4-13.

Henderson Open Space The City of Redding Henderson Open Space area is located south of Cypress Bridge on the east side of the Sacramento River at River Mile (RM) 295. Riparian and side channel restoration at the Henderson Open Space site could consist of enhancing an existing side channel to activate the frequency and duration of flows for Chinook salmon spawning habitat throughout the side channel. This potential modification would create up to 2,000 more linear feet of spawning habitat near areas of the Sacramento River that are actively used by anadromous fish for spawning.

Tobiasson Island Tobiasson Island is located downstream from South Bonnyview Bridge in the center of the Sacramento River at RM 292. Riparian, floodplain, and side channel habitat enhancement at this site would involve creating a side channel through the island to be activated at Sacramento River flows for Chinook salmon spawning. Riparian vegetation would be established along the course of the new side channel, adding approximately 1,350 linear feet of spawning and floodplain habitat to this section of the Sacramento River.

Shea Island Complex The Shea Island Complex is located on the west side of the Sacramento River upstream from the river's confluence with Clear Creek at RM 291. Restoration at the Shea Island Complex to improve side channel, riparian, and floodplain habitat would involve enhancing a major side channel through the site to keep the side channel hydraulically connected with the main stem of the Sacramento River at a broader range of flows. Adding channel complexity and enhancing riparian vegetation throughout the length of the side channel would improve Chinook salmon habitat along an additional 1,930 feet of the Sacramento River.

Kapusta Island Kapusta Island is located adjacent to the Kapusta Open Space area upstream from the I-5 crossing of the Sacramento River at RM 288. Restoration of riparian, side channel and floodplain habitat at Kapusta Island would involve enhancing an existing side channel by allowing it to carry water at a broader range of flows specifically to increase spawning habitat for winter-run and spring-run Chinook salmon. Allowing flow through the island, and increasing floodplain habitat would increase potential spawning habitat in this area of the river by about 1,590 linear feet.

Anderson River Park Anderson River Park is an open space area on the south bank of the Sacramento River downstream from Churn Creek, and upstream from the Deschutes Road crossing at RM 283. Restoration at this site would involve hydraulically reconnecting a remnant Sacramento River side channel with the Sacramento River. Regularly flowing water throughout the length of this side channel would increase anadromous fish rearing habitat along 4,750 feet of side channel in this section of the river.

Reading Island Reading Island lies along the Sacramento River just north of Cottonwood Creek at RM 274. The channel for Anderson Creek, a remnant Sacramento River side channel, defines the western edge of Reading Island. Construction of a levee on Anderson Creek has blocked the channel's connectivity with the Sacramento River and has created Anderson Slough, an area of still water. Riparian, floodplain, and side channel restoration on Reading Island would involve restoring flows in Anderson Creek and through Anderson Slough. These activities, alongside removal of invasive aquatic vegetation in the channel and reestablishment of riparian vegetation would aid in restoring rearing habitat for winter-run Chinook, and spawning habitat for steelhead along 4,225 feet of channel in this area of the river.

Potential Benefits of CP4 and CP4A

Major potential benefits of CP4 and CP4A, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below.

Increase Anadromous Fish Survival CP4 or CP4A would significantly increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in the upper Sacramento River, primarily in dry and critical water years. It is estimated that improved temperature conditions under CP4 could result in an average annual increase in Chinook salmon population of nearly 812,600 outmigrating juvenile fish. It is estimated that improved water temperature and flow conditions under CP4A could result in an average annual increase in Chinook salmon population of nearly 710,000 outmigrating juvenile Chinook salmon.

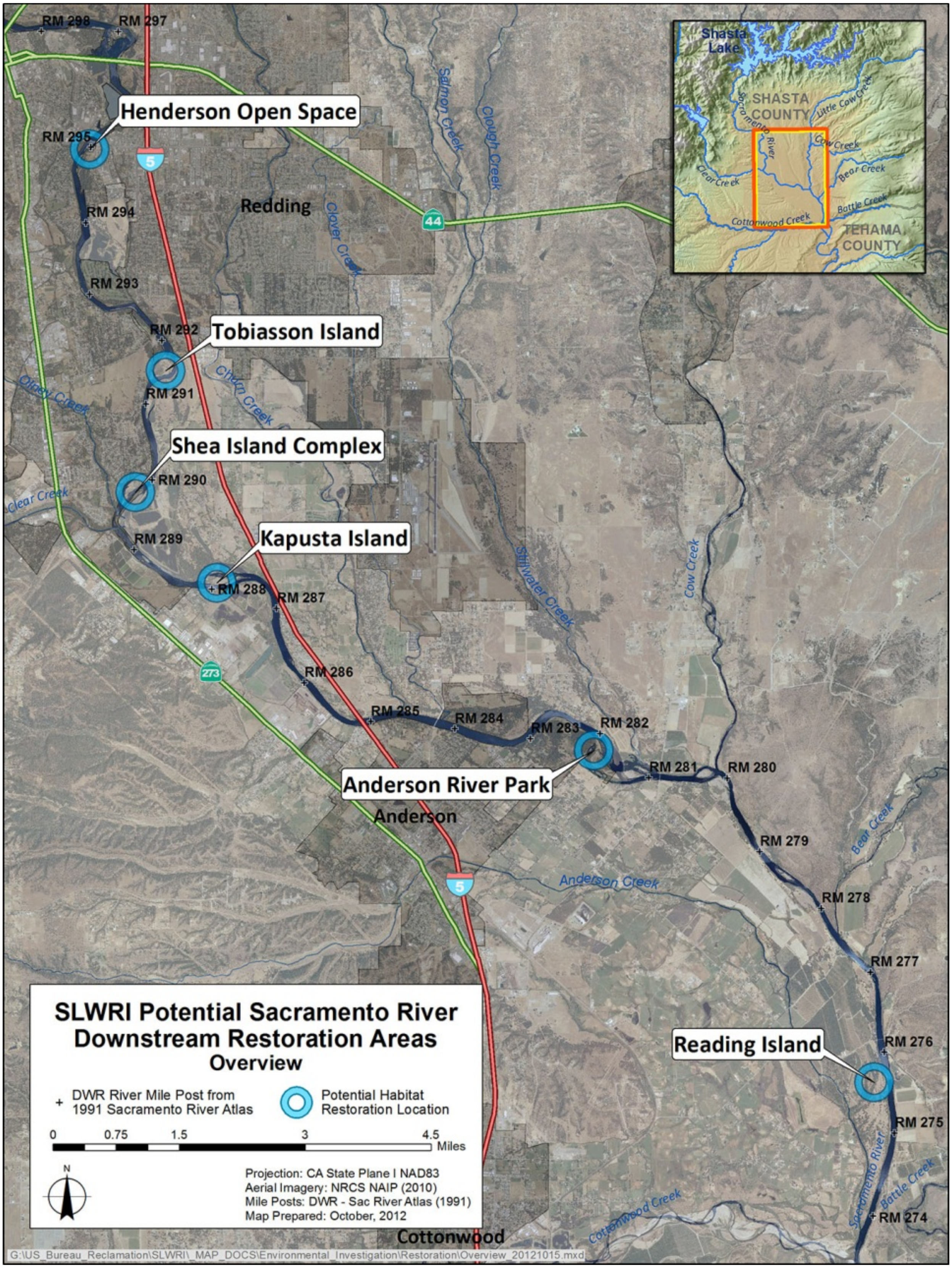
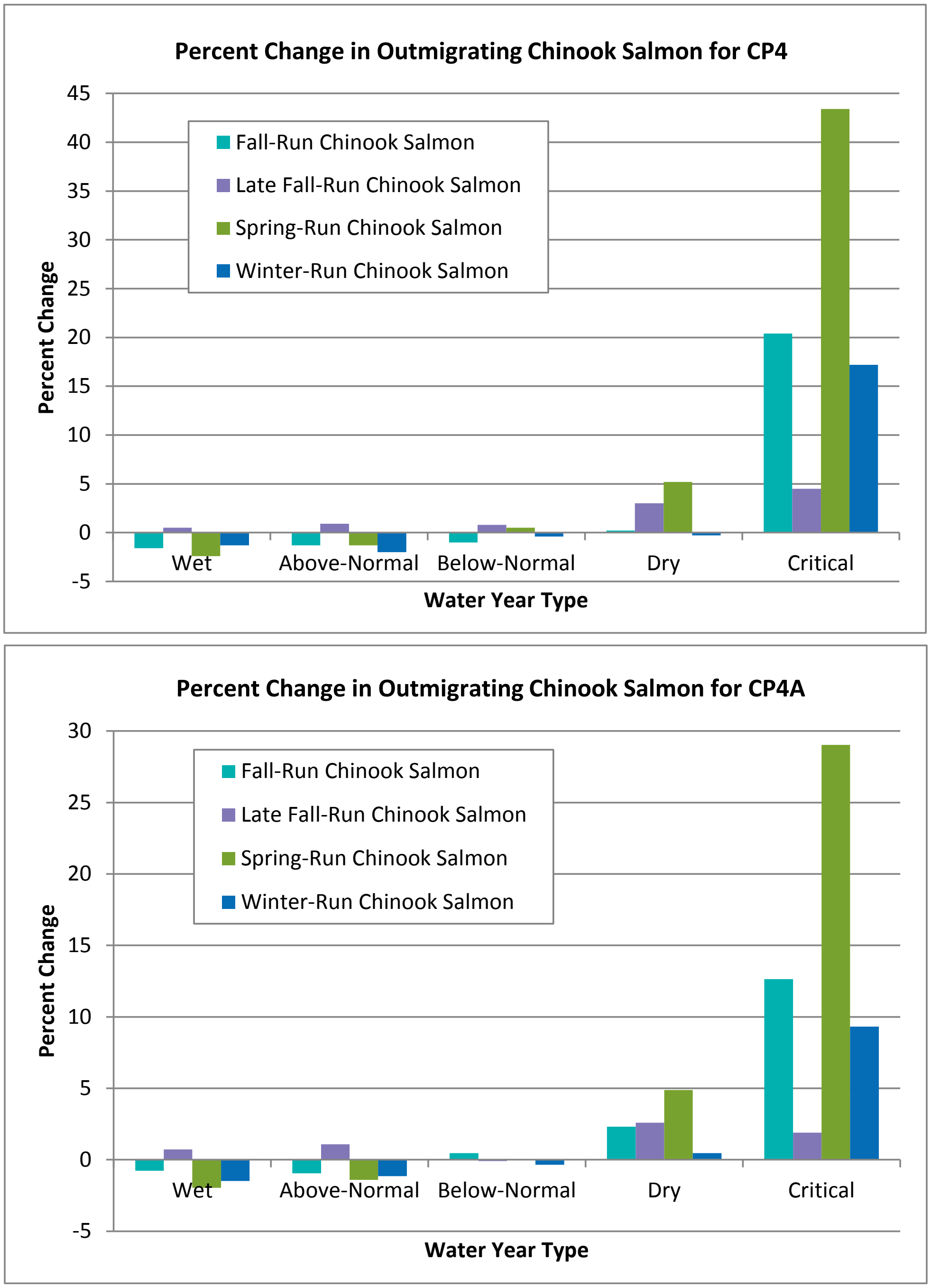


Figure 4-13. Potential Sacramento River Restoration Areas

Under CP4 and CP4A, an increase in the cold-water pool would allow Reclamation to operate Shasta Reservoir to provide not only a more reliable source of water during dry and critical water years, but also to provide more cool water for release into the Sacramento River to improve conditions for anadromous fish. Of the increased storage space for CP4, about 378,000 acre-feet (60 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes. Of the increased storage space for CP4A, about 191,000 acre-feet (30 percent) would be dedicated to increasing the cold-water supply for anadromous fish survival purposes. Reclamation would manage the cold-water pool each year based on recommendations from SRTTG. To assess the effects of operations on Chinook salmon in the upper Sacramento River, the computer model SALMOD was upgraded to evaluate changes in Chinook salmon population between Keswick Dam and the RBPP. In response to changes in Shasta Reservoir operations under CP4 and CP4A during dry and critical water years – the years targeted for improving water reliability for both users and fish – modeling with SALMOD showed increases in production of Chinook salmon populations, especially winter-run and spring-run Chinook (Figure 4-14).

In addition, CP4 and CP4A include a gravel augmentation program. Gravel augmentation would occur on average at one or more locations in the Sacramento River between Keswick Dam and the RBPP for a period of 10 years and, on average, 5,000 to 10,000 tons of gravel would be placed each year, although the specific quantity of gravel placed in a given year may vary from that range. Spawning gravel augmentation is expected to positively influence anadromous fish populations in the Sacramento River.

Increase Water Supply Reliability CP4 or CP4A would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries primarily during drought periods. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. As shown in Table 4-5, CP4 would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural and M&I deliveries by at least 47,300 acre-feet per year and average annual deliveries by about 31,000 acre-feet per year. As shown in Table 4-5, CP4A would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural and M&I deliveries by at least 77,800 acre-feet per year and average annual deliveries by about 51,300 acre-feet per year. The majority of increased dry and critical year water supplies, 42,700 acre-feet for CP4 and 67,100 acre-feet for CP4A, would be for south-of-Delta agricultural and M&I deliveries. In addition, water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. Under CP4 and CP4A, approximately $1.6 million and $2.6 million, respectively, would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.



Note: Simulated Using SALMOD; Water Year Types Based on the Sacramento Valley Water Year Hydrologic Classification

Figure 4-14. Percent Change in Outmigrating Chinook Salmon for CP4 and CP4A

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 127 GWh per year for CP4 and 125 GWh per year for CP4A. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits for both CP4 and CP4A include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Conserve, Restore and Enhance Ecosystem Resources In the upper Sacramento River, the addition of spawning gravel and the restoration of riparian, floodplain, and side channel habitat are expected to improve the complexity of aquatic habitat and its suitability for anadromous salmonid spawning and rearing. Riparian areas provide habitat for a diverse array of plant and animal communities along the Sacramento River, including several threatened or endangered species. Riparian areas also provide shade and woody debris that increase the complexity of aquatic habitat and its suitability for spawning and rearing. Lower floodplain areas, river terraces, and gravel bars play an important role in the health and succession of riparian habitat. Restoration would support the goals of the Sacramento River Conservation Area Forum and other programs associated with riparian restoration along the Sacramento River. Side channels can support important habitat for anadromous salmonids, including rearing and spawning habitat. Side channel habitats also provide refuge from predators and productive foraging habitat for juvenile anadromous salmonids. In addition, improved fisheries conditions as a result of cold-water carryover storage in CP4 or CP4A, as described above, and increased flexibility to meet flow and temperature requirements, could also enhance overall ecosystem resources in the Sacramento River.

Maintain and Increase Recreation Opportunities CP4 and CP4A include features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. Although neither CP4 nor CP4A include specific features to further increase recreation capacity, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. For CP4 and CP4A, the maximum surface area of the lake would increase by about 2,600 acres (9 percent), from 29,700 acres to about 32,300 acres. For CP4, the average surface area of the lake during the recreation season from May through September would increase by about 2,600 acres (11 percent), from 23,900 acres to 26,500 acres. For CP4A, average surface area of the lake during the recreation season from May through September would increase by about 2,300 acres (10 percent), from 23,900 acres to 26,200 acres. There is also limited potential to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Planning Objectives CP4 and CP4A could also provide benefits related to flood damage reduction, and water quality, similar to CP1 and CP2, respectively.

Additional Broad Public Benefits Additional broad public benefits of CP4 and CP4A obtained through pursuing project objectives are summarized in

Table 4-3. Broad public benefits for CP4 and CP4A are similar to those for CP3.

Potential Primary Effects of CP4 and CP4A

Following is a summary of potential environmental consequences of CP4 and CP4A. Potential environmental effects are generally comparable between comprehensive plans; some adverse effects would be exacerbated by larger dam raises and the associated scale of those effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Anticipated effects of construction and increased water surface elevations under CP4 and CP4A are similar to CP3. Potential effects on flow and stages of the upper Sacramento River from CP4 and CP4A are identical to those for CP1 and CP2, respectively. Proposed mitigation measures to address potential adverse impacts of CP4 and CP4A are summarized in Table 4-6. A detailed discussion of potential effects and proposed mitigation measures are included in Chapters 4 through 25 of the EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.

Shasta Lake Area As with the other comprehensive plans, the primary long-term effects of CP4 and CP4A would be due to the increased water surface elevations and inundation area. As with the above plan, raising the full pool of the lake would cause direct effects due to higher water levels, and/or indirect impacts related to facility modifications and relocations. Anticipated construction and relocation effects associated with CP4 and CP4A would be the same as for CP3, as described above. Any potential real estate acquisitions or necessary relocations of displaced parties would be accomplished under Public Law 91-646.

With CP4 and CP4A, Shasta Reservoir would fill to the new full pool storage capacity of 5.19 MAF at a frequency similar to without-project conditions. On the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent of its current capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. Included in Figure 4-2 is an exceedence probability relationship of maximum annual storage in Shasta Lake for this and other dam raises. Under CP4, Shasta Reservoir would fill to 80 percent of the new capacity in about 82 percent of the years. Under CP4A, Shasta Reservoir would fill to 80 percent of the new capacity in about 77 percent of the years. Accordingly, the annual operations in the reservoir under CP4 or CP4A would generally mirror existing operations, except the water surface in the lake would be about 18.5 feet higher. The primary difference in the reservoir area would be that during extended drought periods, the reservoir would be drawn down to approximately 378,000 acre-feet above without-project minimum levels under CP4 and 191,000 acre-feet above without-project minimum levels under CP4A. This is because of the dedicated storage capacity for increasing the cold-water pool for anadromous fish purposes. Figure 4-15 shows the changes from without-project conditions for CP4 and CP4A for a representative period of 1972 through 2003.

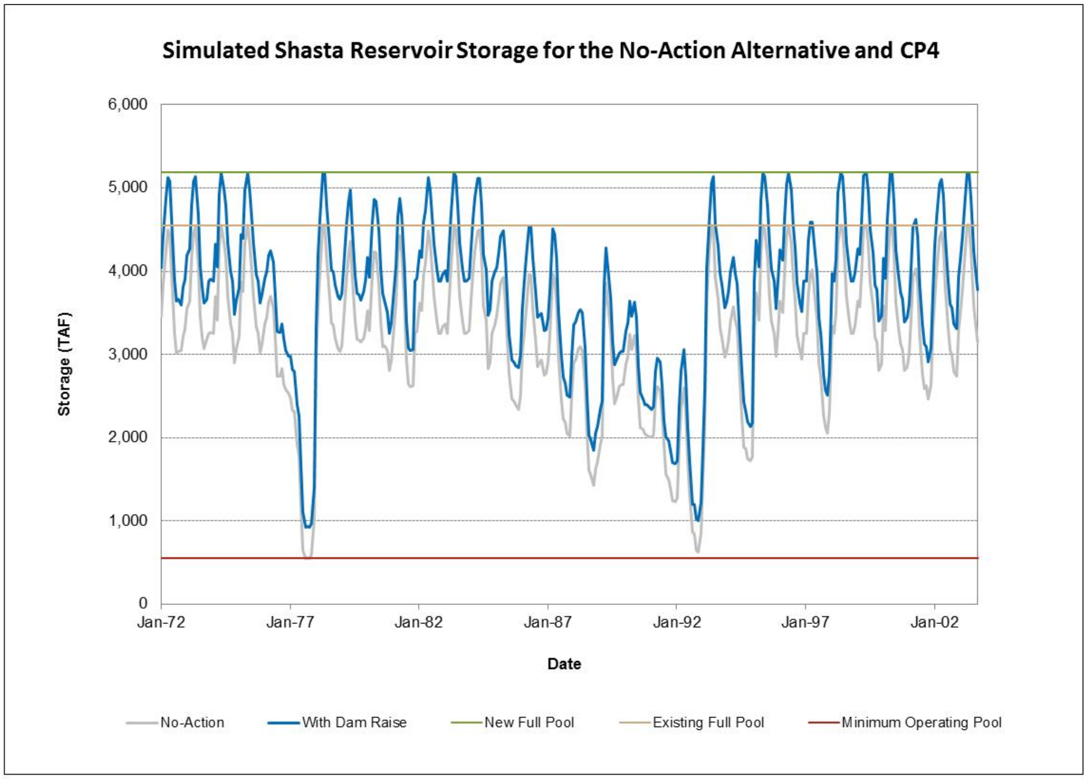
The increased area of inundation for CP4 and CP4A is about 2,600 acres, which is the same as for CP3. Accordingly, the effects of inundation on vegetation in the enlarged drawdown zone and on the lower McCloud River for CP4 and CP4A would be similar to CP3.

As shown in Figure 4-15, since a portion of the increased storage capacity would be dedicated to increasing the cold-water pool, water levels in the lake under CP4 and CP4A would generally be higher than under without-project conditions. It is anticipated that recreation use would generally improve under CP4 and CP4A because of a larger lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. Although water levels would generally be higher than under existing conditions and drawdown during the recreation season would generally be reduced, during some dry years, the total drawdown zone could increase under CP4 and CP4A. Effects to clearances for boat traffic under the Pit River Bridge under CP4 and CP4A would be similar to CP3.

Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

Upper Sacramento River Potential effects on flow and stages of the upper Sacramento River from CP4 are identical to those for CP1 (Figure 4-7). Potential effects on flow and stages of the upper Sacramento River from CP4A are identical to those for CP2 (Figure 4-9).

Some potential exists for impacting existing habitat at upper Sacramento River restoration sites, but these impacts would likely result from converting present land use back to a more typical riverine environment.



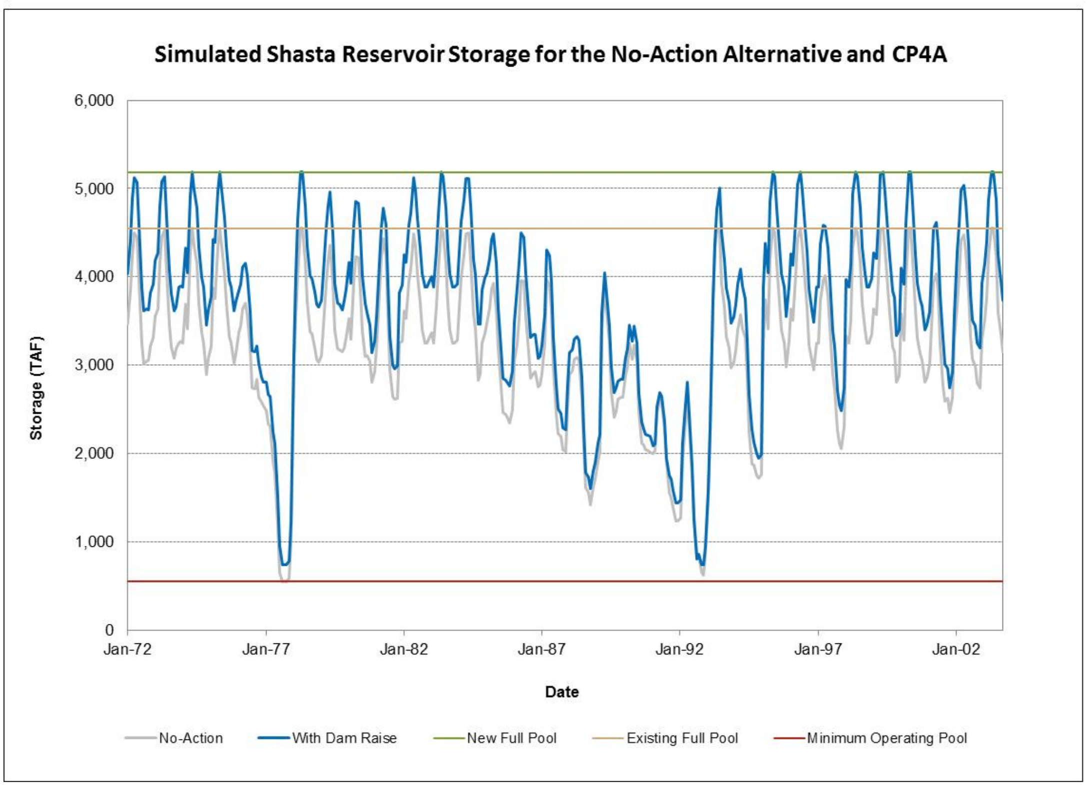


Figure 4-15. Simulated Shasta Reservoir Storage from 1972 to 2003 for CP4 and CP4A Compared to the No-Action Alternative

Preliminary Economics Assessment of CP4

Estimated Costs The estimated construction cost and annual cost of CP4 and CP4A are included in Table 4-7. As shown, for CP4, the estimated construction cost is $1,264 million and the estimated total annual cost is $57.1 million. For CP4A, the estimated construction cost is $1,265 million and the estimated total annual cost is $59.0 million.

Estimated Economic Benefits The estimated average annual monetary benefits of CP4 and CP4A are included in Table 4-8. As shown, for CP4, the estimated average annual monetary benefit, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $86.0 million. For CP4A, the estimated average annual monetary benefit, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $88.9 million. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, the average annual benefit could exceed about $111.6 million per year and $124.1 million per year for CP4 and CP4A, respectively.

CP5 – 18.5-Foot Dam Raise, Combination Plan

CP5 primarily focuses on increased water supply reliability, anadromous fish survival, Shasta Lake area environmental resources, and increased recreation opportunities. Major features of CP5 in the Shasta Lake area are shown in Figure 4-1 and summarized in Table 4-1.

Major Components of CP5

Major components of this plan include the following:

- Raising Shasta Dam and appurtenant facilities by 18.5 feet.
- Constructing additional resident fish habitat in Shasta Lake and along the lower reaches of its tributaries (Sacramento River, McCloud River, and Squaw Creek).
- Constructing shoreline fish habitat around Shasta Lake.
- Augmenting spawning gravel in the upper Sacramento River.
- Restoring riparian, floodplain, and side channel habitat.
- Increasing recreation opportunities at Shasta Lake.
- Implementing the set of eight common management measures previously described.
- Implementing the common environmental commitments described above.

As shown in Table 4-1, by raising Shasta Dam 18.5 feet, from a crest elevation of 1,077.5 feet to 1,096.0 feet (based on NGVD29), CP5 would increase the height of the reservoir full pool by 20.5 feet. The additional 2-foot increase in the height of the full pool above the dam raise height would result from spillway modifications similar to those described for CP1. This increase in full pool height would add approximately 634,000 acre-feet of storage to the reservoir's capacity. Accordingly, storage in the overall full pool would be increased from 4.55 MAF to 5.19 MAF. Figure 2-3 shows the increase in surface area and storage capacity for CP5.

Under CP5, the additional storage in Shasta Reservoir would be used to increase water supply reliability and to expand the cold-water pool for downstream anadromous fisheries. The existing TCD would be extended to achieve efficient use of the expanded cold-water pool. Operations for water supply, hydropower, and environmental and other regulatory requirements would be similar to existing operations, except during dry and critical years when a portion of the increased storage in Shasta Reservoir would be reserved to specifically focus on increasing M&I deliveries. In dry years, 150,000 acre-feet of the 634,000 acre-feet increased storage capacity in Shasta Reservoir would be reserved for increasing M&I deliveries. In critical years, 75,000 acre-feet of the increased storage capacity would be reserved for increasing M&I deliveries.

As described for the above plans, this plan also would include the potential to revise the flood control operational rules for Shasta Dam and Reservoir, which could reduce the potential for flood damage reduction and benefit recreation.

Construct Reservoir Shoreline Enhancement The ecosystem enhancement goal for the shoreline environment of Shasta Lake is to improve the warm-water fish habitat associated with the transition between the reservoir's aquatic and terrestrial habitats. Shoreline enhancement entails the range of enhancement opportunities along the Shasta Lake shoreline below the full pool elevation of 1,090 feet (based on NAVD88)[2] that would occur with an 18.5-foot dam raise. This area is typically between 0.1 mile and 1.5 miles upslope from the current full pool elevation of 1,070 feet (based on NAVD88). The shoreline is defined as the area encompassing nearshore aquatic habitat within the reservoir itself, and vegetation and other habitat components adjacent to the reservoir.

Two categories of potential nearshore warm-water fish habitat enhancement activities would be (1) structural enhancements, which entail placing artificial structures in Shasta Lake's littoral zone, and (2) vegetative enhancements, which entail planting and seeding to provide submerged and partly submerged vegetative cover when the reservoir is at full pool capacity during the winter/spring months.

[2] Shasta Lake water surface elevations are based on NAVD88. All designs and figures for reservoir area infrastructure modifications and relocations to accommodate increased water levels are based on a 2001 aerial survey of the reservoir which was completed using NAVD88.

Vegetative enhancements associated with CP5 include planting willows (Salix) to enhance nearshore fish habitat, and single treatment aerial and hand seeding of annual native grasses to treat shoreline areas at Shasta Lake. Treatment with native grasses would provide only short-term cover, but would be cost-effective across large areas and can be implemented quickly and efficiently. The annual native grasses would provide cover for young fish and also nutrients for plankton as the grasses decompose. The plankton, in turn, are a valuable food source for juvenile fish.

Construct Reservoir Tributary Aquatic Habitat Enhancement The primary goal for the enhancement of aquatic habitat in the watershed is to enhance the connectivity for native fish species and other aquatic organisms between Shasta Lake and its tributaries. Two categories of potential aquatic habitat enhancement in tributaries would be (1) fish passage enhancements, which entail identifying and correcting barriers to fish passage, particularly at culverts and other human-made barriers, and (2) aquatic habitat enhancements, which entail identifying and implementing feasible habitat improvements intended to conserve or restore degraded aquatic and riparian habitat in tributaries to Shasta Lake.

Fish passage enhancements associated with CP5 would include opportunities to restore and/or enhance five perennial stream crossings. Barriers to fish passage in the watersheds above Shasta Lake would be associated primarily with culverts or other types of stream crossings.

Aquatic habitat enhancements associated with CP5 would involve enhancing aquatic connectivity and reducing sediment related to roads constructed across intermittent streams. The preliminary site survey identified opportunities to enhance 14 intermittent stream crossings. Based on the information obtained in the survey, these crossings would provide opportunities for meeting the objectives of enhancing aquatic connectivity and/or reducing the potential for road-related sediment. Two sites have been identified in the Salt Creek watershed, two sites have been identified in the Sugarloaf Creek watershed, and ten sites have been identified in the McCloud River Arm watershed.

Augment Spawning Gravel in Upper Sacramento River As described in CP4 and CP4A, spawning-sized gravel would be placed at multiple locations along the Sacramento River between Keswick Dam and the RBPP. Gravel augmentation under CP5 would be identical to the gravel augmentation measure of CP4 and CP4A.

Restore Riparian, Floodplain, and Side Channel Habitat As described in CP4 and CP4A, riparian, floodplain, and side channel habitat restoration would occur at suitable locations along the Sacramento River. Under CP5, this measure would be identical to that proposed under CP4 and CP4A.

Recreation Enhancements A total of 18 miles of new hiking trails and 6 trailheads would be constructed to enhance recreation under CP5.

Potential Benefits of CP5

Major potential benefits of CP5, related to the SLWRI planning objectives and broad public services, are summarized in Tables 4-2 and 4-3 and described below.

Increase Anadromous Fish Survival CP5 would increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in the upper Sacramento River, primarily in dry and critical water years. It is estimated that improved water temperature and flow conditions under CP5 could result in an annual average increase in the Chinook salmon population of about 377,800 outmigrating juvenile Chinook salmon.

Increase Water Supply Reliability CP5 would increase water supply reliability by increasing water supplies for CVP and SWP irrigation and M&I deliveries. This action would contribute to replacement of supplies redirected to other purposes in the CVPIA. As shown in Table 4-5, CP5 would help reduce estimated future water shortages by increasing the reliability of dry and critical year water supplies for agricultural and M&I deliveries by at least 113,500 acre-feet per year and average annual deliveries by about 75,900 acre-feet per year. The majority of increased dry and critical year water supplies, 88,300 acre-feet, would be for south-of-Delta agricultural and M&I deliveries. In addition, increased water use efficiency could help reduce current and future water shortages by allowing a more effective use of existing supplies. Under CP5, approximately $3.8 million would be allocated over an initial 10-year period to fund agricultural and M&I water conservation programs, focused on agencies benefiting from increased reliability of project water supplies.

Develop Additional Hydropower Generation Higher water surface elevations in the reservoir would result in a net increase in power generation of about 112 GWh per year. This generation value is the expected increased generation from Shasta Dam and other CVP/SWP facilities. Other power benefits include additional capacity (i.e., the rate at which power can be generated) and ancillary services, which provide the ability to manage the electric grid in a reliable manner.

Conserve, Restore, and Enhance Ecosystem Resources CP5 would provide for habitat improvements both in the reservoir area and downstream from Shasta Dam on the upper Sacramento River.

Along the Shasta Lake shoreline, shallow warm-water fish habitat would be improved by using manzanita cleared from above the inundation zone to create structural enhancements, planting willows (*Salix*) to enhance nearshore fish habitat, and seeding of native grasses to treat shoreline areas. Once established, the willows and native grasses would provide submerged and partly submerged vegetative cover when the reservoir is at full pool capacity during the winter/spring months. These improvements would help provide favorable spawning conditions, and juvenile fish leaving the tributaries would benefit from improved adjacent shoreline habitat. Placing manzanita brush structures near the shoreline would enhance the diversity of structural habitat available for the warm-water fish species that occupy Shasta Lake. Establishing vegetation also could benefit terrestrial species that inhabit the shoreline of Shasta Lake.

The lower reaches of perennial tributaries to Shasta Lake would be the focus for aquatic restoration because they provide year-round fish habitat. Native fish species require connectivity to the full range of habitats offered by Shasta Lake and its tributaries. Improved fish passage would address the requirement to provide access and/or modify barriers necessary to improve ecological conditions that support these native fish assemblages. Aquatic habitat improvements would include enhancing aquatic connectivity and reducing sediment related to roads constructed across intermittent streams.

In the upper Sacramento River, the addition of spawning gravel and the restoration of riparian, floodplain, and side channel habitat would be expected to improve the complexity of aquatic habitat and its suitability for spawning and rearing. Riparian areas would provide habitat for a diverse array of plant and animal communities along the Sacramento River, including numerous threatened or endangered species. Riparian areas would also provide shade and woody debris that increase the complexity of aquatic habitat and its suitability for spawning and rearing. Lower floodplain areas, river terraces, and gravel bars would play an important role in the health and succession of riparian habitat. Restoration would support the goals of the Sacramento River Conservation Area Forum and other programs associated with riparian restoration along the Sacramento River. Side channels could support important habitat for anadromous salmonids, including rearing and spawning habitat. Side channel habitats would also provide refuge from predators and productive foraging habitat for juvenile anadromous salmonids.

Maintain and Increase Recreation Opportunities CP5 includes features to, at a minimum, maintain the existing recreation capacity at Shasta Lake. In addition, this alternative involves construction of 18 miles of new trails and 6 trailheads to enhance recreation opportunities at Shasta Lake. As with the other alternatives, benefits to the water-oriented recreation experience at Shasta Lake would likely occur because of the increase in average lake surface area, reduced drawdown during the recreation season, and modernization of recreation facilities. The maximum surface area of the lake would increase by about 2,600 acres (9 percent), from 29,700 acres to about 32,300 acres. The average surface area of the lake during the recreation season from May through September would increase by about 1,900 acres (8 percent), from 23,900 acres to 25,800 acres. There would also be limited potential for reservoir reoperation to provide additional benefits to recreation by allowing more reliable filling of the reservoir during the spring.

Benefits Related to Other SLWRI Planning Objectives CP5 could also provide benefits related to flood damage reduction and water quality, similar to CP3.

Additional Broad Public Benefits Additional broad public benefits of CP5 obtained through pursuing project objectives are summarized in Table 4-3. Broad public benefits for CP5 are similar to those for CP3.

Potential Primary Effects of CP5

Following is a summary of potential environmental consequences of CP5. Potential environmental effects are generally comparable between comprehensive plans; some adverse effects would be exacerbated by larger dam raises and the associated scale of those effects, such as expanded construction areas and increased area of inundation around Shasta Lake. Anticipated effects of construction and increased water surface elevations under CP5 are similar to CP3, CP4, and CP4A as summarized above. Proposed mitigation measures to address potential adverse impacts of CP5 are summarized in Table 4-6. A detailed discussion of potential effects and proposed mitigation measures are included in Chapters 4 through 25 of the accompanying EIS. A detailed discussion of the mitigation plan, including its development and proposed mitigation measures for all comprehensive plans, is included in the Preliminary Environmental Commitments and Mitigation Plan Appendix to the accompanying EIS.

Shasta Lake Area As with the other comprehensive plans, the primary long-term effects of CP5 would be due to the increased water surface elevations and inundation area. As with the above plan, raising the full pool of the lake would cause direct effects due to higher water levels, and/or indirect impacts related to facility modifications and relocations. Anticipated construction and relocation effects associated with CP4 would be the same as CP3, CP4, and CP4A, as described above. Any potential real estate acquisitions or necessary relocations of displaced parties would be accomplished under Public Law 91-646.

With CP5, Shasta Reservoir would fill to the new full pool storage capacity of 5.19 MAF at a frequency similar to without-project conditions. On the basis of water operations modeling (CalSim-II), Shasta Reservoir fills to 80 percent of its current capacity in about 81 percent of the years over the 82-year period of analysis of the CalSim-II model. Included in Figure 4-2 is an exceedence probability relationship of maximum annual storage in Shasta Lake for this and other dam raises. Under CP5, Shasta Reservoir would also fill to 80 percent of the new capacity in about 72 percent of the years. Accordingly, the annual operations in the reservoir would generally mirror existing operations, except the water surface in the lake would be about 18.5 feet higher. The primary difference in the reservoir area would be that during extended drought periods, the reservoir would be drawn down to without-project minimum levels. Figure 4-16 shows the changes from without-project conditions for CP5 for a representative period of 1972 through 2003.

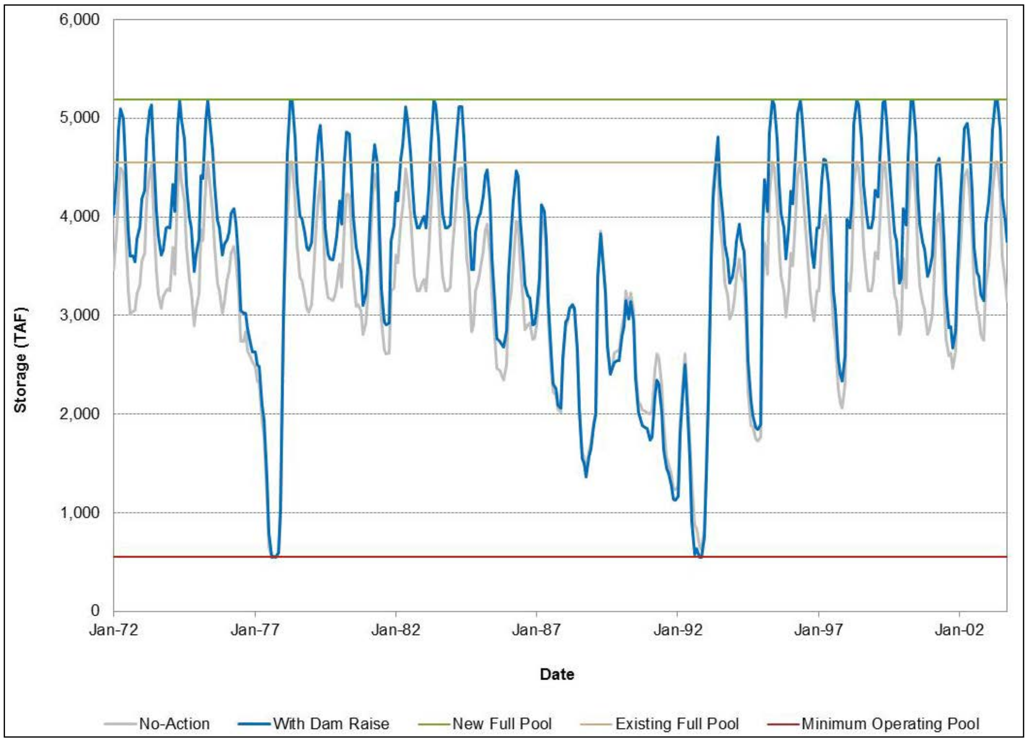


Figure 4-16. Simulated Shasta Reservoir Storage from 1972 to 2003 for the No-Action Alternative and CP5

The increased area of inundation for this plan is about 2,600 acres, which is the same for CP3, CP4, and CP4A. Accordingly, the effects of inundation on vegetation in the enlarged drawdown zone and on the lower McCloud River for CP5 would be similar to CP3, CP4, and CP4A.

As shown in Figure 4-16, water levels in the lake under CP5 would generally be higher than under without-project conditions. It although it is believed that recreation use would generally improve under this plan because of a larger lake surface area, water in the lake would be drawn down to existing conditions during the late fall and winter periods of some dry years, representing a drawdown 20.5 feet greater than under existing conditions. During these periods, the drawdown zone could increase by about 50 linear feet. Effects to clearances for boat traffic under the Pit River Bridge under CP5 would be similar to CP3, CP4, and CP4A.

Additional long-term effects on biological resources associated with the relocation of reservoir area infrastructure are anticipated. Short-term, construction-related impacts are also anticipated in the primary study area.

Upper Sacramento River As with the previous plan, potential effects on flow and stages of the upper Sacramento River from this and other comprehensive plans would be minimal. Figure 4-17 shows CalSim-II simulated Sacramento River flows above RBPP under wet, above- and below-normal, and dry and critical year conditions for the No-Action Alternative compared to CP5. Additional figures are included in the EIS Plan Formulation Appendix that show simulated Sacramento River flows below Keswick Dam and Stony Creek, under wet, above- and below-normal, and dry and critical year conditions for all of the alternatives. As shown, during most years, annual operations of Shasta Reservoir, and subsequent flows and stages in the Sacramento River, would be relatively unchanged. Also, flows and stages would increase slightly from June through November. Although small, this increase would be most pronounced during dry periods as more water is released from Shasta Dam for water supply reliability purposes. During dry periods, however, there are few to no changes in water flows or changes during the winter and spring periods. All potential noticeable changes in flows and stages would diminish rapidly downstream from the RBPP.

Changes in river flows and stages may impact geomorphic conditions along the river, existing riparian vegetation, and other wildlife resources. As described above, the changes in temperatures and flows are expected to have a beneficial impact on anadromous fish resources. A possibility exists, however, that by benefiting anadromous fish, a slightly altered temperature and flow regime may adversely impact warm-water species in the Sacramento River. This effect is not expected to be significant.

Some potential exists for impacting existing habitat at upper Sacramento River restoration sites, but these impacts would likely result from converting present land use back to a more typical riverine environment.

Preliminary Economics Assessment of CP5

Estimated Costs Estimated construction cost and annual cost of CP5 are included in Table 4-7. As shown, the estimated construction cost is $1,283 million. The estimated total annual cost of this plan is $61.0 million.

Estimated Economic Benefits As shown in Table 4-8, the estimated average annual monetary benefit of CP5, assuming the cost of water and energy supplies increases at the same rate as inflation, is about $74.2 million. Assuming the cost of water supplies and hydropower increases at 2 percent above inflation, to account for future diminishment of water and energy supplies and increasing demands, this benefit could exceed about $115.2 million per year. Added benefits for ecosystem restoration recreation enhancements in and around Shasta Lake are estimated to equal to their annual cost.

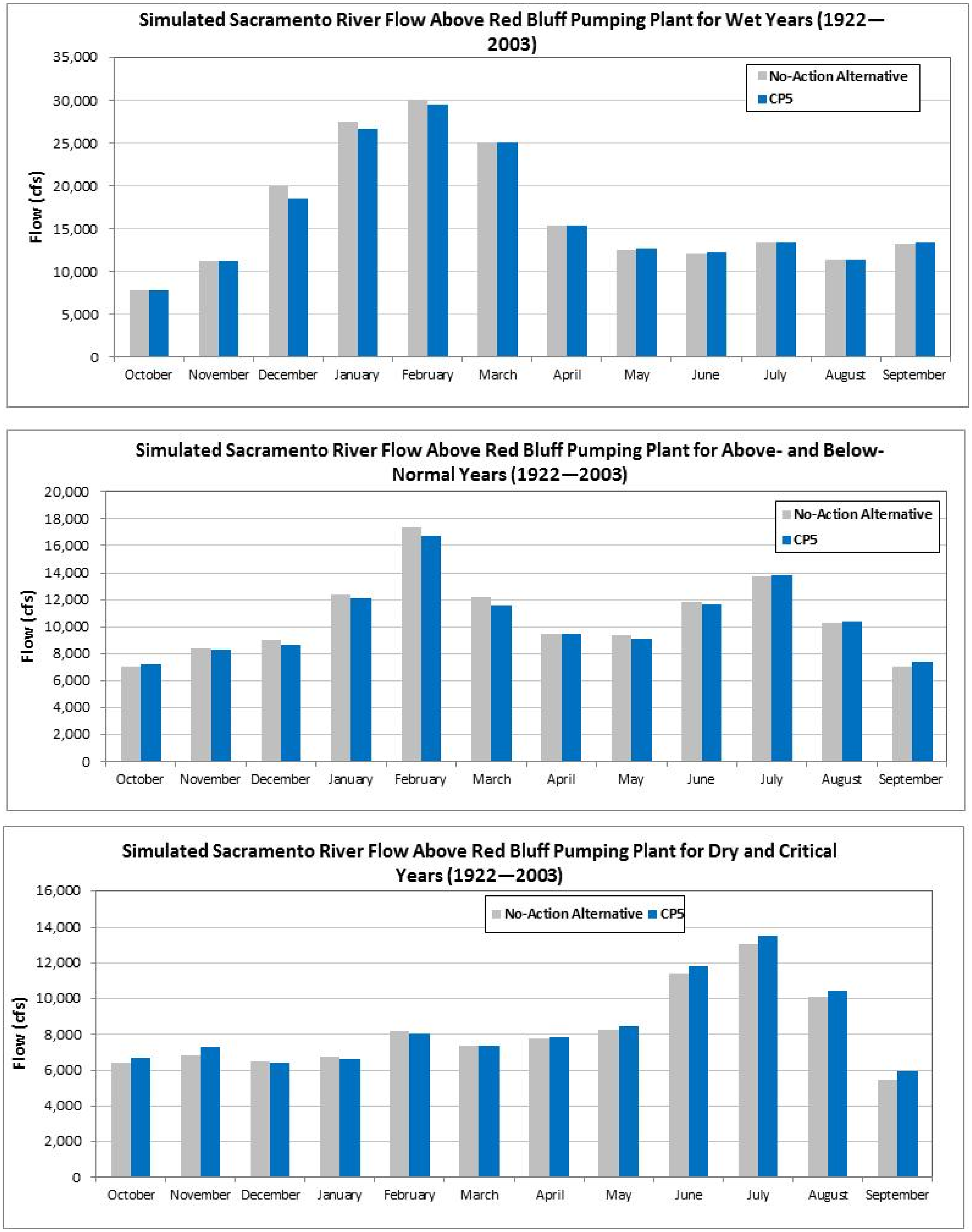


Figure 4-17. Simulated Sacramento River Flow Above Red Bluff Pumping Plant in Wet, Above- and Below-Normal, and Dry and Critical Years for No-Action and CP5

Consistency of Comprehensive Plans with Other Programs

Comprehensive plans were evaluated on their consistency with the CVPIA and contributions toward the overall goals and objectives of the CALFED Programmatic ROD.

Central Valley Project Improvement Act

The CVPIA is a Federal statute passed in 1992 with the following purposes:

> *To protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California; to address impacts of the CVP on fish, wildlife and associated habitats; to improve the operational flexibility of the CVP; to increase water-related benefits provided by the CVP to the state of California through expanded use of voluntary water transfers and improved water conservation; to contribute to the state of California's interim and long-term efforts to protect the Bay-Delta; and to achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agricultural, municipal and industrial and power contractors.*

Anadromous Fish

CVPIA Section 3406(b)(1) required the Secretary to develop an Anadromous Fish Restoration Program. Continued implementation of CVPIA actions and programs, including the Anadromous Fish Restoration Program, constitute the mitigation, restoration, and enhancement requirements of the CVPIA (Section 3406(b)(1)). In comparison to the No-Action Alternative, all comprehensive plans would increase the ability of Shasta Dam to make cold-water releases, and regulate flow and water temperature in the upper Sacramento River. These flow and temperature improvements would result in increased survival of anadromous fish, particularly in dry and critically dry years. Accordingly, consistent with the P&G and Reclamation policy, these increases in anadromous fish survival under comprehensive plans are considered enhancements because they are above and beyond implementation of CVPIA actions and programs.

Water Supply Replacement

Since the CVPIA was enacted, 1.2 million acre-feet of CVP yield have been dedicated and managed annually for the primary purpose of implementing the fish, wildlife, and habitat mitigation and restoration purposes and measures authorized by the CVPIA. All alternatives would increase water supply reliability through increasing dry and critical year water supplies above and beyond the No-Action Alternative, primarily during dry and critical years. This action could contribute to the replacement of supplies redirected to other purposes in the CVPIA.

CALFED Bay-Delta Program

CALFED, a coordinated Federal and State program, was established after the Bay-Delta Accord to address water quality, ecosystem quality, water supply reliability, and Delta levee system integrity. CALFED provides a programmatic framework to develop and implement a long-term comprehensive plan to restore ecological health and improve water management for beneficial uses of the Bay-Delta system. As described in Chapter 3, Section "Planning Constraints and Other Considerations," enlarging Shasta Dam and Reservoir was included in the CALFED Preferred Program Alternative. The accompanying EIS to this Feasibility Report tiers to the CALFED PEIS/R.

CALFED developed the following program objectives for a solution:

- **Water Supply Reliability –** Reduce the mismatch between Bay-Delta water supplies and the current and projected beneficial uses dependent on the Bay-Delta system.
- **Water Quality –** Provide good water quality for all beneficial uses.
- **Ecosystem Quality –** Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.
- **Delta Levee Integrity –** Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees.

Expanding water storage capacity is critical to the successful implementation of all aspects of CALFED. Not only is additional storage needed to meet the needs of a growing population but, if strategically located, such storage will provide much needed flexibility in the system to improve water quality and support fish restoration efforts. Table 4-9 summarizes potential overall contributions of the SLWRI toward CALFED goals. Table 4-10 qualitatively compares anticipated contributions of the comprehensive plans relative to CALFED goals and CALFED Storage Program objectives.

Table 4-9. Summary of Contributions of SLWRI Comprehensive Plans to CALFED Bay-Delta Program Goals

Program Goal	Potential Contributions of SLWRI Comprehensive Plans Toward Program Goals
Water Supply Reliability	• Could increase the reliability of dry and critical year water supplies by up to 113,500 acre-feet per year • Further implement demand reduction practices
Water Quality	• Could contribute to improved operational flexibility and provide increased high-flow releases to reestablish Delta water quality • Could increase Delta outflow during drought years and reduce salinity during critical periods
Ecosystem Quality	• Could increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in upper Sacramento River • Could result in an average annual increase of up to 812,600 outmigrating juvenile Chinook salmon • Could contribute to additional flow releases in Sacramento River and Delta during critical periods for fish species
Delta Levee Integrity	• Could provide greater flexibility in flood control releases, thereby reducing stress on Delta levees

Key:
CALFED = CALFED Bay-Delta Program
Delta = Sacramento – San Joaquin Delta
SLWRI = Shasta Lake Water Resources Investigation

Table 4-10. Comparison of Comprehensive Plans Relative to CALFED Goals and CALFED Storage Program Objectives

Objectives	CP1	CP2	CP3	CP4	CP4A	CP5
CALFED Bay-Delta Program Goals[1]						
Water Quality: Provide good water quality for all beneficial uses	+	++	+++	+++	+++	+++
Ecosystem Quality: Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species	+	++++	+++	+++++++	++++++	++++
Water Supply: Reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses that depend on the Bay-Delta system	+++	++++	++++	+++	++++	++++++
Delta Levee Integrity: Reduce the risk to land use and associated economic activities, water supply, infrastructure and the ecosystem from catastrophic breaching of Delta levees	+	+	+	+	+	+
CALFED Storage Program Element Objectives						
Pursue specific opportunities for new off-stream storage sites and expansion of existing on-stream storage sites as identified in the Programmatic Record of Decision	+	++	+++	+++	+++	+++
Provide financial and technical assistance to implement 1/2 million to 1 million acre-feet of new, locally managed groundwater storage	0[2]	0[2]	0[2]	0[2]	0[2]	0[2]

Notes:
[1] Source: *CALFED Bay-Delta Program Programmatic Record of Decision* (CALFED 2000a)
[2] Although the SLWRI comprehensive plans do not include specific features to fund or assist groundwater storage, enlarging Shasta Reservoir could allow for additional system flexibility for surface water deliveries, decreasing reliance on groundwater pumping. This could reduce groundwater overdraft conditions in CVP and SWP service areas.

Key:
\+ = net positive effect (benefit)
0 = no anticipated effect
CP = comprehensive plan
CALFED = CALFED Bay-Delta Program

Water Supply Reliability

One of the primary goals of CALFED is to improve the reliability of California's water supply within the context of unpredictable hydrology and the competing needs of fish and wildlife and water users. In addition to hydrology, the CALFED Programmatic ROD assumes that water supply reliability is predicated partially on investment in infrastructure to improve storage and conveyance capacity. Included in the CALFED Storage Program Preferred Program Alternative is a proposed raise of Shasta Dam. Water supply reliability depends on capturing water during peak flows and during wet years, as well as on more efficient water use through conservation and recycling. All alternatives identified in this Feasibility Report would increase water supply reliability through increasing water supplies for CVP and SWP deliveries primarily during dry and critical years.

Water Quality

Additional storage in Shasta Reservoir would improve operational flexibility, which could contribute to improved Delta water quality conditions and Delta emergency response. Shasta Dam has the ability to provide increased releases and high-flow releases to reestablish Delta water quality. Improved Delta water quality conditions could benefit water supply reliability and ecosystem restoration by potentially increasing Delta outflow during drought years, and reducing salinity during critical periods.

Ecosystem Quality

Enlarging Shasta Dam and Reservoir could contribute to ecosystem restoration along the Sacramento River and within the Delta. Improvements to water temperature and flows for Sacramento River aquatic species could be accomplished through enlarging Shasta Dam and Reservoir. All alternatives would increase the ability of Shasta Dam to make cold-water releases and regulate water temperature in the upper Sacramento River, primarily in dry and critical years, through new storage that would create a larger cold-water pool in Shasta Reservoir.

Increased Shasta Reservoir storage could contribute to additional flow releases to the Sacramento River during critical periods for fish species. Shasta Dam and Reservoir enlargement could also contribute to Delta species restoration through increased operational flexibility. Increased storage could allow CVP/SWP pumping operations to be shifted to times when fish are less vulnerable to the effects of these pumping operations.

Delta Levee Integrity

Enlarging Shasta Dam and Reservoir could provide greater flexibility in flood control releases in the CVP/SWP system because of the potential for additional flood control space within Shasta Reservoir. Improved operational flexibility in the timing of flood control releases associated with the proposed Shasta Dam raise could reduce stress on Delta levees, and could contribute to maintaining their stability.

CALFED "Beneficiary Pays" Principle

Federal cost allocation procedures and applicable cost-sharing laws/regulations govern how the costs of a project are allocated among project purposes, and apportioned to project beneficiaries. Federal laws and regulations also determine which Federal costs are reimbursable (paid back to the Federal Government by beneficiaries, typically over time) and nonreimbursable (the burden of the Federal taxpayer). Should the project be authorized by Congress, the Federal authorizing language would likely specify any cost-sharing or financing arrangements that deviate from previously established Federal laws.

It is believed that Federal cost allocation and cost-sharing practices are consistent with the CALFED "beneficiary pays" principle.

Consistency with Department of Interior Climate Change Policy

Secretarial Order No. 3289 (as amended, Interior 2010) establishes an Interior-wide approach for applying scientific tools to increase understanding of climate change and to coordinate an effective response to its impacts on tribes and on the land, water, ocean, fish and wildlife, and cultural heritage resources that the Department manages. This Order requires that each bureau and office of the Interior must consider and analyze potential climate change impacts when undertaking long-range planning exercises, setting priorities for scientific research and investigations, developing multi-year management plans, and making major decisions regarding potential use of resources under the Department's purview. The SLWRI has been conducted in accordance with this Order.

As described in the Climate Change Modeling Appendix to the accompanying EIS, numerous studies have been conducted on the potential implications of climate change both on a global scale and in California. Consistent with the SECURE Water Act, Reclamation developed projections of future climate and hydrologic changes under climate change for the Sacramento and San Joaquin River basins (Reclamation 2011e). These projections are summarized in Table 4-11 for the Sacramento River at Bend Bridge and the San Joaquin River at Friant Dam. As shown in Table 4-11, climate change is expected to result in a shift from snow to rain in winter, leading to reduced snowpack, earlier snowmelt, and reduced river flows in summer. This would result in changes to the seasonal timing of flows, reservoir storage levels, flood management, recreation, and hydropower generation. Projected increases in temperatures and changes in timing and magnitude of stream runoff will have important implications for California's water supply and are also expected to affect aquatic species due to changes in river flows and water temperatures.

Climate change is also expected to cause sea level rise, resulting in increases in Delta water salinity. This increasing salinity will influence the suitability of Delta water for agricultural, urban, and environmental uses, likely having substantial impacts on water management throughout the Central Valley and other regions of the State.

Table 4-11. Summary of Simulated Changes in Decade-Mean Hydroclimate for Two Subbasins in the Sacramento and San Joaquin River Basins[1]

Hydroclimate Metric	Change from 1990s		
	2020s	2050s	2070s
Sacramento River at Bend Bridge			
Mean Annual Temperature (°F)	1.3	3.0	4.2
Mean Annual Precipitation (%)	-0.3	0.6	-2.7
Mean April 1st Snow Water Equivalent (%)	-53.4	-75.9	-88.6
Mean Annual Runoff (%)	3.5	2.5	-3.6
Mean December–March Runoff (%)	9.0	13.6	11.0
Mean April–July Runoff (%)	-11.1	-23.0	-36.1
Mean Annual Maximum Week Runoff (%)	12.9	18.4	18.3
Mean Annual Minimum Week Runoff (%)	-0.3	-0.5	-0.6
San Joaquin River at Friant Dam			
Mean Annual Temperature (°F)	1.4	3.3	4.5
Mean Annual Precipitation (%)	-1.3	-5.3	-8.6
Mean April 1st Snow Water Equivalent (%)	-23.1	-39.6	-48.7
Mean Annual Runoff (%)	0.7	-8.7	-10.7
Mean December–March Runoff (%)	13.9	15.8	31.0
Mean April–July Runoff (%)	-6.1	-20.2	-25.0
Mean Annual Maximum Week Runoff (%)	-2.3	-6.6	-16.0
Mean Annual Minimum Week Runoff (%)	-4.0	-6.4	-7.6

Source: Reclamation 2011e

Notes:

[1] Projected changes for the three future decades (2020s, 2050s, 2070s) reflect the average for the subbasin and are measured relative to 1990s baseline conditions.

Key:

ºF = degree Fahrenheit

Each of the SLWRI comprehensive plans includes enlarging Shasta Dam and Reservoir and a variety of management measures to address, in varying degrees, all of the primary and secondary planning objectives. Although measures incorporated into comprehensive plans were not developed specifically to address climate change, increased storage in Shasta Reservoir would provide additional flexibility to adapt to potential changes in hydrology under climate change, such as increases in extreme events (e.g., flooding, droughts). The comprehensive plans would provide additional system flexibility to help offset the potential effects of future climate change as follows:

- Enlarging Shasta Reservoir and increasing seasonal carryover storage would enlarge the cold-water pool, increasing Reclamation's ability to provide cold-water releases from Shasta Dam to improve water temperatures in the upper Sacramento River during drought periods.

- Increasing conservation storage in Shasta Reservoir would provide improved operational flexibility and increased water supply reliability to meet demands, helping to offset potential reductions in water supplies due to climate change.

- Increases in Shasta Reservoir storage and associated water levels could help offset reductions in hydropower generation.

- Increasing storage in Shasta Reservoir would provide greater flexibility for increased releases, including high-flow releases, to improve Delta water quality by increasing Delta outflow during drought years and reducing salinity during critical periods.

- Implementation of the water conservation program under all comprehensive plans would help reduce demands on available water supplies.

- Increased storage in Shasta Reservoir would allow for capture of additional flows during extreme events, reducing the frequency, magnitude, and duration of some potential future flood events.

Projected changes in climate are likely to influence the potential benefits of the SLWRI comprehensive plans. To assess the potential to achieve the SLWRI objectives under projected future climate change, two SLWRI comprehensive plans were selected and analyzed in the Climate Change Modeling Appendix to the accompanying EIS:

- **CP4**, which maximizes anadromous fish survival, was selected to assess the potential to benefit anadromous fish survival under climate change using a method based on the mean state of projected climate changes (“delta” method). The analysis indicated that anadromous fish populations would be substantially impacted by climate change, absent implementation of CP4. The analysis indicated that with implementation of CP4, anadromous fish survival would benefit from reduced water temperatures in the Sacramento River and increased flows.

- **CP5**, which maximizes the potential benefits to water supply reliability, was selected to assess the potential to benefit water supply reliability under climate change using climate modeling tools developed by Reclamation for the CVP Integrated Resource Plan (IRP). The analysis indicated that under climate change scenarios, implementation of CP5 would continue to benefit CVP and SWP operations and infrastructure, including water deliveries for agricultural, M&I, and environmental purposes; river water temperatures; hydropower generation and GHG emissions; and management of Delta salinity levels.

These evaluations indicate that the comprehensive plans are robust and would provide benefits under a range of future climate scenarios.