MISSION STATEMENT

U.S. Department of the Interior

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering wise use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. Administration.

Bureau of Reclamation

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.

Draft Programmatic Environmental Impact Statement
Implementation of the Central Valley Project Improvement Act of 1992

Prepared by the U.S. Bureau of Reclamation
for the Department of the Interior

This Programmatic Environmental Impact Statement (PEIS) is prepared in compliance with the National Environmental Policy Act (NEPA) and the U.S. Bureau of Reclamation (Reclamation) policy and procedures for implementing NEPA.

Reclamation is evaluating the impacts of implementing Title XXXIV of the Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law 102-575), the Central Valley Project Improvement Act (CVPIA). The general purposes of the CVPIA were identified by Congress in section 3402 as follows:

- (a) to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California;
- (b) to address impacts of the Central Valley Project (CVP) on fish, wildlife, and associated habitats;
- (c) to improve the operational flexibility of the CVP;
- (d) 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;
- (e) to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; and
- (f) to achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agriculture, municipal and industrial and power contractors.

This Draft PEIS analyzes 19 alternatives and the No-Action Alternative to identify impacts and benefits following the full or partial implementation of the CVPIA. The Draft PEIS focuses on systemwide impacts of implementing fish and wildlife restoration programs in the Central Valley and the Trinity River basins; providing reliable water supplies to refuges and wetlands; providing for a land retirement program for willing sellers of lands that are characterized by poor drainage; and renewing CVP water contracts including provisions for contract renewals, water pricing, water metering/monitoring, water conservation, and water transfers. The impact analysis focuses on impacts and benefits to surface water facilities and operations, groundwater, fishery resources, vegetation and wildlife, agricultural economics and land use, cost of municipal water supplies, regional economics, recreation, and cultural resources. The PEIS also considers cumulative impacts of concurrent water resource and natural resource programs.

At this time, the actions to be implemented under CVPIA are not specifically defined. Therefore, the impact assessment is programmatic in nature. As project-specific and site-specific actions are defined, the actions will be compared to those evaluated in the PEIS to determine if additional environmental documentation would be required prior to implementation.

For further information regarding this PEIS, please contact Mr. Al Candlish, U.S. Bureau of Reclamation, Mid-Pacific Region, 2800 Cottage Way, Sacramento, California 95825.

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Central Valley Project Improvement Act

Draft Programmatic Environmental Impact Statement

US Department of the Interior

Bureau of Reclamation

Sacramento, California

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CHAPTER I

PURPOSE AND NEED

Chapter I

PURPOSE AND NEED

This document is a programmatic environmental impact statement (PEIS) that addresses the potential impacts of alternatives developed to implement the Central Valley Project Improvement Act (CVPIA). The PEIS was prepared under the National Environmental Policy Act (NEPA) by the U.S. Bureau of Reclamation (Reclamation).

On October 30, 1992, the President signed into law the Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law 102-575) that included Title XXXIV, the CVPIA. The CVPIA, provided in Attachment A, amends the previous authorizations of the California Central Valley Project (CVP) to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic uses and fish and wildlife enhancement as a project purpose equal to power generation. The CVPIA identifies a number of specific measures to meet these new purposes and directs the Secretary of the Interior (Secretary) to operate the CVP consistent with these purposes, to meet the Federal trust responsibilities to protect the fishery resources of affected federally recognized Indian tribes, and to meet all requirements of Federal and California law and to achieve a reasonable balance among competing demands for use of CVP water. Section 3409 directs the Secretary to complete a PEIS to analyze the direct and indirect impacts and benefits of implementing CVPIA. The CVPIA allows the Secretary to renew existing CVP water service and repayment contracts following completion of the PEIS and other environmental documentation, as may be needed.

PURPOSE AND NEED FOR THE ACTION

The Department of the Interior (Interior) is developing programs to improve environmental conditions and modify operations, management, and physical facilities, and thus associated environmental condition, of the CVP to comply with the purposes and goals of the CVPIA and the revised purposes of the CVP. These programs will define operational criteria, management, and structural priorities for the CVP through the next water contracting cycle.

The Federal action to be taken by the Interior is to implement the CVPIA. The general purposes of the CVPIA, and of the action proposed by Interior, were identified by Congress in Section 3402 as follows:

(a) to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California;

(b) to address impacts of the CVP on fish, wildlife, and associated habitats;

(c) to improve the operational flexibility of the CVP;

(d) 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;

(e) to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; and

(f) to achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agriculture, municipal and industrial and power contractors.

These purposes respond to a need to modify the existing water operations and physical facilities of the CVP. Over the past 150 years, competition for freshwater has escalated between fish and wildlife resources, agricultural users, municipal and industrial users, power generators, and flood control operations within the tributary area of the Sacramento-San Joaquin Delta (Delta). In addition, during this period, habitat that supports fish and wildlife resources in the Central Valley has been reduced as agricultural, municipal, and industrial development has occurred and California's economy has grown.

Prior to development of water resources in California, anadromous fish were attracted upstream during storm events from fall through the spring. The storm flows also provided flushing flows to move fish downstream from the upper reaches of the streams where spawning occurred. The rain and snow also repelled saltwater intrusion in the Delta from San Francisco Bay.

Water resource projects throughout the Central Valley and foothills modified the flow patterns by shifting peak river flows from fall through spring months to summer months, highly impacting anadromous fish species which evolved under more natural conditions. In addition to changing flow patterns, the reservoirs and diversions altered the temperature of some stream reaches, blocked fish passage to some colder water stream reaches that were needed for spawning and rearing, and entrained and entrapped juvenile fish in the diversions. Diversions caused direct loss of fish from the streams through entrainment and entrapment, and through impingement and enhancement of conditions for predators. A portion of the reservoirs and diversions in the Central Valley were developed by the CVP.

Fish and wildlife resources also were impacted by construction of levees along many of the rivers and the Delta. The levees eliminated many wetland and shallow water zones where spawning and rearing occurred. The levee maintenance programs also eliminated riparian vegetation that provided shade for temperature control and protection from ultraviolet radiation. Insects that lived in the vegetation and fell into the water provided food for the fish. The vegetation also provided food and habitat for many different types of wildlife.

Municipal development of California also caused reduction in fish and wildlife resources. Communities grew throughout California and the United States which resulted in increased demands for food and water. The increased demands for food resulted in increased need for agriculture, which also required additional water. The CVP, State Water Project (SWP), local water projects, and groundwater users provided water. The communities produced wastewater discharges and increased sediment loadings. These factors also have contributed to the decline of fishery resources in California over the past 150 years.

Wildlife resources also were affected by development of California. Changing flows, storage, and diversion of water and construction of levees reduced wetlands that provided resting and nesting areas and food sources for waterfowl. Since 1850, wetlands in the Central Valley have decreased from 4 million acres to about 300,000 acres in average water years. These wetlands are used year round by many species including wintering habitat for over 12,000,000 migrating birds in the Pacific Flyway. The wetlands and associated habitat are also important to many threatened and endangered species. Loss of wetlands seriously impacted these species.

Many riparian and upland woodlands were destroyed as communities converted land for agricultural and municipal purposes, and used the trees for lumber and fuel. Many threatened and endangered species habitat had been provided by the woodlands.

Impacts to fishery and wildlife resources in California have been ongoing for over 150 years. A portion of the reduction in resources has occurred due to the construction and operation of the CVP. However, a portion of the reduction in habitat also has occurred due to the construction and operation of other water resource systems such as the SWP, water rights holders projects, and levee systems. The implementation of these water resource projects allowed expansion of irrigated agriculture and municipalities. Because of the vast array of actions over the last century, it is impossible to determine the specific causes and effects of the declining resources with respect to any one factor, such as the CVP. Through the CVPIA, Interior is developing policies and programs to improve environmental conditions that were affected by operations, management, and physical facilities of the CVP. The CVPIA also includes tools to facilitate larger efforts in California to improve environmental conditions in the Central Valley and the San Francisco Bay-Delta system.

CENTRAL VALLEY PROJECT AND STATE WATER PROJECT FACILITIES IN THE CENTRAL VALLEY

Major water resource facilities in the Central Valley are shown in Figure I-1. The CVP facilities include reservoirs on the Trinity, Sacramento, American, Stanislaus, and San Joaquin rivers. Water from the Trinity River is stored and re-regulated in Clair Engle Lake, Lewiston Lake, and Whiskeytown Reservoir, and diverted through a system of tunnels and powerplants into the Sacramento River for use by the CVP in the Central Valley.

Water also is stored and re-regulated in Shasta Lake and Folsom Lake for use by the CVP. Waters from all of these reservoirs, and other reservoirs owned and/or operated by the SWP and local water rights holders, flow into the Sacramento River. Some of the CVP contractors divert water directly from or immediately below the dam outlet works. Other CVP contractors, Sacramento River Water Rights contractors, and water rights holders divert water directly from the Sacramento and American rivers.

FIGURE I-1

MAJOR WATER FACILITIES IN THE CENTRAL VALLEY

Water is conveyed in the Sacramento River to the Delta. The CVP water is exported at the Tracy Pumping Plant in the southern end of the Delta. The Tracy Pumping Plant lifts the water into the Delta Mendota Canal which delivers water to CVP contractors and exchange contractors on the San Joaquin River and water rights contractors on the Mendota Pool. The CVP water also can be conveyed to the San Luis Reservoir for deliveries to CVP contractors that divert from the San Luis Canal. Water from San Luis Reservoir also can be conveyed through the Pacheco Tunnel to CVP contractors in Santa Clara and San Benito counties.

The CVP also serves water from the Friant Dam on the San Joaquin River to CVP contractors located near the Madera and Friant-Kern canals. Water from New Melones Reservoir is used by water rights holders in the Stanislaus River watershed and CVP contractors located in the northern San Joaquin Valley.

The SWP water is stored and re-regulated in Lake Oroville. The SWP contractors and SWP water rights settlement contractors divert water from the Feather River and Sacramento River. The SWP water flows in the Sacramento River to the Delta. The SWP water is exported from the Delta at the Banks Pumping Plant. The Banks Pumping Plant lifts the water into the California Aqueduct which delivers water to SWP contractors. The SWP water also can be conveyed to the San Luis Reservoir for deliveries to SWP contractors that divert from the California Aqueduct. These contractors are located in the southern San Joaquin Valley, Central Coastal area, and Southern California. The SWP also delivers water to the Cross-Valley Canal, when capacity is available in the conveyance systems, for CVP water service contractors.

Because both the CVP and the SWP convey water in the Sacramento River and the Delta, operations of the facilities are coordinated based on the Coordinated Operating Agreement (COA), the Bay-Delta Plan Accord, and other agreements.

In recent years, operations of the CVP and SWP have become more constrained. The CVP and SWP are allowed to export water from the Delta when the upstream water demands are met and the Delta is in a balanced or excess condition with respect to flow and water quality under water rights orders from the State Water Resources Control Board (SWRCB). With the increasing upstream water demands due to municipal growth and recent instream fish flow release requirements, the capability of the CVP and SWP to export water from the Delta has been reduced. The reductions in CVP and SWP deliveries north and south of the Delta due to increased municipal demands and environmental requirements are discussed in more detail in the Pre-CVPIA Conditions Technical Appendix of the PEIS.

AUTHORITIES AND INSTITUTIONAL CONSTRAINTS

Federal statutes establish a number of responsibilities for the Secretary. These legislative authorities relate to management of numerous agencies and projects which affect water resource facilities in California. Many responsibilities are specifically mandated. Discretionary authority is provided for other responsibilities. The authorities for the CVP and other actions that affect implementation of CVPIA are presented in Table I-1.

The constraints of the CVPIA also were recognized as the alternatives were developed in the Draft PEIS. The CVPIA was considered very specifically with respect to the Purpose and Need for the Action to define the reasonable range of alternatives. Actions that extend outside of the CVPIA Purpose and Need and other portions of the law will need to be evaluated under separate environmental documentation.

PREPARATION OF THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

PURPOSE OF THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

This document has been prepared in compliance with section 102(2)(c) of NEPA of 1969 as amended (Public Law 91-190), Council on Environmental Quality Regulations dated November 1978, and the current guidelines of Interior for implementation of NEPA.

Specific actions taken by the Secretary to carry out provisions of the CVPIA may be addressed in future technical and environmental documents and/or analyses. These other technical and environmental documents may incorporate the findings of this PEIS by reference. The coverage of general matters in a broad NEPA document with subsequent narrowly focused documents is referred to as tiering. Tiering will help to eliminate repetitive studies and discussions and allow the project-specific documents to focus on specific issues.

Section 3402 of the CVPIA identifies six general purposes, as described above under the Purpose and Need for the Action. In the remaining sections of the CVPIA, Congress identified actions that taken together would achieve these purposes. If the individual actions are not implemented together, all of these purposes may not be achieved. This document presents a programmatic analysis of alternatives for achieving the purpose of CVPIA. This document does not analyze a number of site-specific impacts of specific actions or actions not addressed in the CVPIA, such as changing flood control operations of reservoirs.

Generic analyses are contained in the PEIS of actions that were authorized under CVPIA, but require additional specificity to fully evaluate the effects. These specific actions, such as water transfers, will need to be evaluated under additional documentation on a case-by-case basis as each transfer is proposed. Other future actions may not require any additional environmental documentation if the potential impacts and benefits are discussed in the PEIS and all potential impacts would occur only at a systemwide or regional level.

TABLE I-1
INVENTORY OF MAJOR AUTHORITIES THAT AFFECT THE CENTRAL VALLEY PROJECT

Law or Agreement	Year	Action on CVP
Reclamation Act	1902	Formed legal basis for subsequent authorization of the CVP
Reclamation Project Act	1939	Provided for repayment of construction charges and authorized sale of CVP water to municipalities and other public corporations and agencies, plant investment, and certain irrigation water deliveries to leased lands.
Rivers and Harbors Act	1940	Authorization of CVP for construction and provision that dams and reservoirs used first for river regulation, improvement of navigation, and flood control; second for irrigation and domestic users; and third for power.
Water Service Contracts	1944	Provided for delivery of specific quantities of irrigation and municipal and industrial water to contractors.
American River Division Authorization Act	1949	Provided for Folsom Dam and Sly Park Dam and associated facilities.
Grasslands Development Act	1954	Provided for wells and drainage recovery facilities. Added authority for use of CVP water for fish and wildlife purposes. Also authorized development of facilities in cooperation with the State for furnishing water to the Grasslands area for waterfowl conservation.
Trinity River Act	1955	Provided for operation of the Trinity River Division to be integrated and coordinated with other CVP features. Included provisions for the preservation and propagation of fish and wildlife.
Reclamation Project Act	1956	Provided a right of renewal of long-term contracts for agricultural contractors for a term not to exceed 40 years.
Fish and Wildlife Coordination Act	1958	Provided for integration of Fish and Wildlife Conservation programs with Federal water resources developments; authorized the Secretary to include facilities to mitigate CVP-induced damages to fish and wildlife resources. Required consultation with the Service.
San Luis Unit Authorization Act	1960	Provided for San Luis Dam and associated facilities.
Rivers and Harbors Act	1962	Provided for New Melones, Hidden, and Buchannan Dams.
Reclamation Project Act	1963	Provided a right of renewal of long-term contracts for municipal and industrial contractors.
Water Rights Contracts	1964	Provided diverters holding riparian and appropriative rights on the Sacramento and American Rivers with CVP water to supplement water which historically would have been diverted from natural flows.
Auburn-Folsom South Unit Authorization Act	1965	Provided for Auburn Dam and associated facilities including Folsom-South Canal.
San Felipe Division Authorization Act	1967	Provided for Pacheco Tunnel and associated facilities.

TABLE I-1. CONTINUED

Law or Agreement	Year	Action on CVP
National Environmental Policy Act	1969	Established policy, set goals, and provided means for ensuring scientific analysis, expert agency participation and public scrutiny and input are incorporated into the decision making process regarding the actions of the Federal agencies.
Council on Environmental Quality Regulations	1970	Provided directives for compliance with NEPA.
State Water Resources Control Board (SWRCB) Decision 1379	1971	Established Delta water quality standards to be met by both the CVP and the State Water Resources Project (SWP).
Clean Water Act	1972 Amended 1987	Provided protection for all surface waters to achieve "fishable and swimmable" goals.
Endangered Species Act	1973	Provided protection for animal and plant species that are currently in danger of extinction (endangered) and those that may become so in the foreseeable future (threatened).
SWRCB Decision 1485	1978	Required CVP and SWP to provide water quality protection in the Delta.
Trinity River Stream Rectification	1980	Provide for participation in stream rectification.
Energy and Water Development Appropriation Act	1980	Provided for energy and water development at New Melones Reservoir and archaeological recovery at the reservoir site.
Suisun Marsh Preservation and Restoration Act	1980	Established a cooperative agreement with State of California to improve and manage Suisun Marsh.
Secretarial Decision on Trinity River Release	1981	Allocated CVP yield so that releases can be maintained at 340,000 acre-feet in normal water years, 220,000 acre-feet in dry years, and 140,000 acre-feet in critically dry years.
	Amended 1991	Release 340,000 acre-feet annually for all water year types.
Reclamation Reform Act	1982	Provided for full-cost pricing, including interest on the unpaid pumping plant investment, for certain irrigation water deliveries to leased lands.
Coordinated Operating Agreement (COA)	1986	Agreement between the U.S. Government and the State of California. Determined the respective water supplies and methods to share conveyance facilities of the CVP and the SWP while allowing for a negotiated sharing of Delta excess outflows and the satisfaction of in-basin obligations between the two projects.
Public Law 99-546	1986	Interior and Reclamation directed to include total costs of water and distributing and servicing it in CVP contracts (both capital and operation and maintenance costs).
SWRCB Orders WR 90-05 and WR 91-01	1990 1991	Water Rights Orders that modified Reclamation water rights to incorporate temperature control objectives in Upper Sacramento River.

TABLE I-1. CONTINUED

Law or Agreement	Year	Action on CVP
National Marine Fisheries Service Biological Opinion	1992 1993 1995	Established criteria for operations to protect winter run chinook salmon.
Public Law 102-575, Title 34	1992	Mandates changes in management of the CVP, particularly for the protection, restoration, and enhancement of fish and wildlife.
Draft Water Rights Decision 1630	1992	SWRCB circulated a draft water rights order to modify Decision 1485 to protect Bay-Delta water quality.
U.S. Fish and Wildlife Service Biological Opinion	1993 1994 1995	Established operational criteria to protect delta smelt.
Bay-Delta Plan Accord and SWRCB Order WR 95-06	1994 1995	Agreement and associated SWRCB order to provide for operations of the CVP and SWP to protect Bay-Delta water quality. Also provided for further evaluation and development of a new Bay-Delta operating agreement which is being pursued under the CALFED process.

Structural actions identified in the CVPIA, such as construction of fish screens, are assumed to be implemented in all alternatives as a method towards furthering the purposes of CVPIA. However, specific design criteria and environmental documentation would be contained in subsequent documentation.

Administrative actions, such as contracting for CVP water throughout the Central Valley, are assumed to continue to occur. The impacts of water availability by region and resultant system-wide impacts from use of the CVP water are presented in this Draft PEIS. Additional documentation would be required for the specific contracting actions.

This document will support the programs for implementation of CVPIA with site-specific decisions to be made in the future after the completion of site-specific environmental documentation. Additional environmental documentation may not be required for changes to CVP operations to minimize flow fluctuations, to provide pulse flows, and to meet overall flow targets if these changes are discussed in the PEIS. Chapter VI contains additional discussion of future documentation.

No action addressed in the CVPIA can be fully implemented until the PEIS is completed and adopted or until appropriate separate documentation is completed. There have been interim implementation programs for some actions addressed in the CVPIA. The interim programs were implemented either to maintain CVP operations or because the program required extensive lead time for the study. The interim implementation programs have been developed through a process which has involved public review and changes in response to the public review. Review of implementation actions under the interim programs has been used in the development of the impact assessment portion of the Draft PEIS. The interim process has addressed implementation programs for the following issues.

- Section 3404 (c) Interim Contract Renewals
- Section 3405 (a) Interim Water Transfers under CVPIA
- Section 3405 (b) Water Measurement
- Section 3405 (e) Water Conservation
- Section 3406 (b)(1) Development of the Anadromous Fish Restoration Program
- Section 3406 (b)(1)(B) Reoperation of the CVP without Affecting Deliveries
- Section 3406 (b)(2) Water Management ("Dedication of 800,000 acre-feet")
- Section 3406 (b)(3) Water Acquisition
- Section 3406 (b)(6) Funding for Shasta Temperature Control Device
- Section 3406 (b)(11) Modification to Coleman National Fish Hatchery
- Section 3406 (b)(12) Clear Creek Restoration
- Section 3406 (b)(20) Modification to Glenn-Colusa Irrigation District Diversion Facility
- Section 3406 (b)(21) Avoidance of juvenile anadromous fish loss at diversions including construction of screens, bypasses, fish ladders, and modification of diversions
- Section 3406 (d)(1-2) Provide Firm Level 2 and Acquire Level 4 Refuge Water Supply Studies
- Section 3408 (h) Land Retirement

Following completion of the PEIS, the implementation plans for these programs will be reviewed to determine if additional environmental documentation will be required.

The Draft PEIS does not include a Preferred Alternative. A Preferred Alternative will be identified in the Final PEIS. It is anticipated that the Preferred Alternative will be selected from the range of actions that are evaluated in the Draft PEIS alternatives. The Draft PEIS alternatives include many separate actions that could be combined into hundreds of permutations. For the Draft PEIS, these actions were combined into alternatives to provide the decision maker with information of how different factors would be affected by changes in fish and wildlife habitat actions, water facilities operations, and water pricing and contract provisions. The alternatives were evaluated in this manner to provide "bookends" to the analysis and to identify the most conservative set of impacts that could occur for the different boundary conditions. Therefore, the decision maker could select the boundary conditions for the Proposed Action from the array of different alternatives evaluated in the Draft PEIS. Another reason that the Draft PEIS alternatives were developed as "bookends" and that the menu approach for defining the Preferred Alternative is appropriate is because many of the programs addressed in CVPIA require partners. If the partners do not willingly participate, the action would not be implemented.

STUDY AREA

The Study Area for the Draft PEIS is presented in Figure I-2. The criteria for defining the Study Area were developed through a public scoping process and included three criteria. The first criterion was to include areas with CVP facilities, CVP water users, or water rights holders affected by CVP operations. This criterion resulted in the incorporation of many counties in California. The CVP facilities and users are located throughout the Central Valley, and in Trinity, Contra Costa, Alameda, Santa Clara, and San Benito counties.

FIGURE I-2
STUDY AREA

The second criterion was to include areas that could be directly impacted by changes in CVP operations or actions implemented under the CVPIA, including the Anadromous Fish Restoration Program (AFRP). This criterion resulted in incorporation of watersheds in the Sacramento and San Joaquin basins and coastal communities affected by commercial fishing of anadromous fish. The eastern boundary of the Study Area was limited to the areas within the watersheds that could be affected by provisions of the CVPIA which was defined as extending from the valley floor to the western boundaries of national forests in the Sierra Nevada Mountains. Lake County was excluded from the Study Area because the area is hydrologically isolated except in extremely wet years when flood waters flow from Clear Lake into the Central Valley. Due to the hydrologic isolation of this basin in all but extremely wet years, this basin was not included in this CVPIA analysis.

The third criterion was to include areas that could be directly impacted by water transfer programs which involve CVP water users or CVP facilities, as allowed by the CVPIA. This criterion resulted in the inclusion of counties in the San Francisco Bay Region, Central Coast Region, and South Coast Region where potential users of transferred water are located. It was assumed for the purposes of this Draft PEIS that no new facilities would be constructed under the actions considered. Therefore, the potential for water transfers was limited by the physical capacity and operation rules.

Not all of the technical evaluations include analyses in the full Study Area. For example, the analysis which involved the South Coast areas was limited to the evaluation of alternative actions that involved water transfers. As another example, analysis of specific factors related to increased instream fish flow releases in the Trinity River were only summarized in the Draft PEIS. A separate technical and environmental document is being prepared that evaluates impacts and benefits within the Trinity River watershed of such actions.

STUDY PERIOD

The analysis for the Draft PEIS was conducted for projected conditions in the Year 2022, or 30 years from the adoption of the CVPIA in October 1992.

PARTICIPANTS IN THE PREPARATION OF THE PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

Reclamation and the U.S. Fish and Wildlife Service (Service) will jointly implement the CVPIA. The Secretary has designated Reclamation as the lead agency in preparing the Draft PEIS. Cooperating agencies were involved in substantial research, data collection, participation in development and evaluation of alternatives, and preparation of the Draft PEIS. The following Cooperating Agencies participated in the process.

- California Department of Fish and Game
- California Department of Water Resources
- California State Water Resources Control Board
- Hoopa Valley Tribe
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency

- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Western Area Power Administration

Consulting Agencies were involved in the development of analytical tools and background information. The following Consulting Agencies participated in the process.

- U.S. Geological Survey
- Natural Resource Conservation Service
- Bureau of Indian Affairs

PUBLIC INVOLVEMENT PROCESS

Reclamation started the preparation of the Draft PEIS during the Scoping phase. Scoping served as a fact-finding process that helped identify public concerns and recommendations about the Draft PEIS process, issues that would be addressed in the Draft PEIS, and the scope and level of detail for analyses. Scoping activities began in January 1993 after a Notice of Intent to prepare the Draft PEIS. Throughout the preparation of the Draft PEIS meetings were held with the Cooperating and Consulting Agencies, other agencies, interest groups, and the public. Issues raised during the public involvement process included geographic scope of the PEIS, level of detail, analytical tools used in impact assessments, definition of the No-Action Alternative and other alternatives, and redefinition of the alternatives in an iterative manner. A more detailed discussion of the public involvement process is provided in Chapter VII of this Draft PEIS.

ORGANIZATION OF THE DRAFT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

The CVPIA contains over 60 individual provisions for which multiple implementation methods were developed during the preparation of the Draft PEIS. The development and evaluation of the options were based upon an analysis of many issues which ranged from biological, physical, economic, and social considerations. Many of these evaluations utilized mathematical models, incorporated extensive information from field observations and literature reviews. The Draft PEIS summarizes the technical information and evaluations. Detailed information concerning the technical analyses are presented in technical appendices.

Three types of technical appendices were prepared as part of the Draft PEIS. One type of technical appendix describes the assumptions that led to development of the No-Action Alternative and other alternatives. A second type of technical appendix was prepared for most of the issue areas considered in the PEIS to present the detailed descriptions of the affected environment and impact analyses. The third type of technical appendix presents the assumptions and analytical approaches of the computer models and spreadsheets used in the analyses. The models or spreadsheets and the input and output data are available electronically.

To further assist the reader in utilizing the technical information, the Draft PEIS also includes a glossary of terms, list of acronyms and abbreviations, and metric conversion factors in

Attachment D. Attachment D also includes a Reader's Guide for interpreting frequency curves that are used in the surface water analyses.

A summary of the organizational structure for the Draft PEIS and technical appendices is presented in Figure I-3.

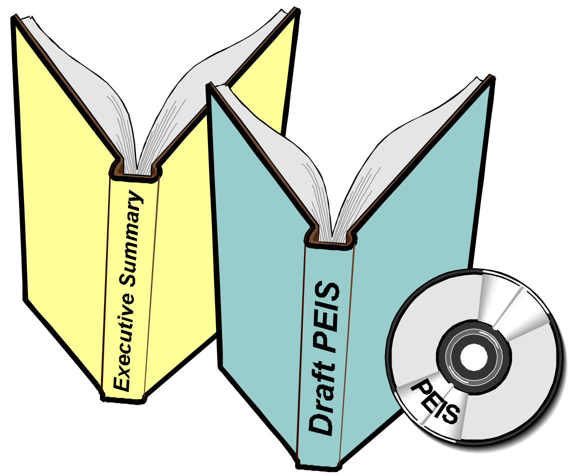
RELATED ACTIVITIES

Due to the extent of the Draft PEIS study area, there are many activities and studies that are currently on-going or planned for the near future that could be affected by the findings of the PEIS or are related actions of the CVPIA. Related studies and projects that have been conducted recently or are currently being completed are summarized in Table I-2.

Preliminary information from these studies has been used to assess cumulative effects of implementing CVPIA and other potential projects in California.

Executive Summary/Draft PEIS

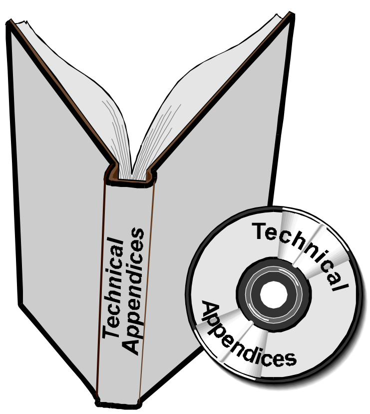
Hardcopy or CD ROM



- Purpose and Need
- Description of Alternatives
- Impact Assessment
- Future "Next Steps"
- Glossary and Other Attachments

Technical Appendices

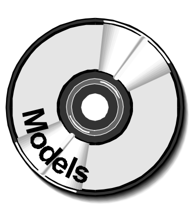
Hardcopy or CD ROM



- Basis for Development of Alternatives
- Detailed Descriptions of Affected Environments and Impact Assessment
- Methodologies Used for Models and Other Analytical Tools

Models Presented on CD-ROM

CD ROM only



- Models and Spreadsheets Used in Impact Assessment
- Data Input Files
- Data Output Files

Note: PEIS documentation is contained in both hardcopy or CD ROM form.

FIGURE I-3

READER'S GUIDE FOR THE DRAFT PEIS

TABLE I-2

RELATED ACTIVITIES

Project or Study and Lead Agency	Summary
Water Rights Process for CVP and SWP - State Water Resources Control Board (SWRCB)	In response to Bay-Delta Plan Accord, SWRCB is evaluating alternatives to Decision 1485 and the Bay-Delta Plan Accord to meet water rights and water quality issues in the Delta by parties that affect the Delta. This process may increase the amount of water provided by other water rights holders to meet Bay-Delta Water Quality Standards, and/or it may change Delta export criteria. Therefore, CVP operations to meet CVPIA actions to protect fish in the streams and the Delta may change. Because the outcome of this study was not known, a conservative assumption was used in the Draft PEIS. It was assumed in the Draft PEIS, that the Bay-Delta Plan Accord criteria would be the long-term plan for the Delta. The SWRCB is completing an Environmental Impact Report (EIR) as part of this process.
CALFED Bay-Delta Program - CALFED	Established in May 1995, the consortium of federal and state agencies is charged with the development of a long-term solution to the Delta water concerns. This process could change the Bay-Delta operations criteria, provide additional conveyance and storage facilities that would effect Delta exports, and identify actions that may need to be met by the CVP and other water rights holders. Because the outcome of this study was not known, a conservative assumption was used in the Draft PEIS. It was assumed in the Draft PEIS, that the Bay-Delta Plan Accord criteria would be the long-term plan for the Delta. CALFED is completing an EIR/EIS as part of this process.
Place of Use EIR for CVP water supplies - Reclamation/SWRCB	Some areas adjacent to the existing CVP service area have been served with CVP water. This process considered the impacts of expanding the SWRCB designated Place of Use for CVP water to include these areas. The SWRCB and Reclamation are preparing the EIR as part of the approval process. The Draft PEIS assumes that this process will be completed by the Year 2022 to include lands currently receiving CVP water.
Refuge Water Conveyance Study - Reclamation	This study identified the need to improve or construct water conveyance facilities to delivery existing water supplies and Level 2 and Level 4 water supplies in accordance with the 1989 Refuge Water Supply Study and the San Joaquin Basin Action Plan. Environmental documentation is being prepared for the facilities. The Draft PEIS assumes that the conveyance facilities will be approved and completed by the Year 2022.
Sacramento River Toxic Pollutant Control Program - SWRCB and Central Valley Regional Water Quality Control Board	Program to reduce pollutants into the Sacramento River, especially metals. This program could improve fishery conditions in the Sacramento River. The Draft PEIS assumes that this program is ongoing in the Year 2022.

TABLE I-2. CONTINUED

Project or Study and Lead Agency	Summary
Iron Mountain Mine Superfund Site - U.S. Environmental Protection Agency (EPA)	Iron Mountain Mine was operated periodically for copper, zinc, gold, and other metals for about 100 years. Acid mine drainage with high metal concentrations flows from the mine into Spring Creek, a tributary to the Sacramento River. In recognition of the threat to water quality, EPA listed the site on the National Priority List in 1983. Remediation of the site is being addressed under the Comprehensive Environmental Response, Compensation, and Liability Act. To date, EPA has issued three Records of Decision for the site and many remedial activities have been undertaken. At this time, Interior has not considered if activities for remediation of Iron Mountain Mine may be addressed through CVPIA activities. The Draft PEIS assumes that remediation will continue and that water quality will improve.
Trinity River Studies - U.S. Fish and Wildlife Service (Service)	In October 1984, the Service began a 12-year study to describe the effectiveness of increased flows and other habitat restoration activities to restore fishery populations in the Trinity River. An EIS/EIR is being prepared under a concurrent program to evaluate alternatives to restore and maintain natural production of anadromous fish in the Trinity River mainstem downstream of Lewiston Dam. Information from this program was used in the Draft PEIS.
2004 Power Marketing Plan - Western Area Power Administration (Western)	Western markets surplus power generated by the CVP to Preference Power Customers. This plan evaluated the availability of surplus CVP power and alternatives to meet the customers demands starting in the Year 2004 when new contracts will be executed. An EIS was prepared as part of this process. The Draft PEIS evaluated programmatic changes in CVP power generation.
State Water Project Supplemental Water Program	This program is to allow the transfer of unused water rights, CVP water contracts, or SWP water entitlements to water users that have an unmet water demand.
Delta Wetlands	This water storage/wetlands restoration project will be developed by a private party. Water would be diverted from the Delta and stored within several Delta islands. The project also will include restoration of several other islands to provide mitigation for lost habitat on flooded islands. This project would require a change in water rights and therefore, approval by the SWRCB. The SWRCB is preparing an EIR as part of the approval process. This program is not included in the Draft PEIS alternatives.

CHAPTER II

DESCRIPTION OF ALTERNATIVES

Chapter II

DESCRIPTION OF ALTERNATIVES

This chapter presents a description of the alternatives considered in the Draft PEIS and a summary of the impact assessment.

DEVELOPMENT OF ALTERNATIVES

Alternatives considered in the PEIS were developed by Reclamation, the Service, and cooperating agencies through an extensive scoping effort and a three-phase screening process. The process is described in more detail in the Evaluation of Preliminary Alternatives Technical Appendix.

The CVPIA included provisions for supporting studies, such as evaluation of future actions to increase CVP firm yield. These provisions were not included in the Draft PEIS alternatives. As the studies progress, future environmental documents will be completed to analyze potential benefits and impacts.

The CVPIA also included provisions for programs that could be evaluated in a programmatic, or regional basis, without completing extensive studies. The following provisions were considered in the development of Draft PEIS alternatives.

- Anadromous Fish Restoration Program with flow and non-flow restoration methods, and fish passage improvements
- Preliminary Trinity River Fish and Wildlife recommendations
- Reliable Water Supply Program for Refuges and Wetlands identified in 1989 Refuge Water Supply Study and the San Joaquin Basin Action Plan
- Protection and restoration program for native species and associated habitats
- Land Retirement Program for Willing Sellers for land characterized by poor drainage
- CVP Water Contract Provisions for contract renewals, water pricing, water metering/monitoring, water conservation methods, and water transfers

Implementation methods were considered for actions within each of these programs at a programmatic level. The alternatives also were developed based upon the definition of the No-Action Alternative, as described below.

DEFINITION OF THE NO-ACTION ALTERNATIVE

The No-Action Alternative is used as a basis for comparison of other alternatives. The No-Action Alternative includes projects and policies that would either be impacted by the CVPIA or that would impact implementation of the CVPIA.

The No-Action Alternative reflects conditions in the Year 2022 if CVPIA had not been adopted and includes existing facilities and land uses. In addition, the No-Action Alternative includes projections concerning future growth, land use changes, and changes in CVP operational policies which are being considered and have undergone separate environmental documentation. The No-Action Alternative also included assumptions concerning concurrent but separate issues, such as the assumption that ocean harvest limitations for sport and commercial salmon fishing would be consistent with 1992 policies and will be evaluated in a separate process by NMFS and other groups. Another assumption included in the No-Action Alternative that is being addressed under a separate program is the U.S. Department of Agriculture farm commodities program. The No-Action Alternative assumed that the program would not vary from 1992 policies.

The No-Action Alternative included assumptions for:

- ♦ Physical features
- ♦ Operations
- ♦ Water contracts
- ♦ Central Valley Project Conservation Program

ASSUMPTIONS FOR PHYSICAL FEATURES UNDER THE NO-ACTION ALTERNATIVE

Existing physical features of the CVP constitute the starting point for defining the No-Action Alternative. The No-Action Alternative also includes projects that would have been implemented without adoption of the CVPIA. The criteria for inclusion of the future facilities in the No-Action Alternative were if the project had: 1) authorization and funding for design; 2) final environmental documents, permits, and approvals; and 3) initial authorization and funding for construction without CVPIA. Future facilities in the No-Action Alternative included the Shasta Temperature Control Device, the SWP Coastal Aqueduct, the Metropolitan Water District of Southern California Eastside Reservoir, and the Contra Costa Water District Los Vaqueros Reservoir. All of these facilities were under construction during the preparation of the PEIS.

ASSUMPTIONS FOR OPERATIONS UNDER THE NO-ACTION ALTERNATIVE

The operational and regulatory policies and assumptions included in the No-Action Alternative are presented in Table II-1. Some of the policies were being developed prior to the adoption of CVPIA. The No-Action Alternative includes assumptions of the results of the ongoing evaluation processes for these polices. For example, the No-Action Alternative includes assumptions for implementation of the Bay-Delta Plan Accord. Policies in the No-Action Alternative that are different than what was considered as "existing conditions" are noted in

TABLE II-1

OPERATIONS, POLICIES, AND REGULATORY REQUIREMENTS ASSUMED IN THE NO-ACTION ALTERNATIVE

Issue or Policy	Description	Change from pre-CVPIA Conditions
Acreage Limitations in Contracts	Existing acreage limitation regulations adopted to implement Reclamation Reform Act of 1982.	No Change
Central Valley Project Operations	Continued operations as presented in CVP-OCAP 1992 and other operational procedures for CVP, adjusted for biological opinions and water quality standards. (Biological opinions (May 1995) for winter-run chinook salmon and delta smelt. Bay-Delta Plan Accord and SWRCB Order 95-06.)	The process that led to biological opinions and the Bay-Delta Planning process had started before passage of CVPIA.
Contract Amounts for CVP (including shortage criteria)	Contracts would be renewed, per 1956 and 1963 acts, prior to Year 2022, including contracts with CVP and DWR associated with the Cross-Valley Canal. *Maximum contract amount:* Not to exceed existing contract amounts. Water deliveries not to exceed capacity of existing conveyance facilities. *Agricultural Water Service Contracts, Water Rights Contracts, and Exchange Contracts:* CVP water deliveries limited by maximum use between 1980 and 1993, projected use as addressed in environmental documentation; or maximum contract amount, whichever is less. Shortage Criteria per OCAP. *Municipal and Industrial Water Service Contracts:* Total demand based upon 2020 demands in DWR Bulletin 160-93. CVP water deliveries limited by: a) maximum use between 1980 and 1993, b) projected use as addressed in environmental documentation, or c) maximum contract amount, whichever is less. Shortage Criteria with maximum shortage of 25%. *Refuges:* Delivery of Level 1 and Level 2 water supplies by existing suppliers. Shortage Criteria for CVP supplies per Shasta Index.	No Change Consistent with recent policies for refuge water deliveries
CVP Conservation Program	A long-term adaptive management program to address biological needs of special-status species, with an emphasis on habitat in areas affected by the CVP.	Discussions were started independent of CVPIA
Coordinated Operations of CVP and SWP	Based upon Coordinated Operations Agreement framework with additional assumptions to implement new provisions of Bay-Delta Plan.	Changes due to implementation of Bay-Delta Plan.
Delta Factors	Continued use of seasonal barriers at Old River and continued operation of Delta Cross Channel gates.	No Change
Land Retirement	Retirement of 45,000 acres between 1992 and 2022 under existing State of California land retirement programs, per DWR Bulletin 160-93.	No Change, program had started in 1992

TABLE II-1. CONTINUED

Issue or Policy	Description	Change from pre-CVPIA Conditions
Minimum Instream Flow Requirements for CVP Facilities	*Sacramento River:* Per SWRCB Order 91-01 and the Winter-Run Chinook Salmon Biological Opinion. *American River:* Per Modified SWRCB D-1400 strategy of CVP operations with a fixed amount of flood control storage under the Corps of Engineers interim requirements.	Sacramento and American Rivers: Process that led to biological opinions and flood control criteria had started before passage of CVPIA
	Stanislaus River: Per SWRCB D-1422, including water quality standards on the San Joaquin River at Vernalis and dissolved oxygen requirements at Ripon; and 155,700 af/yr in all years but Critical Dry Years, then 98,300 af/yr per initial studies conducted under the 1987 agreements with DFG and the Service.	Stanislaus River: No Change, however, annual operations in the late 1980s different due to drought
	Trinity River: Per Secretary's 1991 Decision (340,000 af/yr in all years).	No Change
Shortage Criteria for State Water Project	Monterey Agreement provisions for SWP.	Completed during preparation of PEIS
Non-CVP Water Users	Use water demands in DWR Bulletin 160-93.	No Change
Power Marketing	Existing Agreement between United States and PG&E would not be renewed. Project Use load met at all times.	Discussions were started independent of CVPIA
Red Bluff Diversion Dam Gate Closure	Mid-May through mid-September per winter run chinook salmon biological opinion	Discussions were started independent of CVPIA
Tracy Direct Loss Mitigation Agreement	Reduces and offsets direct loss of fish associated with operations of the Tracy Pumping Plant and Fish Facility	No Change
Water Conservation	Water conservation levels based on assumptions presented in DWR Bulletin 160-93 for all water users, plus requirements by 1982 Reclamation Reform Act for CVP contractors.	No Change
CVP Ratesetting and Water Pricing	Existing ratesetting and cost-allocation policies, and ability-to-pay policies per Reclamation Mid-Pacific Region Policies, including 1988 policies, and Reclamation Reform Act draft rules and regulations.	No Change
Water Transfers	CVP water can be transferred within CVP water service contractors, SWP water can be transferred per the Monterey Agreement, and water rights holders can transfer water under SWRCB guidelines.	No Change
Water Rights	Total water rights would be delivered in all water year types without shortages even if water rights had not been fully utilized under pre-CVPIA conditions.	No Change

Table II-1. The policies and facilities included in the No-Action Alternative are described in more detail in the Development of the No-Action Alternative Technical Appendix and the Pre-CVPIA Conditions Technical Appendix.

The CVP facilities operations in the No-Action Alternative are in accordance with the Long-Term CVP Operations Criteria and Plan (CVP-OCAP), Reclamation's Mid-Pacific Region guidelines, the National Marine Fisheries Service (NMFS) biological opinion for winter-run chinook salmon, the Service's biological opinion for Delta smelt, and the Bay-Delta Plan Accord. Due to the coordinated nature of operations of the CVP and the SWP, some policies apply to both the CVP and SWP, such as implementation of the Bay-Delta Plan Accord.

Non-CVP facilities operations in the No-Action Alternative are in accordance with existing operational policies as defined by the SWP, Corps of Engineers, State Water Resources Control Board (SWRCB), and the Federal Energy Regulatory Commission (FERC).

Some of the operational policies included in the No-Action Alternative were developed prior to more recent policies, therefore potential conflicts occur. For example, the Coordinated Operation Agreement (COA) was adopted in 1986. The COA includes formulas to define how much water the CVP and the SWP can export from the Delta. As the Bay-Delta Planning process proceeds, portions of the COA will incorporate new standards. However, for the purposes of the Draft PEIS, it is assumed that the agreements established by the COA would be similar to future agreements with changes incorporated to reflect Delta export operations. Additional information concerning how operational policies were interpreted for the No-Action Alternative are included in Attachment G of the Draft PEIS.

WATER CONTRACT AMOUNT ASSUMPTIONS UNDER THE NO-ACTION ALTERNATIVE

The long-term contract renewal process was initiated in 1989 due to the expiration of Friant Unit water service contracts. Pursuant to the 1956 and 1963 Reclamation Acts, the CVP water service contractors had the right to renew existing contracts. Over 67 contracts expired between 1993 and 1997. However, due to the passage of CVPIA, only short-term interim contract renewals can occur until all appropriate NEPA documentation is completed.

The contract amounts will be determined in the contract renewal process through comparison of beneficial uses for CVP water, economic potential for CVP contract repayment, and potential for water conveyance. During the contract renewal process, a needs analysis to determine beneficial use of the CVP water will be completed. All contract renewal amounts will be subject to review under the NEPA process. A site-specific assessment to determine potential impacts of using CVP water on Federally and State listed and proposed species also will be completed. During the NEPA review process, the public will have the opportunity to evaluate and provide input with respect to the beneficial use of CVP water. This type of review is also provided for municipalities through the review of environmental documentation for general plans, specific community plans, and water supply master plans.

For the purposes of the PEIS, it was assumed that the contract amounts in the Draft PEIS alternatives would not be greater than existing contract amounts. To increase the contract amounts will require additional site-specific environmental and technical documentation. However, it was necessary to estimate potential need without completing contract-specific needs analyses. The maximum amount of CVP water delivered for each long-term CVP water service contractor was compared to the contract amount. Historic use during the period of 1980 through 1993 was used for this analysis because delivery amounts were consistently available for all contractors and other water users served by the CVP during this period.

If the maximum amount delivered during this period was equal to the maximum contract amount, the maximum contract amount was assumed for the Draft PEIS analysis. If the maximum amount delivered was less than the contract amount, then the following criteria were used to determine the contract amounts to be used in the Draft PEIS.

- ♦ **Criteria 1:** If an environmental document had been completed that evaluated the impacts of using CVP water, and conveyance capacity was available to deliver the CVP water to the agency boundary, then the contract amount assumed in the environmental documentation or the conveyance capacity, whichever was less, was used in the Draft PEIS analysis. The maximum historic use was not considered in the analysis. This type of analysis was only available for municipalities that had environmental documentation for land use plans, as shown in the following examples. The assumed contract amount did not exceed existing contract amounts.

Example 1:

Maximum Contract Amount	= 10,000 acre-feet
Maximum Historic Use	= 7,000 acre-feet
Maximum Conveyance Capacity from CVP Supplies	= 10,000 acre-feet
Amount Assumed in General Plan Environmental Documents	= 10,000 acre-feet
AMOUNT ASSUMED IN PEIS	= 10,000 ACRE-FEET

Example 2:

Maximum Contract Amount	= 10,000 acre-feet
Maximum Historic Use	= 2,000 acre-feet
Maximum Conveyance Capacity from CVP Supplies	= 5,000 acre-feet
Amount Assumed in General Plan Environmental Documents	= 5,000 acre-feet
AMOUNT ASSUMED IN PEIS	= 5,000 ACRE-FEET

Example 3:

Maximum Contract Amount	= 10,000 acre-feet
Maximum Historic Use	= 10,000 acre-feet
Maximum Conveyance Capacity from CVP Supplies	= 15,000 acre-feet
Amount Assumed in General Plan Environmental Documents	= 15,000 acre-feet
AMOUNT ASSUMED IN PEIS	= 10,000 ACRE-FEET

♦ **Criteria 2:** If the maximum historical amount was less than the contract amount, and if an environmental document had not been completed that evaluated the impacts of using CVP water, then the contract amount was assumed to be the maximum historical amount, as shown in the following example. This criteria was used primarily for agricultural areas because they did not have environmental documentation and agricultural water supplies were not addressed in the county general plans. This criteria also was used for municipalities that had not completed environmental documentation, including documentation for conveyance facilities.

Example:

Maximum Contract Amount	= 10,000 acre-feet
Maximum Historic Use	= 7,000 acre-feet
Maximum Conveyance Capacity from CVP Supplies	= 7,000 acre-feet
Amount Assumed in General Plan Environmental Documents	= No Document
AMOUNT ASSUMED IN PEIS	= 7,000 ACRE-FEET

The contract amounts assumed in the No-Action Alternative and all PEIS alternatives are presented in Table II-2.

The CVP contract amount assumptions were developed only for use in the Draft PEIS. Reclamation intends to deliver the full CVP water contract amount consistent with hydrologic conditions and regulatory and environmental requirements. The specific allocations under a CVP water service contract in the Draft PEIS would not inhibit or contribute in any way to the contractors' ability to develop projects to take delivery of full contract amounts prior to contract renewal.

The Draft PEIS provides an indication of the amount of water available to deliver for contract under different operational and hydrological assumptions. All decisions concerning CVP contract renewal amounts would not be based upon the findings of the PEIS, but rather upon project-specific contract renewal environmental documentation. In those documents, all contractors would be considered equally within their appropriate type of contract.

The Draft PEIS analysis also assumes the normal monthly operations of the Central Valley water resources facilities over the historic hydrological period of 1922 through 1991 for use in the hydrologic model simulations. Emergency operations of individual facilities, such as might occur after a major contaminant spill in the Delta or a levee failure, or the incidents of peak hourly flow conditions were not considered in the Draft PEIS. Therefore, actual annual contract deliveries may vary from patterns evaluated in the Draft PEIS.

The No-Action Alternative assumptions also address water deliveries to the refuges. The water is supplied from historical water suppliers, which include the CVP, SWP, tailwater return flows from upstream water users, and water rights holders. The delivery amounts assumed in the No-Action Alternative for the refuges and wetlands considered in the PEIS are shown in Table II-3. The refuges and wetlands considered in the PEIS are limited to those identified in the CVPIA as

TABLE II-2

CVP CONTRACT AMOUNT AND DIVERSION OBLIGATION ASSUMPTIONS USED IN THE PEIS ALTERNATIVES

Water Users	Existing Contract Amounts (1,000 acre-feet)	Amounts in Draft PEIS (1,000 acre-feet)
North of the Delta		
CVP Agricultural Water Service Contractors	570	480
Sacramento River Water Rights Contractors	1,940	1,870
CVP Municipal/Industrial Water Service Contractors	540	260
Municipal/Industrial Water Rights Holders	530	530
Water Service Contractors and Water Rights Holders that use Stoney Creek	4	4
Water Service Contractors that use Sly Park and Sugar Pine Units	26	26
South of the Delta		
CVP Agricultural Water Service Contractors	1,980	1,980
San Joaquin River Exchange Contractors	880	880
CVP Municipal/Industrial Water Service Contractors	160	160
Water served from the Stanislaus River		
CVP Water Service Contractors with firm water supply	49	49
CVP Water Service Contractors with interim water supply	106	106
CVP Water Rights Holders served at Goodwin Dam	600	600
Other Riparian Water Rights Holders	48	48
Friant Division		
Madera Canal Water Service Contractors	490	490
Buchanan and Hidden Unit Water Service Contractors	50	50
CVP Friant-Kern Canal Agricultural Water Service Contractors (includes Class I and Class II waters)	1,720	1,720
CVP Friant-Kern Canal Municipal/Industrial Water Service Contractors	65	65

NOTE:
Refuge water supply contracts presented in Tables II-3, II-6, and II-7

TABLE II-3

REFUGE WATER SUPPLIES IN THE NO-ACTION ALTERNATIVE

Refuge	Refuge Water Deliveries at Refuge Boundary Plus Conveyance Losses (in 1,000 acre-feet)
SACRAMENTO VALLEY REFUGES	
Sacramento National Wildlife Refuge	46.4
Delevan National Wildlife Refuge	20.9
Colusa National Wildlife Refuge	25.0
Sutter National Wildlife Refuge (1)	23.5
Gray Lodge Wildlife Management Area (1)	35.4
Total for Sacramento Valley Refuges	**151.2**
SAN JOAQUIN VALLEY REFUGES	
San Luis National Wildlife Refuge	25.3
Kesterson National Wildlife Refuge	10.0
Volta Wildlife Management Area	13.0
Los Banos Wildlife Management Area	16.7
San Joaquin Basin Action Lands	
Freitas	5.3
West Gallo	10.8
Salt Slough	6.0
China Island	0.0
East Gallo	0.0
Grasslands Resource Conservation District	47.8
Mendota National Wildlife Refuge	18.5
Merced National Wildlife Refuge (1)	20.0
Kern National Wildlife Refuge	10.0
Pixley National Wildlife Refuge	0.0
Total for San Joaquin Valley Refuges	**183.4**
TOTAL FOR ALL REFUGES	**334.6**

NOTE:
Values based upon values in 1989 Refuge Water Supply Study and San Joaquin Basin Action Plan.
Values have been subsequently modified to reflect more recent data.
All values in 1,000 acre-feet.
(1) Water provided by non-CVP sources.

the refuges addressed in the 1984 Refuge Water Supply Study and the San Joaquin Basin Action Plan.

CENTRAL VALLEY PROJECT CONSERVATION PROGRAM

The No-Action Alternative will include the CVP Conservation Program (Conservation Program), a long-term management program to address the biological needs of special-status species in the areas affected by the CVP. This program is currently being implemented by Reclamation and the Service. The special-status species include federally listed species; in addition, species that are candidates or are proposed species for Federal listing as well as other species of concern may benefit from the Conservation Program if they have high-priority biological needs. The Conservation Program will implement an aggressive, adaptive management program to protect, restore, and enhance these species and the ecosystems which support them throughout the Central Valley of California and other areas where CVP water is delivered. Reclamation and the Service expect the long-term implementation of the Conservation Program to be accomplished through partnerships with other programs that can contribute to and share goals of the Conservation Program. Considerable public involvement in refining, developing, and implementing the program is envisioned. The objectives of the Conservation Program are listed below.

- Address the needs of special-status species in an ecosystem-based manner
- Assist in the conservation of biological diversity
- Improve overall conditions for these species

Meeting these objectives would enhance the overall quantity and quality of habitat and populations of special-status species throughout the Central Valley and help ensure that current and future operations of the CVP will not jeopardize the existence of any species.

Initially, the Conservation Program will address the high-priority needs of special-status species identified during recent consultations under Section 7 of the Endangered Species Act for CVP short-term interim contract renewals. The initial list includes actions presented in Attachment H of the PEIS, such as the establishment of additional wild populations of the riparian bush rabbit in the San Joaquin Valley by protection of habitat; increasing areas of flood refuges; establishing a working fire management plan; and management of wetland, riparian, and grassland mosaic ecosystem habitats. A preliminary list of species and actions is included in Attachment H of the PEIS; it will be modified as new scientific information becomes available, specific actions are completed, and the public has an opportunity to provide input.

The Conservation Program will benefit special-status species in the areas affected by the CVP through the following actions.

- Addressing the biological needs of priority special-status species through land acquisition, management, restoration, and monitoring

- Conducting studies to determine critical life requisites, habitat needs, and other relevant information (such as minimum viable population analysis)

DEFINITION OF PEIS ALTERNATIVES

The alternatives were developed to evaluate a range of actions, or programs, to meet the objectives of CVPIA and implement provisions of CVPIA. Different actions were added to the PEIS alternatives to represent a matrix of proposed actions. Table II-4 displays the alternatives and what follows is a description of the actions. For some programs, several implementation methods were identified which resulted in different benefits and impacts at a programmatic level. For other actions, differences in implementation methods could not be discerned at a programmatic level. However, differences could occur at a site-specific level. For example, fish protection facilities at a specific diversion would result in a reduction in mortality at a programmatic level. However, the design and siting criteria would need to be examined at a site-specific level to determine specific benefits and impacts. For this type of program, a single implementation method was considered in the PEIS. Additional engineering, economic, and environmental analyses would be considered before site-specific projects are implemented. The programs that only had one implementation method at a programmatic level were included in all alternatives as "core programs." The following Core Programs are included in the alternatives.

- Renew all CVP service, water rights, and exchange contracts
- Implement water measurement
- Implement (b)(1) “other” program
- Upgrade Tracy and Contra Costa pumping plants fish protection facilities
- Construct Shasta Temperature Control Device
- Complete improvements to Coleman National Fish Hatchery
- Implement Non-Flow Stream Restoration Actions in Central Valley streams
- Complete modifications to Anderson-Cottonwood Irrigation District and Glenn-Colusa Irrigation District diversion facilities for fish protection
- Implement Seasonal Field Flooding
- Increase instream Fish Flow releases in Trinity River
- Purchase 30,000 acres of retired land

Actions with multiple implementation methods formed the basis for differentiating the alternatives. The multiple implementation methods were combined into four Alternatives and 15 Supplemental Analyses. The Alternatives represented specific assumptions for well-defined multiple implementation methods. The Supplemental Analyses represented the differences between more general assumptions for less defined implementation methods. The Supplemental Analyses were attached to the alternatives to provide additional comparisons with Alternatives 1,2, 3, and 4. Six of the Supplemental Analyses were developed specifically as alternatives to evaluate water transfer opportunities under CVPIA provisions. The following actions were considered in multiple implementation methods.

- Implement Fish and Wildlife actions per Sections 3406(b)(2) and (3) of CVPIA
- Provide Level 2 and Level 4 refuge water supplies
- Implement water pricing actions
- Modify Red Bluff Diversion Dam
- Construct Delta Fish Barriers
- Provide for water transfers
- Revegetate retired lands

TABLE II-4

SUMMARY OF ASSUMPTIONS FOR CVPIA PROVISIONS IN THE NO-ACTION ALTERNATIVE AND PEIS ALTERNATIVES

	Contract Renewals (3404(c)) Core Program	Water Transfer Actions (3405(a)) Core Program	Water Measurement (3405(b)) Core Program	Water Pricing Actions (3405(d)) Core Program	Water Conservation (3405(e)) Core Program	Reoperation and (b)(2) Water (3406(b)(1 & 2)) Multiple Option Program	Water Acquisition for Streams (3406(b)(3)) Multiple Option Program	"(b)(1) Other" Program (3406(b)(1)) Core Program	Delta Actions(3406(b) (4-5 & 14-15)) Multiple Option Program	Shasta Temperature Control Device (3406(b)(6)) Core Program	Red Bluff Diversion Dam Operations (3406(b)(10)) Multiple Option Program	Non-flow Stream Restoration Actions (3406(b)(11 -13, 17, 20, & 21)) Core Program	Seasonal Field Flooding (3406(b)(22)) Core Program	Increased Releases for Trinity River (3406(b)(23)) Core Program	Refuge Water Supplies (3406(d)(1-2)) Multiple Option Program	Land Retirement (3408(h)) Core Program
No-Action Alternative	All Contracts Renewed	Only non-CVPIA transfers occur (see text for description)	Per Reclamation Reform Act	Per Reclamation Reform Act	Per Reclamation Reform Act with Phased Implementation of Best Management Practices	Not Included (Bay-Delta Plan Accord included)	Not Included	Not Included	Not Included	Funded by Non-CVP Funds	Gates opened mid-September through mid-May	Not Included	Not Included	Not IncludedMinimum of 340,000 af/year	Level 2 provided by historical supplies with frequent shortages	No Land Retirement Program funded with CVP funds
Alternative 1	Same as No-Action Alternative	Same as No-Action Alternative	Evaluate Measurement at Point of Diversion and at Point of Use	Tiered Pricing: 80% @ Contract Rate, 10% @ Full Cost, 10% @ Blended Rate with Ability-to-Pay	Per Reclamation Reform Act and Implementation of All Best Management Practices	Bay-Delta Plan Component and Instream Component	Same as No-Action Alternative	Implement Habitat Improvements (See Text for Description)	No Structural Improvements for the Old River Barrier and Georgiana Slough	Funded by Restoration Funds and Non-CVP Funds	Same as No-Action Alternative	Habitat Restoration on many Central Valley Streams	Incentive Payments to Seasonally Flood up to 80,000 acres/year	Increased Stream Release up to 750,000 af/year	CVP provides Level 2 with shortage criteria equal per Shasta Index with maximum shortage of 25%	Retire up to 30,000 acres of lands with drainage problems with no Formal Revegetation Plan
Supplemental Analysis 1a	Same as No-Action Alternative	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Bay-Delta Plan Component, Instream Component, and Delta Component	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Supplemental Analysis 1b	Same as No-Action Alternative	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Structural Improvements for the Old River Barrier and Georgiana Slough	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

TABLE II-4. CONTINUED

	Contract Renewals (3404(c)) Core Program	Water Transfer Actions (3405(a)) Core Program	Water Measurement (3405(b)) Core Program	Water Pricing Actions (3405(d)) Core Program	Water Conservation (3405(e)) Core Program	Reoperation and (b)(2) Water (3406(b)(1 & 2)) Multiple Option Program	Water Acquisition for Streams (3406(b)(3)) Multiple Option Program	"(b)(1) Other" Program (3406(b)(1)) Core Program	Delta Actions(3406(b) (4-5 & 14-15)) Multiple Option Program	Shasta Temperature Control Device (3406(b)(6)) Core Program	Red Bluff Diversion Dam Operations (3406(b)(10)) Multiple Option Program	Non-flow Stream Restoration Actions (3406(b)(11 -13, 17, 20, & 21)) Core Program	Seasonal Field Flooding (3406(b)(22)) Core Program	Increased Releases for Trinity River (3406(b)(23)) Core Program	Refuge Water Supplies (3406(d)(1-2)) Multiple Option Program	Land Retirement (3408(h)) Core Program
Supplemental Analysis 1c	Same as No-Action Alternative	Same as No-Action Alternative	Same as Alternative 1	Tiered Pricing: 80% @ Full Cost, 10% @ 110% Full Cost, 10% @ 120% Full Cost with Ability-to-Pay	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Supplemental Analysis 1d	Same as No-Action Alternative	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	CVP provides Level 2 all years without shortages	Same as Alternative 1
Supplemental Analysis 1e	Same as No-Action Alternative	Water Transfers without Additional Transfer Fees	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Supplemental Analysis 1f	Same as No-Action Alternative	Water Transfers with $50/af Additional Transfer Fees	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Supplemental Analysis 1g	Same as No-Action Alternative	Same as No-Action Alternative	Same as Alternative 1	Tiered Pricing: as in Alternative 1 without Ability-to-Pay	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1

TABLE II-4. CONTINUED

	Contract Renewals (3404(c)) Core Program	Water Transfer Actions (3405(a)) Core Program	Water Measurement (3405(b)) Core Program	Water Pricing Actions (3405(d)) Core Program	Water Conservation (3405(e)) Core Program	Reoperation and (b)(2) Water (3406(b)(1 & 2)) Multiple Option Program	Water Acquisition for Streams (3406(b)(3)) Multiple Option Program	"(b)(1) Other" Program (3406(b)(1)) Core Program	Delta Actions(3406(b) (4-5 & 14-15)) Multiple Option Program	Shasta Temperature Control Device (3406(b)(6)) Core Program	Red Bluff Diversion Dam Operations (3406(b)(10)) Multiple Option Program	Non-flow Stream Restoration Actions (3406(b)(11 -13, 17, 20, & 21)) Core Program	Seasonal Field Flooding (3406(b)(22)) Core Program	Increased Releases for Trinity River (3406(b)(23)) Core Program	Refuge Water Supplies (3406(d)(1-2)) Multiple Option Program	Land Retirement (3408(h)) Core Program
Supplemental Analysis 1h	Same as No-Action Alternative	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Retire up to 30,000 acres of lands with drainage problems using Restoration Funds for Revegetation Program
Supplemental Analysis 1i	Same as No-Action Alternative	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Gates open all year	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Alternative 2	Same as No-Action Alternative	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Acquire 60,000 af on Stanislaus and Tuolumne Rivers, each, and 50,000 af on Merced River. Do not Export Acquired Water	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	CVP provides Level 2 with shortage criteria per Shasta Index & acquires Level 4 supplies with shortages per water supply	Same as Alternative 1
Supplemental Analysis 2a	Same as No-Action Alternative	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1	Structural Improvements for the Old River Barrier and Georgiana Slough	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1
Supplemental Analysis 2b	Same as No-Action Alternative	Water Transfers without Additional Transfer Fees	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1

TABLE II-4. CONTINUED

	Contract Renewals (3404(c)) Core Program	Water Transfer Actions (3405(a)) Core Program	Water Measurement (3405(b)) Core Program	Water Pricing Actions (3405(d)) Core Program	Water Conservation (3405(e)) Core Program	Reoperation and (b)(2) Water (3406(b)(1 & 2)) Multiple Option Program	Water Acquisition for Streams (3406(b)(3)) Multiple Option Program	"(b)(1) Other" Program (3406(b)(1)) Core Program	Delta Actions(3406(b) (4-5 & 14-15)) Multiple Option Program	Shasta Temperature Control Device (3406(b)(6)) Core Program	Red Bluff Diversion Dam Operations (3406(b)(10)) Multiple Option Program	Non-flow Stream Restoration Actions (3406(b)(11 -13, 17, 20, & 21)) Core Program	Seasonal Field Flooding (3406(b)(22)) Core Program	Increased Releases for Trinity River (3406(b)(23)) Core Program	Refuge Water Supplies (3406(d)(1-2)) Multiple Option Program	Land Retirement (3408(h)) Core Program
Supplemental Analysis 2c	Same as No-Action Alternative	Water Transfers with $50/af Additional Transfer Fees	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1
Supplemental Analysis 2d	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Tiered Pricing: As in Supplementa l Analysis 1c	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1
Alternative 3	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Acquire 200,000 af on Stanislaus, Tuolumne, and Merced Rivers, each; 30,000 af on Calaveras River; 70,000 af on Mokelumne River; and 100,000 af on Yuba River. Can Export Acquired Water.	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1
Supplemental Analysis 3a	Same as No-Action Alternative	Water Transfers without Additional Transfer Fees	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 3	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as No-Action Alternative	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 2	Same as Alternative 1

TABLE II-4. CONTINUED

	Contract Renewals (3404(c)) Core Program	Water Transfer Actions (3405(a)) Core Program	Water Measurement (3405(b)) Core Program	Water Pricing Actions (3405(d)) Core Program	Water Conservation (3405(e)) Core Program	Reoperation and (b)(2) Water (3406(b)(1 & 2)) Multiple Option Program	Water Acquisition for Streams (3406(b)(3)) Multiple Option Program	"(b)(1) Other" Program (3406(b)(1)) Core Program	Delta Actions(3406(b) (4-5 & 14-15)) Multiple Option Program	Shasta Temperature Control Device (3406(b)(6)) Core Program	Red Bluff Diversion Dam Operations (3406(b)(10)) Multiple Option Program	Non-flow Stream Restoration Actions (3406(b)(11 -13, 17, 20, & 21)) Core Program	Seasonal Field Flooding (3406(b)(22)) Core Program	Increased Releases for Trinity River (3406(b)(23)) Core Program	Refuge Water Supplies (3406(d)(1-2)) Multiple Option Program	Land Retirement (3408(h)) Core Program
Alternative 4	**Same as No-Action Alternative**	**Same as No-Action Alternative**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 1**	**Bay-Delta Plan Component, Instream Component, and Delta Components**	**Same as Alternative 3Do not Export Acquired Water**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as No-Action Alternative**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 2**	**Same as Alternative 1**
Supplemental Analysis 4a	**Same as No-Action Alternative**	**Water Transfers without Additional Transfer Fees**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 4**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as No-Action Alternative**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 1**	**Same as Alternative 2**	**Same as Alternative 1**

This section describes the implementation methods included in the Core Programs and in the alternatives. The following section of this chapter compares the structure of the Draft PEIS alternatives and how the decision maker could use the alternatives to make a decision and implement the next steps.

CORE PROGRAMS INCLUDED IN ALL ALTERNATIVES

The Core Programs are implemented in the same manner in all Alternatives and Supplemental Analyses. Several of the Core Programs included actions that were initiated prior to implementation of the CVPIA but were not completed at the time of the PEIS preparation. For these programs, preliminary information was used to develop the assumptions. The Core Programs are listed in Table II-5. Details for three of these programs, Implementation of the (b)(1) "other" Program, Increased Instream Fish Flow Releases on the Trinity River, and Land Retirement are provided separate from other programs presented in Table II-5. As the Core Programs are implemented, the actions will require additional technical and environmental analyses and evaluation by the public and interest groups.

Implementation of the (b)(1) "other" Program

In addition to the needs of specific fish and migratory waterfowl addressed in other portions of the CVPIA, Reclamation and the Service also would address the needs of other species that may have been adversely affected by construction and operation of the CVP. The (b)(1) "other" Program would make all reasonable efforts to mitigate for past impacts of the CVP on fish, wildlife, and habitat resources not specifically identified in other portions of the CVPIA. The following items are the initial objectives of the (b)(1) "other" Program.

- Protect and restore native habitats impacted by the CVP that are not specifically addressed in the Fish and Wildlife Restoration Activities section of the CVPIA. Initial focus will be on habitats known to have experienced the greatest percentage decline in habitat quantity and quality since construction of the CVP, where such decline could be attributed to the CVP (based upon direct and indirect loss of habitat from CVP facilities and use of CVP water).

- Stabilize and improve populations of native species impacted by the CVP that are not specifically addressed under the Fish and Wildlife Restoration Activities section of the CVPIA. The initial focus would be given to federally-listed, proposed or candidate species, other non-listed State and Federal species of special concern including resident fish and migratory birds, and other native wildlife species associated with habitats which have declined in quantity and quality as a result of the CVP.

- Coordinate with and participate in other efforts contributing to the alleviation of the CVP impacts, including related provisions of the CVPIA.

- Develop partnerships with others to achieve the greatest possible benefit for species and habitats, and the most efficient use of program funds.

The initial actions to be coordinated with the ongoing actions developed under the Conservation Program, as described under the No-Action Alternative, would be the actions summarized in Attachment H of this PEIS. This list would be supplemented periodically.

TABLE II-5

CORE PROGRAMS INCLUDED IN ALL PEIS ACTION ALTERNATIVES

Core Program Action	CVPIA Section
Renew all CVP Service, Water Rights, and Exchange Contracts (no change from No-Action Alternative).	Section 3404(c)
Implement water measurement: Implement with measurement devices at point of diversion from CVP supplies and estimates for individual users, or with measurement devices at point of use.	Section 3405(b)
Implement water conservation standards: Include water conservation for municipal and on-farm uses assumed in the DWR Bulletin 160-93; and conservation plans completed under the 1982 Reclamation Reform Act with implementation of all cost-effective Best Management Practices that are economical and appropriate, including measurement devices, pricing structures, demand management, public information; and financial incentives.	Section 3405(e)
Implement (b)(1) "other" Program (see text for description)	Section 3406(b)(1)
Upgrade Tracy and Contra Costa Pumping Plants fish protection facilities	Sections 3406(b) (4-5)
Construct Shasta Temperature Control Device (same facilities as in the No-Action Alternative with funding per CVPIA)	Section 3406 (b)(6)
Complete improvements to Coleman National Fish Hatchery	Section 3406(b)(11)
Complete habitat improvements in Clear Creek (expand spawning and rearing areas, and periodically clear the McCormick-Saeltzer Dam sediment trap)	Section 3406(b)(12)
Implement Non-Flow Stream Restoration Actions in Central Valley streams and the Delta (see Attachment F of the PEIS for list of potential actions)	Section 3406(b)(13)
Complete modifications to Anderson-Cottonwood Irrigation District Diversion to protect fish	Section 3406(b)(17)
Complete modifications to Glenn-Colusa Irrigation District Diversion Facility to protect fish	Section 3406(b)(20)
Avoidance of juvenile anadromous fish loss at diversions including construction of screens, bypasses, fish ladders, and modification of diversion (see Attachment F of the PEIS for list of potential actions)	Section 3406(b)(21)
Implement Seasonal Field Flooding: Flood up to 80,000 acres in Central Valley with payments up to $25/acre (1992 dollars). Land to be flooded primarily would be rice fields that are designed to be flooded.	Section 3406(b(22)
Increase Instream Fish Flow Releases in Trinity River (see text for description)	Section 3406(b)(23)
Purchase 30,000 acres of retired lands from willing sellers (see text for description)	Section 3408(h)

As implementation proceeds, the emphasis of this program would focus more on ecosystem-level actions, regardless of federal or state listing programs for special status species.

The benefits of the (b)(1) "other" Program would be to mitigate, as feasible, the past impacts of the CVP to fish, wildlife, and habitats; and to improve biological status of species and habitats for special status species and native non-special status species and habitats.

The (b)(1) "other" Program would expend approximately $1 to $2 million (1992 dollars) annually from the Restoration Fund. As opportunity permits, these funds would be combined with funding from other programs with similar goals, ensuring priority projects are coordinated and receive the greatest possible benefit.

Implementation of Increased Instream Fish Flow Releases in the Trinity River

The CVPIA recognizes a concurrent program that is evaluating alternatives to improve fishery conditions in the Trinity River. This study will evaluate and analyze a range of alternatives to restore and maintain the natural production of anadromous fish populations of the Trinity River mainstem downstream of Lewiston Dam. The alternatives considered in the study included many factors, including several different instream fish flow release patterns.

Changes in the instream fish flow release pattern affects the amount of water that can be exported to the CVP from the Trinity River. Changes in the amount of CVP exports from the Trinity River can significantly affect how the CVP is operated. Therefore, to provide an appropriate analysis of changes in CVP operations for the Draft PEIS alternatives, it was necessary to develop an assumption for the instream fish flow releases in the Trinity River.

For the Draft PEIS analysis, the Service developed an instream fisheries flow release pattern for the Trinity River, as included in Attachment G of the PEIS. This instream fisheries flow release pattern was incorporated into all Alternatives and Supplemental Analyses.

Land Retirement Actions

The extent of the land retirement program is currently being determined. For the purposes of the Draft PEIS, it was assumed that the land retirement program would be similar in nature to the land retirement program described by the San Joaquin Valley Drainage Program (SJVDP) for selective purchase from willing sellers of irrigated lands that are characterized by low productivity, poor drainage, and high selenium concentrations in shallow groundwater. Up to 30,000 acres of land would be retired under the Draft PEIS alternatives using mechanisms provided by CVPIA. It is assumed that the land would be located in the San Joaquin and Tulare Lake Regions of the study area and that the associated water would remain with the district. This programmatic approach for the Draft PEIS provides an analysis of changing crop patterns in the area of the Central Valley characterized by drainage problems without specifically addressing the retirement of individual parcels.

As other studies are completed, the land retirement program could be expanded to include other lands and/or the purchase of water with the land. The environmental documentation to address the other areas will be completed with the site-specific documents.

MULTIPLE OPTION PROGRAMS

The multiple option programs considered in the Alternatives and the Supplemental Analyses are listed in Table II-6. Additional information is presented below for programs or actions related to fish and wildlife, water pricing, and water transfers.

Fish and Wildlife Management Programs

The Fish and Wildlife Management Programs included methods to improve habitat, as defined by the Anadromous Fish Restoration Program (AFRP) and refuge water supplies. The program associated with refuge water supplies was defined in a 1989 Refuge Water Supply Study and the San Joaquin Basin Action Plan completed by Reclamation. The following subsections describe the AFRP and how the AFRP was included in the Draft PEIS alternatives. Level 2 and Level 4 refuge water supplies assumed in the alternatives are listed in Tables II-7 and II-8, respectively.

Anadromous Fish Restoration Program. One of the sections of the CVPIA directs the development and implementation of the Anadromous Fish Restoration Program (AFRP). The goal of the AFRP is to develop reasonable efforts to ensure that by the Year 2002, natural production of anadromous fish in the Central Valley rivers and streams would be sustainable on a long-term basis at levels not less than twice the average levels attained during the period of 1967 through 1991. Total Fish population objectives are:

♦ Chinook salmon, all races	990,000
♦ Steelhead (spawing upstream of Red Bluff Diversion Dam)	13,000
♦ Striped bass	2,500,000
♦ American shad	4,300
♦ White sturgeon	11,000
♦ Green sturgeon	2,000

The Service is taking the following steps to develop the AFRP: 1) attain the best available scientific and commercial data; 2) develop a long-term Restoration Plan that identifies the general approaches and actions to attain the goal; and 3) develop short-term implementation plans as tiers to the Restoration Plan. The tiered implementation plans would be revised at least every 3 to 5 years. The AFRP also will be reviewed and updated every 5 years.

The AFRP goals were based upon best available scientific information to provide a platform on which participating agencies and the public could develop reasonable actions. Information used in the AFRP was collected from available reports, input from stakeholders, and input from the scientific community. In December 1995, the Service prepared a Draft Restoration Plan. The purpose of this plan was to identify general approaches and actions to attain the goals and objectives of AFRP. The Draft Restoration Plan was reviewed by the public and interested agencies and groups. The Revised Draft Restoration Plan was released in June 1997. The Revised Draft Restoration Plan included actions based upon scientific knowledge and the following reasonableness criteria.

- The technical and legal basis of the actions must be reasonable.
- Interior or supportive partners must have the authority to implement the actions.
- Potential partners that would be required to implement actions must be supportive

TABLE II-6

MULTIPLE OPTION PROGRAMS IN PEIS ACTION ALTERNATIVES

Multiple Option Program Actions	CVPIA Section	Alternative or Supplemental Analysis
Fish and Wildlife Water Management Actions: Implement CVP re-operation or "(b)(1) water", and dedication of 800,000 acre-feet of CVP water or "(b)(2) water" from Anadromous Fish Restoration Program.	Section 3406(b)(1-2)	**Alternatives 1, 2, 3, and 4 & Supplemental Analyses 1a through 1i, 2a through 2d, 3a, and 4a:** Implement reoperation and (b)(2) water in the CVP-controlled streams (Sacramento, American, Stanislaus, and lower San Joaquin rivers and Clear Creek), and reoperation in the Delta. (see text for additional details) **Alternative 4 & Supplemental Analyses 1a:** In addition, implement (b)(2) water in the Delta. (see text for additional details)
Fish and Wildlife Water Management Actions: Implement water acquisition or "(b)(3) water" from willing sellers on the streams from Anadromous Fish Restoration Program.	Section 3406(b)(3)	**Alternatives 2 and 4 & Supplemental Analyses 2a through 2d, and 4a:** Purchase water from willing sellers on tributary streams of the Delta. Use water to increase instream fish flows and Delta outflow. (see text for additional details) **Alternative 3 and Supplemental Analysis 3a:** Purchase water from willing sellers on tributary streams to increase instream fish flows. Do not specifically use water to increase Delta outflow. (see text for additional details)
Refuge Water Supply Actions: Provide firm CVP water supplies to meet average historical refuge water deliveries "Level 2 Supplies", as described in the 1989 Refuge Water Supply Study and the San Joaquin Basin Action Plan. Level 2 Supplies presented in Table II-7.	Section 3406(d)(1-2)	**Alternatives 1, 2, 3, and 4 & Supplemental Analyses 1a through 1c, 1e through 1i, 2a through 2d, 3a, and 4a:** Provide firm CVP water supplies to refuges at average historic water supply levels. The Level 2 water supplies would be subject to hydrologic shortages described by the Shasta criteria with a maximum shortage of 25% of the total amount (no change from the No-Action Alternative). **Supplemental Analysis 1d:** Same as above, however, the Level 2 water supplies would not be subject to hydrologic shortages.
Refuge Water Supply Actions: Purchase water from willing sellers to meet "ultimate" refuge water deliveries "Level 4 Supplies", as described in the 1989 Refuge Water Supply Study and the San Joaquin Basin Action Plan. Level 4 Supplies presented in Table II-8.	Section 3406(d)(1-2)	**Alternatives 2, 3, and 4 & Supplemental Analyses 2a through 2d, 3a, and 4a:** Purchase water from willing sellers to increase water supply levels from Level 2 to Level 4. The additional water supplies would be subject to hydrologic shortages associated with the purchased water.

TABLE II-6. CONTINUED

Water Pricing Actions: Implement tiered water pricing for CVP water service contracts.	Section 3405(d)	**Alternatives 1, 2, 3, and 4 & Supplemental Analyses 1a, 1b, 1d through 1f, 1h, 1i, 2a through 2c, 3a, and 4a:** Based upon "80/10/10 Tiered Water Pricing up to Full Cost Approach" and the use of the Ability-to-Pay policies. (see text for discussion) **Supplemental Analyses 1c and 2d:** Based upon "80/10/10 Tiered Water Pricing up to Full Cost Plus Approach" and the use of the Ability-to-Pay policies. (see text for discussion) **Supplemental Analysis 1g:** Based upon "80/10/10 Tiered Water Pricing up to Full Cost Approach" without the use of the Ability-to-Pay policies. (see text for discussion)
Red Bluff Diversion Dam Actions: Modify Red Bluff Diversion Dam gate operations to protect juvenile chinook salmon from injury and disorientation while passing through diversion dam. The dam structure allows water to move from the Sacramento River to the Tehama-Colusa Canal and Corning Canal. The modifications also would protect the salmon from predation by squawfish below the dam.	Section 3406(b)(10)	**Alternatives 1, 2, 3, and 4 & Supplemental Analyses 1a through 1h, 2a through 2c, 3a, and 4a:** Fish passage improvements to Red Bluff Diversion Dam based upon findings from ongoing fish screen studies. Gates would continue to be open from mid-September through mid-May as required by the winter run chinook salmon biological opinion. Gates would be closed mid-May through mid-September which would form Lake Red Bluff. Diversions would continue at No-Action Alternative levels. **Supplemental Analysis 1i:** Fish passage improvements to Red Bluff Diversion Dam based upon findings from ongoing fish screen studies. Gates would be open all year. Diversions would continue at No-Action Alternative levels.
Delta Fish Barrier Actions: Construct fish barrier in Georgiana Slough and permanent barrier in Old River.	Sections 3406(b)(14-15)	**Alternatives 1, 2, 3, and 4 & Supplemental Analyses 1a, 1c through 1i, 2b through 2c, 3a, and 4a:** Fish barriers would be non-structural. **Supplemental Analyses 1b and 2a:** Fish barriers would be structural.

TABLE II-6. CONTINUED

Water Transfer Actions: Provide for water transfers to meet agricultural and municipal water needs in California.	Section 3405(a)	**Alternatives 1, 2, 3, and 4 & Supplemental Analyses 1a through 1d, 1g through 1i, 2a, and 2d:** Only CVP water can be transferred within the CVP service area. San Joaquin River Exchange Contractors cannot transfer CVP water. Individuals cannot transfer CVP water. Agricultural CVP water cannot be transferred to municipal CVP users. (no change from No-Action Alternative) **TRANSFER ALTERNATIVES: Supplemental Analyses 1e, 2b, 3a, and 4a:** Water transfers would occur between all parties based upon demand, capacity of conveyance facilities, and economic effectiveness. Cost of transferred CVP water would be equal to the cost of service for municipal CVP water, and the higher cost of cost of service or full cost for agricultural CVP water. Costs of transferred CVP water and all other water supplies also would include the cost to the seller to make the water available, including the amount of lost income. A $25/acre-foot (1992 dollars) charge per CVPIA would be added to transfer agricultural CVP water to non-CVP municipal water users. The Restoration Fund charge would be increased for the transfer of agricultural CVP water to CVP municipal water users. **TRANSFER ALTERNATIVES: Supplemental Analyses 1f and 2c:** All charges described above for Supplemental Analyses 1e, 2b, 3a, and 4a, plus an additional $50/acre-foot charge on all CVP water transfers. The additional monies would increase contributions to the Restoration Fund. The additional charge would require additional Congressional authorization.
Revegetation Actions: Restore habitat on retired lands.	Section 3408(h)	**Alternatives 1, 2, 3, and 4 & Supplemental Analyses 1a through 1g, 1i, 2a through 2c, 3a, and 4a:** Fallowed lands would remain vacant or minimal dry farming could occur. The uncultivated land would be irrigated at least once to allow revegetation to avoid erosion. However, most plants would be weedy species and animals probably would not be special-status species. **Supplemental Analysis 1h:** Specific revegetation programs and animal reintroduction programs would be implemented on fallowed lands to improve the land for special-status species.

TABLE II-7

LEVEL 2 REFUGE WATER SUPPLIES IN PEIS ALTERNATIVES

Refuge	Level 2 Supply At Refuge Boundary	Conveyance Loss	Amount To Be Diverted
Sacramento Valley Refuges			
Sacramento National Wildlife Refuge	46.4	15.5	61.9
Delevan National Wildlife Refuge	20.9	7.0	27.9
Colusa National Wildlife Refuge	25.0	8.3	33.3
Sutter National Wildlife Refuge	23.5	2.6	26.1
Grey Lodge National Wildlife Refuge	35.4	5.2	40.6
Total for Sacramento Valley Refuges	**151.2**	**38.6**	**189.8**
San Joaquin Valley Refuges			
San Luis National Wildlife Refuge	19.0	6.3	25.3
Kesterson National Wildlife Refuge	10.0	1.1	11.1
Volta Wildlife Management Area	13.0	0.0	13.0
Los Banos Wildlife Management Area	16.6	2.8	19.4
San Joaquin Basin Action Lands			
Freitas	5.3	1.8	7.1
West Gallo	10.8	3.6	14.4
Salt Slough	6.7	1.2	7.9
China Island	7.0	1.2	8.2
Grasslands Resource Conservation District	125.0	22.1	147.1
Mendota Wildlife Management Area	27.6	0.0	27.6
Merced National Wildlife Refuge	15.0	5.0	20.0
East Gallo	8.9	2.9	11.8
Kern National Wildlife Refuge	9.9	1.5	11.4
Pixley National Wildlife Refuge	1.3	0.0	1.3
Total for San Joaquin Valley Refuges	**276.1**	**49.5**	**325.6**
TOTAL FOR ALL REFUGES	**427.3**	**88.1**	**515.4**

NOTE:
Values based upon values in 1989 Refuge Water Supply Study and San Joaquin Basin Action Plan.
Values have been subsequently modified to reflect more recent data.
All values in 1,000 acre-feet.

TABLE II-8

LEVEL 4 REFUGE WATER SUPPLIES IN PEIS ALTERNATIVES

Refuge	Level 4 Supply At Refuge Boundary	Conveyance Loss	Amount To Be Diverted
Sacramento Valley Refuges			
Sacramento National Wildlife Refuge	50.0	16.7	66.7
Delevan National Wildlife Refuge	30.0	10.0	40.0
Colusa National Wildlife Refuge	25.0	8.3	33.3
Sutter National Wildlife Refuge	30.0	3.3	33.3
Grey Lodge National Wildlife Refuge	44.0	7.0	51.0
Total for Sacramento Valley Refuges	**179.0**	**45.3**	**224.3**
San Joaquin Valley Refuges			
San Luis National Wildlife Refuge	19.0	6.3	25.3
Kesterson National Wildlife Refuge	10.0	1.1	11.1
Volta Wildlife Management Area	16.0	0.0	16.0
Los Banos Wildlife Management Area	25.5	5.1	30.6
San Joaquin Basin Action Lands			
Freitas	5.3	1.8	7.1
West Gallo	10.8	3.6	14.4
Salt Slough	10.0	1.8	11.8
China Island	10.5	1.8	12.3
Grasslands Resource Conservation District	180.0	31.8	211.8
Mendota Wildlife Management Area	29.7	0.0	29.7
Merced National Wildlife Refuge	16.0	5.3	21.3
East Gallo	13.3	4.4	17.7
Kern National Wildlife Refuge	25.0	3.7	28.7
Pixley National Wildlife Refuge	6.0	0.8	6.8
Total for San Joaquin Valley Refuges	**377.0**	**67.7**	**444.7**
TOTAL FOR ALL REFUGES	**556.0**	**113.0**	**669.0**

NOTE:
Values based upon values in 1989 Refuge Water Supply Study and San Joaquin Basin Action Plan.
Values have been subsequently modified to reflect more recent data.
All values in 1,000 acre-feet.

Based on current information, Interior believes a reasonable program will achieve doubling goals for some species and discrete runs on some streams. In almost all cases, Interior believes that improvement can occur to identified anadromous species populations even if doubling goals are not achieved. Monitoring will be used extensively to provide crucial information about ecosystem responses to specific project implementation. Information from the monitoring program will be used with Adaptive Management to modify the actions. In addition, Interior would use partnerships with other Federal, state, and private entities to meet the overall goals.

Implementation of the Anadromous Fish Restoration Program in the Draft PEIS Alternatives. The AFRP was implemented in the Draft PEIS alternatives through the instream and Delta habitat and flow improvements. The habitat improvements were included in the Revised Draft Restoration Plan as "ACTIONS" to be completed in each watershed (a list is included in Attachment F of the PEIS).

The flow improvements were developed based upon information developed by the Service in October 1996 (the basis for the flow improvements are included in Attachment G of the PEIS). The following three tools were identified in the CVPIA to improve flows. The definitions were developed for the purposes of the PEIS, as shown in Table II-6.

- ***Reoperation of the CVP in accordance with Section 3406(b)(1)(B)***. Reoperation is defined as changes in CVP operations that do not impact water deliveries to CVP water users.

- ***Dedication of 800,000 acre-feet of CVP water in accordance with Section 3406(b)(2) (or "(b)(2) Water")***. The "(b)(2) Water Management" is defined as operation of the CVP in a manner that would allow the CVP to dedicate and manage 800,000 acre-feet/year of CVP water for fish and wildlife purposes, as measured as a reduction in deliveries to CVP water service contractors.

- ***Water Acquisitions in accordance with Section 3406(b)(3).*** Water Acquisitions from willing sellers would be used to provide increased instream flows in specific months to improve habitat, in accordance with preliminary information developed by AFRP.

For the Draft PEIS alternatives, water facilities operations were modified to reflect the use of these three tools. Because the Draft PEIS and AFRP were being developed at the same time, preliminary information from the AFRP was used in development of the Draft PEIS alternatives, as described below. The formal Water Management Plan process between Reclamation and the Service to develop a long-term operations plan is being developed. A simplified version of the process was developed for the Draft PEIS based upon conservative assumptions. The alternatives may not meet the doubling goals as defined within the Service's Draft Restoration Plan.

Reoperation and (b)(2) Water Management. To develop alternatives for Reoperation and (b)(2) Water Management, preliminary AFRP information was used in an iterative process to develop target flows for the CVP-controlled streams and the Delta. "Reoperation" is defined as changes in CVP operations that do not impact water deliveries to CVP water users. Reoperation had been initiated prior to the passage of CVPIA through adaptive management programs between Reclamation, the Service, and Department of Fish and Game. Reoperation can only affect stream flows on CVP-controlled streams identified in the CVPIA: Sacramento, American, Stanislaus, and lower San Joaquin rivers and Clear Creek.

The "(b)(2) Water Management" is defined as operation of the CVP in a manner that would allow the CVP to dedicate and manage 800,000 acre-feet/year of CVP water for fish and wildlife purposes, as measured as a reduction in deliveries to CVP water service contractors. The (b)(2) Water Management cannot adversely impact non-CVP water rights holders (including the SWP), Sacramento River Water Rights Contractors, or San Joaquin River Exchange Contractors as compared to the No-Action Alternative. In addition, the (b)(2) Water Management cannot impact the ability of the CVP to meet the winter-run chinook salmon or delta smelt biological opinion. The (b)(2) Water Management process can reduce deliveries to agricultural CVP water service contractors as much as 100% of the allocation under the No-Action Alternative. However, the (b)(2) Water Management was defined in the Draft PEIS to not reduce municipal CVP water service contract deliveries more than 25% because municipal users frequently do not have options to operate without CVP water.

The (b)(2) Water Management included the following three components.

- Bay-Delta Plan Component
- Instream Component
- Delta Component (in addition to the Bay-Delta Plan Component)

The "Bay-Delta Plan Component" includes the reduction in CVP water deliveries that occurred due to implementation of the Bay-Delta Plan Accord, as described in the Accord. This reduction in deliveries also was included in the No-Action Alternative. The Bay-Delta Plan Component is included in all Alternatives and Supplemental Analyses.

The "Instream Component" refers to use of (b)(2) water on the CVP-controlled streams to meet the Draft AFRP target flows. The primary goal of the (b)(2) Water Management Instream Component was to provide water for AFRP salmon and steelhead target flows in the Sacramento, American, Stanislaus, and Lower San Joaquin rivers and in Clear Creek. The Instream Component is included in all Alternatives and Supplemental Analyses.

The "Delta Component" refers to the use of (b)(2) water in the Delta to meet Draft AFRP target flows and operational considerations in excess of those identified in the Bay-Delta Plan. The Delta Component is only included in Alternative 4 and Supplemental Analysis 1a.

The average annual reductions in CVP deliveries due to use of (b)(2) water is presented in Table II-9 for each of the hydrologic periods selected for evaluation. The average annual reduction in CVP deliveries does not reach 800,000 acre-feet during any of the hydrologic periods because the CVP operations are limited due to the need to meet water rights, water right and exchange contracts, winter-run chinook salmon and delta smelt biological opinions, flood control operations criteria, and water quality requirements in the San Joaquin River.

TABLE II-9

ANNUAL CVP DELIVERY IMPACTS OF (b)(2) WATER MANAGEMENT AS COMPARED TO OPERATIONS UNDER SWRCB D-1485 IN YEAR 2020 CONDITIONS

Hydrologic Period	Water Year Type	Average Annual (b)(2) Water Management (1,000 acre-feet)		
		Bay-Delta Plan & Instream Components	Bay-Delta Plan, Instream, & Delta Components	Bay-Delta Plan, Instream, & Delta Components
		Alternatives 1-3 & Supplemental Analyses 1b -1i, 2a-2d, & 3a	Supplemental Analysis 1a	Alternative 4 & Supplemental Analyses 4a
1922 - 90	Simulation Period	-360	-460	-480
1928 - 34	Dry	-560	-630	-620
1944 - 50	Below Normal	-490	-590	-610
1951 - 57	Above Normal	-200	-320	-350
1959 - 62	Below Normal	-530	-530	-580
1967 - 71	Wet	-190	-310	-250
1978 - 80	Above Normal	-130	-300	-300
1987 - 90	Dry	-740	-760	-770

The Delta Component in Supplemental Analysis 1a was based upon preliminary information developed in February 1996 by the AFRP, as described in Attachment G. Due to the addition of the Delta Components, operations in the streams also were modified.

The Delta Component in Alternative 4 was based upon preliminary information developed in October 1996 by the AFRP, as described in Attachment G. Due to the addition of the Delta Components, operations in the streams also were modified.

Water Acquisitions to Meet Instream Target Flows. Water acquisitions in the Draft PEIS alternatives would be implemented in accordance with the requirements of the State Water Resources Control Board (SWRCB). This approval process would require compliance with the State Water Code. The Water Code prevents transfers that would have an unreasonable impact on fish, wildlife, or instream uses (Water Code Sections 1025.5(b), 1725, 1736). The Water Code also prevents public agencies from conveying transferred water if fish, wildlife, or other beneficial instream uses are unreasonably affected or if the overall economy or environment in the county where the water originates would be unreasonably affected (Water Code Section 1810(d)). The SWRCB would need to confirm that adverse impacts would not occur or would be mitigated. For example, the willing seller may need to consider downstream uses of water, such as water supply or water quality purposes. To avoid adverse impacts, the willing seller may need to provide additional flows in specific periods to avoid affecting downstream users.

For the purposes of the Draft PEIS, it was assumed that municipalities would not be willing sellers because projected water demands exceed projected supplies. In addition, it was assumed that agricultural SWP contractors would not be willing sellers because the municipal SWP contractors would have first right of refusal for all transfers, and that the SWP municipal contractors would purchase the water.

The following four water acquisition alternatives were developed in the Draft PEIS alternatives to improve instream fishery flows.

- **Alternative 1 and Supplemental Analyses 1a through 1i:** No water would be acquired to improve instream fishery flows.

- **Alternative 2 and Supplemental Analyses 2a through 2d:** Water would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced rivers and on the tributary creeks of the Upper Sacramento River that support spring-run. The acquired water would be managed towards meeting target flows for the streams. The acquired water also would be used to improve flows in the Delta. Therefore, the acquired water could not be exported by the CVP or SWP.

- **Alternative 3 and Supplemental Analysis 3a:** Water would be acquired from willing sellers on the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers and on the tributary creeks of the Upper Sacramento River to improve instream flows in accordance with target flows. The acquired water would not be managed for increased flows through the Delta. Therefore, the acquired water could be exported if Bay-Delta Plan conditions were met.

- **Alternative 4 and Supplemental Analysis 4a:** Water would be acquired for the streams as under Alternative 3. The acquired water would be managed towards meeting target flows for the streams and to improve flows in the Delta. Therefore, the acquired water could not be exported by the CVP or SWP.

Water acquisitions were not considered on the Sacramento River because changes in operations would have impacted the ability of the CVP to operate to the winter run chinook salmon biological opinion. Water acquisitions were not considered on the American River because most of the water is used to serve municipal users.

The amounts of water to be acquired are presented in Table II-10. The amounts of water acquired under the alternatives were limited by costs. Purchase of the acquired water was assumed to be funded with Restoration Funds authorized under CVPIA. It was assumed that a long-term average total of $50 million/year (1992 dollars) would be collected in the Restoration Fund. Under Alternative 2, it was assumed that flow and non-flow habitat improvement actions and other CVPIA programs would be funded within the $50 million/year limitation (1992 dollars). Therefore, based upon estimated costs for non-flow habitat improvements and other CVPIA programs, funding limitations for water acquisition were determined as described in the following portion of this chapter.

TABLE II-10

WATER ACQUISITION GOALS FOR INSTREAM FISHERY HABITAT IN PEIS ALTERNATIVES

Stream(s)	Acquisition Targets in Alternative 2 and Supplemental Analyses 2a -2d	Acquisition Targets in Alternatives 3 and 4 and Supplemental Analyses 3a and 4a
Mill, Deer, Battle, Chico, Antelope, Cow, and Butte Creeks and Bear River	Amount not Quantified for PEIS Alternatives	Amount not Quantified for PEIS Alternatives
Yuba River	None	100
Mokelumne River	None	70
Calaveras River	None	40
Stanislaus River	60	200
Tuolumne River	60	200
Merced River	50	200
NOTE: All values in 1,000 acre-feet		

Under Alternatives 3 and 4, the cost limitation was increased to $120 million/year (1992 dollars). The higher cost limitation reflected three factors that could occur. First, some of the non-flow habitat improvement actions could be funded by non-CVPIA programs, such as CALFED, therefore, more funds may be available for water acquisition. Second, if willing sellers only occurred in one or two watersheds more funds could be used in the remaining watersheds to purchase more water. This analysis considers higher amounts of water than probably could be purchased under average conditions to allow for this scenario. Finally, if the price of water were less than what is used in this analysis, the remaining Restoration Funds could purchase more water in the watersheds than considered under this analysis, if the water is available.

Use of the acquired water within an operational pattern was determined by comparing the available water to biological priorities developed in the preliminary AFRP information. Base instream flows in the No-Action Alternative were compared to the biological priorities (described in Attachment G). Acquired water was used to meet the next set of priorities, or target flows, identified by the AFRP. The overall goal was to increase instream flows towards conditions that exist during wet weather periods. The overall goals were not met except in several extremely wet years for limited periods of time. Therefore, for the purpose of PEIS, instream target flows were developed to use the amount of acquired water considered in the alternatives in the most appropriate manner based upon available information.

Base flows are not known for the creeks that are tributary to the Upper Sacramento River. Therefore, it was difficult to determine quantities for development of target flows. It also was difficult to develop a water operation to meet target flows on the Bear River without impacting the SWP operations. Therefore, quantities were not developed for acquisition in the Bear River watershed. Approximate costs and benefits were estimated due to water acquisition on these watersheds for the purposes of the Draft PEIS.

The analysis of agricultural economics was used to determine the actions that would be implemented to make the water available for acquisition. These actions included increased water conservation that would not be economical without the revenue from water sales, changes in crop patterns, and land fallowing. Under Alternative 2, the amount of fallowed land was relatively small as compared to irrigated acreage in the affected watersheds. However, under Alternatives 3 and 4, the amount of fallowed land increased significantly especially in the Stanislaus, Tuolumne, and Merced river watersheds. Therefore, to improve fish and wildlife habitat, it was assumed under Alternatives 3 and 4 that on up to 15% of the fallowed land conservation easements could be purchased by Interior to allow habitat restoration for special status species and other native species.

Water Pricing Actions

Three different water pricing concepts were considered in the Draft PEIS alternatives. All three pricing concepts implemented tiered water pricing as required by CVPIA. Two of the pricing concepts continued to use the Ability-to-Pay policies included in the No-Action Alternative. One of the pricing concepts eliminated the Ability-to-Pay policy.

Tiered Water Pricing from Contract Rate to Full Cost Rate. The water pricing actions under Alternatives 1, 2, 3, and 4 and Supplemental Analyses 1a, 1b, 1e through 1i, 2a through 2c, 3a, and 4a were based upon use of a "80/10/10 Tiered Water Pricing from Contract Rate to Full Cost" approach with Ability-to-Pay policies. Under this approach, the first 80% of contract volume would be priced at the applicable Contract Rate in accordance with current Reclamation pricing policies for the CVP. The next 10% of the contract volume would be priced at a value equal to the average between the Contract Rate and Full Cost Rate as defined in current Reclamation pricing policies. The final 10% of the contract volume would be priced at Full Cost Rate as defined in current Reclamation pricing policies. The Contract Rate for agricultural contracts is equal to operation and maintenance expenses plus capital cost recovery for CVP facilities without interest charges. The Full Cost Rate for agricultural contracts includes the interest charges. Tiered water pricing from Contract Rate to Full Cost Rate is shown in the following example. The Contract Rate for municipal and industrial contracts are equal to Full Contract rates for agricultural contracts.

The Contract Rate would continue to be determined in accordance with the Reclamation Reform Act and current pricing policies as in the No-Action Alternative. The final price of CVP water would be determined using the current Ability-to-Pay policies, if applicable. The Ability-to-Pay policies provides relief to the users on the repayment of the capital cost of the CVP facilities. The relief could be up to 100% of the capital cost repayment and is based upon local farm budgets. The Ability-to-Pay policies do not apply to CVP operation and maintenance costs or any non-CVP costs, including Federal government loans for construction of irrigation facilities. The Ability-to-Pay policies do not apply to the increments due to tiered pricing.

The price for CVP water also would include collection of the Restoration Funds at a rate of $6/acre-foot (1992 dollars) for agricultural water contractors and $12/acre-foot (1992 dollars) for municipal water contractors. It is assumed that all contracts will be renewed to avoid additional charges specified in the CVPIA for not modifying contracts to include CVPIA provisions.

Tiered Water Pricing from Full Cost Rate to Full Cost Plus Rate. The water pricing actions under Supplemental Analysis 1c and 2d would be based upon a "80/10/10 Tiered Water Pricing from Full Cost Rate to Full Cost Plus" approach with Ability-to-Pay policies. The first 80% of contract volume would be priced at the Full Cost rate. The next 10% of the contract volume would be priced at a value 10% higher than Full Cost rate. The final 10% of the contract volume would be priced at a value 20% higher than Full Cost rate, as shown in the following example. The rates would continue to be determined in accordance with the Reclamation Reform Act and current pricing policies as in the No-Action Alternative, including the current Ability-to-Pay policies. The price for CVP water also would include collection of the Restoration Funds.

EXAMPLES OF TIERED PRICING

No-Action Alternative:

Contract Amount =	100,000 acre-feet
Contract Rate =	$20/acre-foot
Full Cost Rate =	$60/acre-foot
Cost of Full Deliveries =	(100,000 af) x ($20/af) = $2,000,000

Tiered Pricing from Contract Rate to Full Cost Rate:

Contract Amount =	100,000 acre-feet
Contract Rate =	$20/acre-foot
Full Cost Rate =	$60/acre-foot
Cost of Full Deliveries =	(80,000 af) x ($20/af) + (10,000 af) x ($40/af) + (10,000 af) x ($60/af) = $2,600,000

Tiered Pricing from Full Cost Rate to Full Cost Plus Rate:

Contract Amount =	100,000 acre-feet
Contract Rate =	$20/acre-foot
Full Cost Rate =	$60/acre-foot
Cost of Full Deliveries =	(80,000 af) x ($60/af) + (10,000 af) x ($66/af) + (10,000 af) x ($72/af) = $6,180,000

Tiered Water Pricing without Ability-to-Pay Policies. Actions under Supplemental Analysis 1g would be identical to those discussed under Tiered Water Pricing from Contract Rate to Full Cost Rate, except there would be no relief for the capital cost portion of the repayment price under the Ability-to-Pay policies.

Water Transfer Programs

The potential impact of CVPIA water transfers were assessed by implementing transfers as Supplemental Analyses on the main alternatives. The main alternatives did not include transfers because transfers under CVPIA would be voluntary between buyer and seller. Therefore, transfers under CVPIA could not be considered mandatory. In addition, the specific definition of alternatives with transfers is not known at this time to allow analysis in the quantitative manner used for the main alternatives.

Therefore, the analyses of water transfers are evaluated as analyses of opportunities for water transfers and evaluation of how implementation of CVPIA may affect those opportunities. The specific volumes of water described in the Draft PEIS alternatives should not be considered as predictions, but rather as reasonable representations of the potential water market. The alternatives with transfers assume that all CVP water would be transferrable. The analysis generally identified water transfer opportunities as buying and selling by region at a programmatic level. The analysis evaluated average and dry water year conditions to determine the sensitivity of the market.

The alternatives with transfers assumed that there would be no new facilities constructed. Therefore, transfers may be limited by existing conveyance capacities. In addition, no new groundwater wells or recharge facilities would be constructed to provide for conjunctive use programs. If new facilities were constructed, the opportunities for water transfers may increase more than discussed in the Draft PEIS alternatives.

The No-Action Alternative for the Draft PEIS does not include any types of transfers because of the speculative nature of the transfer market. It was not possible to predict the transfer market in the Year 2022 with or without implementation of CVPIA. For the purposes of developing and comparing the alternatives with transfers, a Base Transfer Scenario was required. The Base Transfer Scenario included the No-Action Alternative assumptions and a water transfer market defined by comparing available water supplies, associated costs of those water supplies, general capacity of major conveyance facilities, and water shortages as determined by water supply analyses and population projections. These same factors were considered for the alternatives with transfers with the introduction of CVP water into the transfer market.

All transfers would occur under the same rules that were described above under Water Acquisitions for fish and wildlife purposes. Therefore, specific environmental documentation would be required prior to the implementation of transfers with and without CVPIA.

It is assumed that the cost of the transferred water would be equal to the capital and operation and maintenance costs to make the water available, including the amount of lost income. The cost of transferred water also would include specific transfer costs. Under Supplemental Analyses 1e, 2b, 3a, and 4a, the costs would include a $25/acre-foot charge in accordance with the CVPIA. Actions under Supplemental Analyses 1f and 2c are similar to those under Supplemental Analysis 1e and 2b, except that an additional water transfer fee would be included in the cost of water. The addition of a $50/acre-foot fee on all CVP water transfers was identified during the screening process for alternatives development as one possible way of increasing contributions to the Restoration Fund, if needed.

SUMMARY OF THE DEFINITION OF DRAFT PEIS ALTERNATIVES

The alternatives represent ways to implement CVPIA provisions and meet the CVPIA objectives.

COMPARISON OF THE DRAFT PEIS ALTERNATIVES TO CVPIA PROVISIONS

As described above, for some CVPIA provisions only one implementation method was identified at a programmatic level (Core Programs). For other provisions, several implementation methods were identified. To combine the multiple implementation methods into alternatives, the main alternatives were developed with the Core Programs and sequential implementation of more defined programs for AFRP and refuge water supply. Therefore, the main alternatives built upon each other as well as the No-Action Alternative. The less defined programs with multiple implementation methods were used to develop the Supplemental Analyses which built upon the main alternatives. The Supplemental Analyses were not directly compared to the No-Action Alternative. Rather, the Supplemental Analyses were compared to the main alternatives which were compared to the No-Action Alternative. A comparison of the implementation methods for CVPIA provisions considered in the Draft PEIS alternatives is shown in Table II-4.

COMPARISON OF DRAFT PEIS ALTERNATIVES WITH CVPIA OBJECTIVES

The Draft PEIS alternatives were developed to meet the following objectives of the CVPIA, as identified in Section 3402 of the law.

- ♦ 3402 (a) to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California;
- ♦ 3402 (b) to address impacts of the CVP on fish, wildlife, and associated habitats;
- ♦ 3402 (c) to improve the operational flexibility of the CVP;
- ♦ 3402 (d) 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;
- ♦ 3402 (e) to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; and
- ♦ 3402 (f) to achieve a reasonable balance among competing demands for use of CVP water, including the requirements of fish and wildlife, agriculture, municipal and industrial and power contractors.

The alternatives addressed these objectives through development of multiple implementation methods of various actions addressed in the CVPIA. The assignment of the different implementation methods to each alternative is summarized in Table II-11.

Improvements to Fish and Wildlife Habitat (Section 3402(a) and (b))

All of the alternatives included methods to meet the objectives in Sections 3402 (a) and (b) to protect, restore, and enhance fish and wildlife habitat in the Central Valley and Trinity River Basin. This was accomplished through the implementation of the AFRP programs with flow and non-flow restoration actions, increased instream fish flow releases in the Trinity River, and improved water supplies for refuges. The AFRP programs that address flow improvements in the streams and in the Delta include the use of Reoperation of the CVP, use of (b)(2) water, and water acquisition from willing sellers. The degree to which the alternatives improve conditions varies with specific elements of the alternatives, but all alternatives meet the basic objective of improvement for these resources. The alternative which results in the greatest benefit for fish and wildlife habitat is Alternative 4. Under Alternative 4, the (b)(2) Water Management program includes the Bay-Delta Plan, Instream, and Delta components and the amount of water acquired for improved instream and Delta flows is the highest as compared to the other alternatives.

Improvements to Operational Flexibility (Section 3402 (c))

Improvements to operational flexibility, as addressed in Section 3402(c), to meet all purposes of the CVP is difficult to define. The purposes of the CVP include water supply, power generation, flood control, recreational opportunities, navigation on the Sacramento River, and fish and wildlife habitat and enhancement. Many purposes of the CVP require different operational criteria which may result in conflicts or benefits. For example, reservoir releases in the fall to provide storage for flood control increases flood control flexibility, but decreases water storage which may be needed for deliveries or power generation during the next summer if precipitation is low.

All of the Draft PEIS alternatives improve operational flexibility for fish and wildlife. The degree to which the alternatives improve conditions varies with specific elements of the alternatives. The alternatives did not attempt to change the flood control or navigation criteria used for CVP operations because these criteria are established through separate processes which involve evaluation of public safety by Federal and State agencies. Therefore, the alternatives did not change the existing operational flexibility of flood control or navigation.

All of the alternatives improve recreational opportunities associated with birdwatching and hunting at the refuges and fishing in the streams and in the ocean. Recreational opportunities at the CVP reservoirs are slightly improved under some conditions and slightly reduced under other conditions. All variations are within normal operational conditions. The maximum improvement for recreational opportunities is under Alternative 4 because the refuges receive Level 4 water supplies with limited shortages and improvements to fishery conditions are the greatest of all the alternatives considered.

TABLE II-11

COMPARISON OF ASSUMPTIONS IN DRAFT PEIS ALTERNATIVES WITH CVPIA OBJECTIVES

	Protect, Restore, and Enhance Fish and Wildlife Habitat(3402(a -b))	Improve Operational Flexibility(3402(c))	Increase Water-Related Benefits Through Water Transfers and Conservation(3402(d))	Improve Protection of Bay-Delta(3402(e))	Achieve a Reasonable Balance Between Competing Demands(3402(f))
Alternative 1	Non-Flow Habitat Improvements, (b)(1) "other" program, Reoperation and (b)(2) Water Management with Bay-Delta Plan and Instream Components, increased instream fish flow releases in Trinity River, and Level 2 refuge water supplies	Provisions for fish and wildlife habitat and recreational opportunities. Reduced overall flexibility for water supply and power generation uses.	Water conservation actions for CVP contractors	Non-Flow Habitat Improvements, (b)(1) "other" programs, Reoperation and (b)(2) Water Management with Bay-Delta Plan and Instream Components	Additional actions to meet fish and wildlife needs while attempting to maximize water supply operations
Supplemental Analysis 1a	Assumptions in Alternative 1 plus implementation of Delta Components of (b)(2) Water Management	Assumptions in Alternative 1 plus further provisions for fish and wildlife purposes	Same as Alternative 1	Assumptions in Alternative 1 plus Delta Components of (b)(2) Water Management	Assumptions in Alternative 1 plus implementation of Delta Components of (b)(2) Water Management
Supplemental Analysis 1b	Assumptions in Alternative 1 plus fish passage improvements at Georgiana Slough and Old River	Assumptions in Alternative 1 plus further operational flexibility at Georgiana Slough and Old River	Same as Alternative 1	Assumptions in Alternative 1 plus fish passage improvements at Georgiana Slough and Old River	Assumptions in Alternative 1 plus fish passage improvements at Georgiana Slough and Old River
Supplemental Analysis 1c	Potentially same as Alternative 1, or potentially increased stream flows or Delta outflows	Assumptions in Alternative 1 plus potential increases in fish and wildlife habitat, water supply, or power generation	Same as Alternative 1	Potentially same as Alternative 1, or potentially increased stream flows or Delta outflows	Assumptions in Alternative 1 plus potential reduction in CVP water demand
Supplemental Analysis 1d	Assumptions in Alternative 1 plus full Level 2 water supplies provided in critical dry years	Assumptions in Alternative 1 plus additional habitat at refuges	Same as Alternative 1	Same as Alternative 1	Assumptions in Alternative 1 plus additional habitat at refuges
Supplemental Analysis 1e	Same as Alternative 1	Assumptions in Alternative 1 plus provisions for water transfers	Assumptions in Alternative 1 plus water transfers involving CVP users under CVPIA provisions	Same as Alternative 1	Assumptions in Alternative 1 plus provisions for water transfers
Supplemental Analysis 1f	Same as Alternative 1	Same as Supplemental Analyses 1e	Same as Supplemental Analyses 1e	Same as Alternative 1	Same as Supplemental Analyses 1e
Supplemental Analysis 1g	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1	Same as Alternative 1
Supplemental Analysis 1h	Assumptions in Alternative 1 plus habitat for special-status and native species at land retirement sites	Assumptions in Alternative 1 plus additional habitat	Same as Alternative 1	Same as Alternative 1	Assumptions in Alternative 1 plus additional habitat

TABLE II-11. CONTINUED

	Protect, Restore, and Enhance Fish and Wildlife Habitat(3402(a -b))	Improve Operational Flexibility(3402(c))	Increase Water-Related Benefits Through Water Transfers and Conservation(3402(d))	Improve Protection of Bay-Delta(3402(e))	Achieve a Reasonable Balance Between Competing Demands(3402(f))
Supplemental Analysis 1i	Same as Alternative 1	Assumptions in Alternative 1 plus operational flexibility at Lake Red Bluff	Same as Alternative 1	Same as Alternative 1	Assumptions in Alternative 1 plus operational changes at Lake Red Bluff
Alternative 2	Assumptions in Alternative 1 plus acquisition of water on San Joaquin River tributaries and upper Sacramento River creeks to improve instream and Delta fisheries habitat; and acquisition of water to provide Level 4 refuge water supplies	Assumptions in Alternative 1 plus operational flexibility for fish and wildlife purposes	Assumptions in Alternative 1 plus transfers under the Water Acquisition Program	Assumptions in Alternative 1 plus acquisition of water on San Joaquin River tributaries and upper Sacramento River creeks to improve instream and Delta habitat	Assumptions in Alternative 1 plus water acquisition for instream and Delta purposes and Level 4 refuge water supplies. No change in CVP operations as compared to Alternative 1.
Supplemental Analysis 2a	Assumptions in Alternative 2 plus fish passage improvements at Georgiana Slough and Old River	Assumptions in Alternative 2 plus operational flexibility for fish purposes at Georgiana Slough and Old River	Same as Alternative 2	Assumptions in Alternative 2 plus fish passage improvements at Georgiana Slough and Old River	Assumptions in Alternative 2 plus fish passage improvements at Georgiana Slough and Old River
Supplemental Analysis 2b	Same as Alternative 2	Assumptions in Alternative 2 plus provisions for water transfers	Assumptions in Alternative 2 plus water transfers involving CVP users under CVPIA provisions	Same as Alternative 2	Assumptions in Alternative 2 plus provisions for water transfers
Supplemental Analysis 2c	Same as Supplemental Analysis 2b	Same as Alternative 2	Assumptions in Alternative 2, plus potential improvements due to water transfers involving CVP users under CVPIA provisions, however water transfers would be similar to those without CVPIA due to increased water transfer fees	Same as Alternative 2	Same as Supplemental Analysis 2b
Supplemental Analysis 2d	Potentially same as Alternative 2, or potentially increased stream flows or Delta outflows	Assumptions in Alternative 2 plus potential increase in fish and wildlife habitat, water supply, or power generation	Same as Alternative 2	Potentially same as Alternative 2, or potentially increased stream flows or Delta outflows	Assumptions in Alternative 2 plus potential reduction in CVP water demand
Alternative 3	Assumptions in Alternative 2 plus additional acquisition of water on San Joaquin River, Delta, and lower Sacramento River tributaries to improve instream fisheries habitat conditions, and potential acquisition of conservation easements	Assumptions in Alternative 2 plus operational flexibility for fish and wildlife purposes	Assumptions in Alternative 2 plus transfers under the Water Acquisition Program	Assumptions in Alternative 2 plus increased Delta inflow in some months due to water acquisition	Assumptions in Alternative 2 plus water acquisition for instream purposes. Improvements in water supply operations due to use of acquired water only for instream purposes.

TABLE II-11. CONTINUED

	Protect, Restore, and Enhance Fish and Wildlife Habitat(3402(a -b))	Improve Operational Flexibility(3402(c))	Increase Water-Related Benefits Through Water Transfers and Conservation(3402(d))	Improve Protection of Bay-Delta(3402(e))	Achieve a Reasonable Balance Between Competing Demands(3402(f))
Supplemental Analysis 3a	Same as Alternative 3	Assumptions in Alternative 3 plus provisions for water transfers	Assumptions in Alternative 3 plus water transfers involving CVP users under CVPIA provisions	Same as Alternative 3	Assumptions in Alternative 3 plus provisions for water transfers
Alternative 4	Assumptions in Alternative 3 plus use of acquired water in the Delta and additional use of (b)(2) water for the Delta Components	Assumptions in Alternative 3 plus operational flexibility for fish and wildlife purposes	Assumptions in Alternative 3 plus transfers under the Water Acquisition Program	Assumptions in Alternative 3 plus use of acquired water in the Delta and additional use of (b)(2) water for the Delta Components	Assumptions in Alternative 3 plus acquired water for instream and Delta purposes, and (b)(2) water for Delta Component.
Supplemental Analysis 4a	Same as Alternative 4	Assumptions in Alternative 4 plus provisions for water transfers	Assumptions in Alternative 4 plus water transfers involving CVP users under CVPIA provisions	Same as Alternative 4	Assumptions in Alternative 4 plus provisions for water transfers

Operational flexibility with respect to water supplies and power generation was severely reduced under the No-Action Alternative as compared to the recent conditions due to non-CVPIA actions. Recent requirements established through the winter run chinook salmon and delta smelt biological opinions and through the Bay-Delta Plan Accord reduced operational flexibility to allow improvement to water quality and fish and wildlife habitat. Operational flexibility was further reduced under the No-Action Alternative due to the need to deliver water from CVP-controlled streams to water rights users. Diversions for water rights holders are projected to increase by more than 200,000 acre-feet of water over recent conditions, as described in the Pre-CVPIA Conditions and No-Action Alternative technical appendices. The projected increases in diversions will all be used for municipal uses which will change the storage and release patterns from the reservoirs. As discussed in the Pre-CVPIA Conditions and Surface Water and Facilities Operations technical appendices, under the No-Action Alternative, delivery of CVP water to water service contractors in many months in drier water years is incidental to operations for the Bay-Delta Plan Accord, biological opinions, water rights holders, water rights contractors, and water rights exchange contractors.

Under the Draft PEIS alternatives, the overall flexibility of the CVP water supply operations is reduced. However within each alternative, water delivery operations were improved to the greatest extent possible using the available analytical tools through an iterative process. The least amount of water supply operational flexibility occurs in Alternative 4 because the (b)(2) Water Management includes the Delta Component and because approximately 800,000 acre-feet of water is acquired to improve instream and Delta flows which reduces the amount of water available in the Delta for export by the CVP and SWP. The greatest amount of water supply operational flexibility occurs in Alternative 3 and Supplemental Analysis 1c. Under Alternative 3, acquisition of approximately 800,000 acre-feet of water for instream purposes increases Delta inflow and therefore, increases available water supplies in the Delta for export by the CVP and SWP. Under Alternative 1c, increased water costs under tiered water pricing results in reduction in CVP demand of approximately 570,000 acre-feet. This CVP water could be available for use by other CVP contractors or to improve operational flexibility.

Under the Draft PEIS alternatives, the operational analyses did not attempt to optimize power generation. Overall operational flexibility for power generation is reduced in alternatives. As discussed for water supply operations, the overall flexibility for power generation was severely reduced under the No-Action Alternative as compared to recent conditions. The alternatives further reduced the ability to generate power due to the implementation of Reoperation and (b)(2) Water Management. The Draft PEIS did not quantitatively attempt to optimize power generation under the alternatives because the programmatic level of analysis used in the PEIS was not adequate to optimize the power generation operations. Power generation must be optimized using an hourly time step because the value of power changes on an hourly basis. The Draft PEIS evaluated all water and power generation facilities operations on a monthly time step. However, as with water operations, the highest operational flexibility for power generation would occur under Alternative 3 and Supplemental Analysis 1c.

Improved Benefits due to Water Transfers and Water Conservation (Section 3402(d))

All of the Draft PEIS alternatives included water conservation programs under CVPIA, as addressed in Section 3402 (d). The water conservation programs would require implementation of all Best Management Practices that are economical and appropriate. This requirement is more stringent than previous water conservation program criteria for the State of California which did not mandate implementation of all appropriate Best Management Practices.

Water conservation and other water demand management practices also are included in Alternatives 2, 3, and 4 and Supplemental Analyses 1e, 1f, 2a through 2d, 3a, and 4a. All of these programs increase water-related benefits in California through water transfer from willing sellers to Interior under the Water Acquisition Program for fish and wildlife purposes. All of the water acquisitions would be required to meet the water transfer criteria under the SWRCB guidelines.

Water transfers under CVPIA are considered for municipal and agricultural purposes under Supplemental Analyses 1e, 1f, 2b, 2c, 3a, and 4a. These alternatives were developed and compared to a Base Transfer Scenario which is equivalent to the No-Action Alternative with non-CVPIA transfers. Because it is difficult to speculate on future actions of willing sellers and the transfer market, water transfers were not included in the main No-Action Alternative or other alternatives. Rather, these Draft PEIS alternatives considered water transfer opportunities based upon water demands, the cost of surface water and groundwater supplies, and general conveyance capacity of major facilities. Actual water transfers would be considered on a site-specific basis for which separate environmental documentation would be completed. It was assumed that the water transfers would not impact ongoing water supply operations of the CVP or other water purveyor, or that the impacts would be mitigated. The analyses do indicate that a water market exists for transferred water and that water transfers would occur with or without CVPIA. The analysis shows that if transfers occur under CVPIA, the demand would not change but would be met by CVP users rather than water rights holders. The analyses also indicate that if additional charges are added to the transferred CVP water, the transfer market would be similar to that under the Base Transfer Scenario.

Protection of the Bay-Delta (Section 3402(e))

All of the alternatives would improve water quality and biological conditions in the Bay-Delta due to the implementation of Reoperation and (b)(2) Water Management, as required under Section 3402(e). The greatest improvement would occur under Alternative 4. Under Alternative 4, the (b)(2) Water Management program includes the Bay-Delta Plan, Instream, and Delta components and the amount of water acquired for improved instream and Delta flows is the highest as compared to the other alternatives.

Achieving a Reasonable Balance Among Competing Demands (Section 3402(f))

Achieving a reasonable balance among competing uses is a principle purpose of the CVPIA, as required under Section 3402(f). Since Congress has specified a number of required actions that are included in all of the alternatives, all of the alternatives implement the purpose of the

Congressional purpose of achieving a reasonable balance. Each of the alternatives mixes various elements that modify this balance to some degree, thereby allowing the decision maker a reasonable range of choices based upon public involvement and the analysis in the NEPA process. Alternative 4 provides the greatest shift towards fish and wildlife uses and Alternative 1 provides the least shift towards these new competing uses. Supplemental Analysis 4a provides the greatest balance between the competing demands because water transfers to Interior allow improvements in instream and Delta conditions and water transfers to municipal and agricultural users allow users to meet water demands if the water prices are appropriate.

FUNDING OF CVPIA ACTIONS

The extent of the CVPIA actions evaluated in the Draft PEIS alternatives was limited by the estimated funding availability, as discussed above in the Fish and Wildlife Management Actions portion of this chapter. Many of the non-flow restoration actions would be partially funded by the Restoration Fund and partially funded by Federal funds not reimbursed by the CVP users and funds from the State of California. In addition, water acquisition, land retirement, refuge water conveyance facilities, and the (b)(1) "other" Program required funding from these sources.

General cost estimates were developed for the non-flow actions listed in Attachment F. Costs for structural provisions to improve fish passage and fish protection are estimated at approximately $368 million in capital costs and $14 million/year in operation and maintenance costs. Costs for non-flow actions for other types of habitat restoration are estimated at approximately $300 million in capital costs and $10 million/year in operation and maintenance. A portion of these costs would be funded by Restoration Fund, a portion would be funded through other Federal funds that are not identified at this time, and a portion would be funded through State funds that are not identified at this time. The estimated costs for the actions to be entirely or partially funded under the Restoration Funds under Draft PEIS alternatives are summarized in Table II-12.

The Restoration Fund has an overall limit of $50 million/year (1992 dollars) that can be collected. However, the actual amount of funds that would be collected would be less than this amount if full contract amounts cannot be delivered to CVP water service contracts due to shortages. It is estimated that the Restoration Fund would collect $40 to $45 million/year (1992 dollars) under each alternative if no water transfers occurred. This would limit the capability of Interior to implement the actions listed under CVPIA, including those actions listed under AFRP.

SUMMARY OF IMPACT ASSESSMENTS

The alternatives considered in this chapter were analyzed to determine the potential for adverse and beneficial impacts associated with implementation of the alternatives as compared to continuation of the No-Action Alternative conditions. The results of this analysis are presented in Chapter IV of this PEIS. The most significant changes under the alternatives as compared to the No-Action Alternative are related to changes in water facilities operations and deliveries, changes in power generation, improvements in fishery resources, changes in agricultural land use and economics, and improvements in waterfowl habitat, as summarized below.

TABLE II-12

ESTIMATED ANNUAL COSTS FOR ACTIONS IN ALTERNATIVES 1, 2, 3, AND 4

	Restoration Costs (in million dollars, 1992 dollars)											
	Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Actions	Restoration Funds	Other Federal Funds	State Funds	Restoration Funds	Other Federal Funds	State Funds	Restoration Funds	Other Federal Funds	State Funds	Restoration Funds	Other Federal Funds	State Funds
Non-Flow Restoration Actions	$35	$10	$15	$35	$10	$15	$35	$10	$15	$35	$10	$15
Land Retirement	$2			$2			$2			$2		
Level 2 Refuge Water Supply Conveyance Costs	$5	$5		$5	$5		$5	$5		$5	$5	
Level 4 Refuge Water Supplies					$7	$3		$7	$3		$7	$3
(b)(1) "other" Program	$2			$2			$2			$2		
Water Acquisition	$0			$10			$64			$64		
TOTAL COSTS	$44	$15	$15	$54	$22	$18	$108	$22	$18	$108	$22	$18

Note:

The estimated costs for non-flow restoration actions are presented as amortized capital costs over 30 years with annual operation and maintenance costs as appropriate.

Estimated costs for water acquisition and land retirement are shown as amortized capital costs over 30 years.

CHANGES IN WATER FACILITIES OPERATIONS

Changes in water facilities operations were identified for CVP operations, CVP water service contractors, and water rights holders that would participate in water acquisition programs. Changes to CVP operations were similar in all alternatives and were primarily related to 1) reduced diversions from the Trinity River Basin to the Sacramento River; 2) increased releases from Shasta Lake in fall, spring, and summer months to meet target flows and to meet requirements in the Sacramento River that had been partially met by water from the Trinity River Basin; 3) increased flows on Clear Creek in non-critically dry years; 4) reduction in summer releases from Folsom Lake to increase end-of-water year storage in September to stabilize flows in October through February in the American River; and 5) increased instream flows in the Stanislaus River during non-critically dry years. In the Delta, average annual CVP exports decrease primarily due to decreased spring and summer Trinity River Basin diversions to the Sacramento River and (b)(2) Water Management.

The CVP operations of reservoirs would be similar in all alternatives, although operations of New Melones Reservoir would be modified under each alternative due to water acquisitions. The CVP operations in the Delta would be similar in Alternatives 1 and 2 and Supplemental Analyses 1b through 1d, 1e through 1i, and 2a through 2c. Under Alternative 3 and Supplemental Analyses 3a, acquired water could be exported and therefore, the annual exports by both the CVP and SWP would increase as compared to other alternatives. Under Alternative 4 and Supplemental Analyses 4a, Delta exports are reduced as compared to the other alternatives due to the implementation of (b)(2) Water Management in the Delta in addition to the Bay-Delta Plan and due to use of acquired water in the streams and in the Delta.

Water deliveries to CVP water service contractors are less in each of the alternatives as compared to the No-Action Alternative. Water deliveries to the water rights contractors and exchange contractors do not change between the No-Action Alternative and the other alternatives.

For the water acquisitions actions under Alternatives 2, 3, and 4 and Supplemental Analyses 2a through 2d, 3a, and 4a, water generally would either be released in the spring or stored for release in the fall. The water acquisition increases instream flows in the river where the water is acquired and also in downstream rivers and in the Delta.

CVP water operations could vary significantly under Supplemental Analyses 1c and 2d as compared to the other alternatives. Under these alternatives, CVP water service contract demands would be reduced by 570,000 acre-feet/year due to the high price of CVP water. The water could be reallocated to other CVP contractors, used to meet other fish and wildlife needs, or transferred by the CVP contractors with reduced demands. If the water is used by other CVP contractors or transferred, CVP operations may not change noticeably. If the water is used for fish and wildlife needs, reservoir storage and stream flows may change significantly.

CHANGES IN POWER RESOURCES

Changes in CVP operations, especially increased releases for instream fish flows in the Trinity River Basin, would shift patterns of CVP power generation. Under all alternatives, peak CVP power generation would be similar and would shift from summer months to the spring and fall months when the demand for hydropower is less than in the summer. Therefore, the cost of replacement power generation to meet summer month loads may increase the overall cost of power supplies to Western Area Power Administration preference power customers. Under all alternatives, peak CVP loads would be reduced. The reduction in CVP Project Use is the least in Alternative 3 and Supplemental Analysis 3a due to increased Delta exports.

CHANGES IN FISHERY RESOURCES

Under Alternative 1 and Supplemental Analyses 1a through 1i, flows for fish would be increased on CVP-controlled rivers. Reservoirs would be reoperated to reduce short-term flow fluctuations in several rivers. In addition, non-flow actions, including improvements to fish screens, improvements to passage on several rivers, physical habitat restoration, improved water quality, and increased predator control, would be implemented. These actions would result in general improvements to all environmental conditions, although adverse effects would occur in some study area rivers. The following benefits would occur.

- Improved water temperature in Clear Creek and the Stanislaus River
- Improved conditions affecting losses to diversions in all study area rivers and in the Delta
- Reduced short-term changes in river surface levels in Clear Creek and the Sacramento, American, Tuolumne, and Merced rivers
- Reduced concentrations of pollutants in the Delta and in the Sacramento, Mokelumne, San Joaquin, Tuolumne, and Merced rivers
- Reduced levels of predation associated with diversions, barriers, and habitat structure in the Delta, in the Sacramento River and its minor tributaries, and in the Yuba, Mokelumne, San Joaquin, Stanislaus, Tuolumne, and Merced rivers
- Improvements to conditions affecting movement of adult and juvenile fish in Clear Creek, the Delta, the minor tributaries to the Sacramento River, and the Yuba, San Joaquin, and Stanislaus rivers
- Increased habitat quantity and quality in the Delta, and in all study area rivers
- Improved food web support in the Delta and in all study area rivers

The adverse impacts are mainly the result of changes in the timing of river flow patterns and reductions in the amount of water imported into the Sacramento River basin from the Trinity River basin. The following adverse impacts would occur.

- Degraded water temperature conditions in the American and Merced rivers
- Worsened conditions affecting egg and larval movement in the Sacramento River
- Decreased habitat quality and quantity in the Merced River

Conditions under Supplemental Analyses 1a and 1b would improve fishery conditions in the Delta as compared to Alternative 1 due to increased Delta inflows and reduced pumping, and additional fish protection, respectively.

Alternative 2 and Supplemental Analyses 2a through 2d include all the actions implemented under Alternative 1 and increase flow on the San Joaquin, Stanislaus, Tuolumne, and Merced rivers. In addition to those benefits described under Alternative 1, this alternative would result in the following benefits for fish. No additional adverse impacts would occur.

- ♦ Improved water temperature conditions in the Stanislaus, Tuolumne and Merced rivers
- ♦ Improved conditions affecting losses to diversions in the Delta
- ♦ Improved conditions related to fish movement in the Delta and in the San Joaquin, Stanislaus, Tuolumne, and Merced rivers
- ♦ Improved habitat quality and quantity in the Delta and in the San Joaquin, Stanislaus, Tuolumne, and Merced rivers
- ♦ Improved food web support in the Delta and in the San Joaquin, Stanislaus, Tuolumne, and Merced rivers

Conditions under Supplemental Analyses 2a would improve most fishery conditions in the Delta as compared to Alternative 2 due to additional fish protection. Adverse impacts may occur for delta smelt and striped bass.

Alternative 3 and Supplemental Analyses 3a include all the actions implemented under Alternative 2 and increase flow on the minor tributaries to the Sacramento River and the Yuba, Mokelumne, Calaveras, San Joaquin, Stanislaus, Tuolumne, and Merced rivers. In addition to those benefits described under Alternative 2, this alternative would result in the following benefits for fish. No additional impacts would occur.

- ♦ Improved water temperature conditions in the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers
- ♦ Improved conditions for some fish species affecting loss to diversions in the Delta
- ♦ Improved conditions related to short-term changes in river surface level in the Yuba and Mokelumne rivers
- ♦ Improved conditions related to fish movement in the Delta and in the Yuba, Mokelumne, San Joaquin, Stanislaus, Tuolumne, and Merced rivers
- ♦ Improved habitat quality and quantity in the Delta and in the Yuba, Mokelumne, San Joaquin, Stanislaus, Tuolumne, and Merced rivers
- ♦ Improved food web support in the Delta and in the Yuba, Mokelumne, San Joaquin, Stanislaus, Tuolumne, and Merced rivers

Alternative 4 and Supplemental Analysis include all the actions implemented under Alternative 3 and adds improvements to passage, diversions, and flow in the Delta. In addition to those benefits described under Alternative 3, this alternative would result in the following benefits for fish. No additional impacts would occur.

- ♦ Improved conditions affecting losses to diversions in the Delta
- ♦ Improved conditions related to movement in the Delta
- ♦ Increased habitat quality and quantity in the Delta
- ♦ Improved food web support in the Delta

While doubling of fish populations may not be achieved under any of these alternatives, Interior believes improvements will occur.

CHANGES IN AGRICULTURAL LAND USE AND ECONOMICS

Implementation of the alternatives would result in changes in irrigated acreage. In the Sacramento River Region, the reduction in irrigated acreage would range from less than 0.1% in Alternative 1 to 1% in Alternative 4 as compared to the No-Action Alternative. This would result in a change in gross revenue that ranged from 0.01% to 0.5%, respectively.

The total percentage change in irrigated acreage was the highest in the San Joaquin River Region in all alternatives. The reduction in irrigated acreage would range from 1% in Alternative 1 to 6% in Alternative 4 as compared to the No-Action Alternative. This would result in a change in gross revenue that ranged from 0.7% to 2%, respectively.

In the Tulare Lake Region reduction in irrigated acreage would range from 0.6% in Alternative 3 to 0.9% in Alternative 4 as compared to the No-Action Alternative. This would result in a change in gross revenue that ranged from 0.3% to 0.4%, respectively.

CHANGES IN VEGETATION AND WILDLIFE

Under the No-Action Alternative, urban development could affect special-status species in all study regions. In areas served by the CVP, the Conservation Program will benefit the biological needs of priority special-status species through land acquisition, habitat management, habitat restoration, and monitoring and species management studies.

Under Alternative 1 and Supplemental Analyses 1a through 1i, fallowing and retirement would benefit special-status wildlife species in the San Joaquin River and Tulare Lake regions. The restoration of a meander belt on the upper Sacramento River would have a beneficial effect on riparian habitat in the area, and riparian restoration on other rivers in the Sacramento River and San Joaquin River regions would have locally beneficial effects on the extent and condition of riparian habitat. This restoration would also benefit the special-status wildlife species that inhabit riparian areas. Level 2 refuge water supplies would increase the amount of wetland habitat available to waterfowl and waterbirds. Higher levels of bird use and less-than-optimal wetland availability could result in increased crowding of waterfowl, which may lead to outbreaks of avian diseases. The flooding of approximately 80,000 acres of agricultural habitat during winter would offer major benefits for migratory waterfowl, shorebirds, and wading birds, including special-status species.

Implementation of the b(1) “other” program would benefit species not specifically identified in the CVPIA through habitat restoration, maintenance, enhancement, and protection through partnerships with willing landowners, coordination with ongoing state and federal habitat restoration activities, and partnerships with other agencies and the public.

The impacts of Alternative 2 and Supplemental Analyses 2a through 2d would be similar to those of Alternative 1. In addition, higher spring flows on the Stanislaus, Tuolumne, and Merced rivers would lead to a higher stage for the San Joaquin River at Vernalis, and would benefit riparian habitat. Further, the provision of Level 4 refuge water supplies would lead to optimal management of these facilities by increasing food availability, decreasing potential for disease by increasing “flow-through” of water, improving foraging conditions by maintaining water depths at optimal levels, and improving the control of undesirable vegetation.

The impacts of Alternatives 3 and 4 and Supplemental Analyses 3a and 4a would be similar to those of Alternative 2, except that additional agricultural land would be fallowed, and conservation easements would be acquired on a portion of the land. Further, increased flows in the Stanislaus, Tuolumne, and Merced rivers would lead to greater improvements in riparian vegetation on the San Joaquin River near Vernalis.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Contract renewals could be considered as essentially irreversible and irretrievable commitments of water resources during the period of the contract. Also, additional commitment of water to Delta outflow for fishery uses is lost for freshwater uses south of the Delta. Construction of habitat restoration, groundwater wells by CVP contractors to replace reduced CVP water supplies, and fish passage facilities are included in all of the alternatives.

SHORT-TERM USES OF THE ENVIRONMENT VERSUS LONG-TERM PRODUCTIVITY

None of the Draft PEIS alternatives detract from long-term environmental productivity. Rather, the alternatives may change long-term uses of water resources enhancing the net productivity of the natural and human environments.

SUMMARY OF IMPACTS AND BENEFITS

The impacts and benefits of implementing the Draft PEIS alternatives are summarized in Tables II-13 (surface water, CVP power resources, and groundwater), II-14 (fisheries and vegetation/wildlife resources), II-15 (recreation, fish/wildlife/recreation economics, and cultural resources), and II-16 (agricultural economics and land use, municipal water costs, regional economics, and social analysis). Impacts in air quality, mosquitos as a public health risk, drinking water quality considerations in the Delta, soils and geology, and visual resources did not markedly change across the alternatives and therefore are not summarized in these tables. The alternative with the most environmental benefits is Alternative 4 or Supplemental Analysis 4a. The other alternatives have varying degrees of benefits and impacts to the issue areas as evaluated at the programmatic level.

ENVIRONMENTAL COMMITMENTS AND UNAVOIDABLE ADVERSE IMPACTS

Adverse impacts of implementation of the Draft PEIS alternatives are summarized in Table II-17. Adverse impacts to some issues can be reduced through the adoption of environmental commitments, as shown in Table II-17. The environmental commitments are presented as potential mitigations. The final environmental commitments would be selected based upon comments received on the Draft PEIS and the final selected range of actions.

TABLE II-13

SUMMARY OF IMPACT ASSESSMENT FOR SURFACE WATER, CVP POWER RESOURCES, AND GROUNDWATER

Alternative or Supplemental Analysis	Surface Water	Groundwater	CVP Power Resources
No-Action Alternative	**Average Annual CVP Deliveries** 5,770,000 acre-feet **Average Annual SWP Deliveries** 3,330,000 acre-feet Reservoir operations, river flows, and Delta outflow are generally as described under affected environment, with changes in operations due to increased water rights and M&I demands at a 2020 level of development. Average annual refuge deliveries of about 335,000 acre-feet from historical sources.	**Average Regional Depth to Groundwater** Sacramento River Region (west): 94 feet. Sacramento River Region (east): 100 feet. San Joaquin River Region: 85 feet. Tulare Lake Region (north): 200 feet. Tulare Lake Region (south): 313 feet. **Potential for Long-Term Change in Subsidence** Sacramento River Region: increase above recent conditions near Davis-Zamora. San Joaquin River Region: increase above recent conditions on westside. Tulare Lake Region: increase above recent conditions on westside.	**CVP Generation** Average annual: 4935 GWh/yr. Average annual dry period (1929-1934): 2764 GWh/yr. Average monthly available capacity: 1597 MW. Average monthly dry period (1929-1934) available capacity: 1380 MW. **CVP Project Use** Average annual: 1425 GWh/yr. Average annual dry period (1929-1934): 974 GWh/yr. Average monthly on-peak capacity: 184 MW. Average monthly dry period (1929-1934) on-peak capacity: 142 MW. **Market Value of Power** Average annual energy available for sale: 3511 GWh/yr. Average monthly capacity with energy for sale: 756 MW, based on 90 percent exceedence synthetic dry year. Average monthly capacity without energy for sale: 708 MW, based on 90 percent exceedence synthetic dry year. Total average annual market value: $125,800,000.

TABLE II-13. CONTINUED

Alternative or Supplemental Analysis	Surface Water	Groundwater	CVP Power Resources
1 Changes as Compared to the No-Action Alternative	**Average Annual CVP Deliveries** Reduction of 470,000 acre-feet due to instream (b)(2) Water Management component, increased Level 2 refuge deliveries, and increased Trinity River inflows. **Average Annual SWP Deliveries** Potential increase of 100,000 acre-feet due to incidental benefit as a result of the actions in Alternative 1 Increase and stabilize fall/winter Shasta and Folsom lakes releases per AFRP flow targets. Average annual Shasta September carry over storage reduced by 60,000 acre-feet. Increase average annual Folsom Lake September carry over storage by 80,000 acre-feet. Increase Clear Creek flows to meet AFRP flow targets in all but critically dry years. Provide Stanislaus spring pulse flows in April through June in all but critical dry years. Average annual New Melones Reservoir September carry over storage decreases by 100,000 acre-feet. Trinity River flows increase from 50,000 to 410,000 acre-feet/year depending on water year type. Average annual Claire Engle Lake September carry over storage decreases by 200,000 acre-feet. Average Annual Trinity River Basin diversions to the Sacramento River decrease by 180,000 acre-feet. Average annual Delta outflows reduced by 60,000 acre-feet due primarily to the reduction in diversions from the Trinity River Basin. CVP provides additional 233,000 acre-feet in average annual refuge deliveries to provide Level 2 refuge water supplies.	**Change in Average Regional Depth to Groundwater** Sacramento River Region (west): no change. Sacramento River Region (east): increase depth 2%. San Joaquin River Region: increase depth 2%. Tulare Lake Region (north): increase depth 3%. Tulare Lake Region (south): decrease depth 1%. **Potential for Long-Term Change in Subsidence** Sacramento River Region: same as No-Action Alternative. San Joaquin River Region: increase from No-Action Alternative. Tulare Lake Region: increase from No-Action Alternative.	**CVP Generation** Average annual reduction of 5.4%. Average annual dry period (1929-1934) reduction of 5.0%. Average monthly available capacity reduction of 1.4%. Average monthly dry period (1929-1934) available capacity reduction of 4.7%. **CVP Project Use** Average annual reduction of 10.3%. Average annual dry period (1929-1934) reduction of 10.7%. Average monthly on-peak capacity reduction of 8.1%. Average monthly dry period (1929-1934) on-peak capacity reduction of 8.9%. **Market Value of Power** Reduction in average annual energy available for sale of 3.4%. Increase in average monthly capacity with energy for sale of 6.0%, based on 90% exceedence synthetic dry year. Reduction in average monthly capacity without energy for sale of 12.1%, based on 90% exceedence synthetic dry year. Increase in total average annual market value of 0.1%.

TABLE II-13. CONTINUED

Alternative or Supplemental Analysis	Surface Water	Groundwater	CVP Power Resources
1a Changes as Compared to Alternative 1	**<u>Average Annual CVP Deliveries</u>** Reduction of 100,000 acre-feet due to use of (b)(2) Water Management actions in addition to Bay-Delta Plan Accord. **<u>Average Annual SWP Deliveries</u>** Decrease of 40,000 acre-feet in average annual SWP deliveries. North of Delta reservoir and river operations are similar to Alternative 1 Average annual Delta outflows increased by 140,000 acre-feet, due to use of (b)(2) Water Management for Delta components. Reduced CVP operational flexibility to fill San Luis Reservoir in the fall and supplement San Luis Reservoir releases in April and May. Average annual refuge deliveries are the same as Alternative 1.	Conditions are similar to Alternative 1 except in Tulare Lake Region (north) where average regional depth to groundwater increases by 6 percent.	CVP power generation would be similar to Alternative 1. CVP Project Use would be reduced due to the decrease in CVP deliveries and Tracy Pumping Plant exports.
1b Changes as Compared to Alternative 1	Average annual conditions similar to Alternative 1 Potential need for additional CVP and SWP reservoir releases during dry years to offset potentially higher salinity water entering the Delta due to increased reverse flows in the lower San Joaquin River west of Jersey Point.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.
1c Changes as Compared to Alternative 1	Reduction of 570,000 acre-feet in CVP average annual deliveries due to increased water pricing. Use of non-delivered CVP water not determined at this time. Options include re-allocation to other CVP contractors, transfer by CVP contractors with reduced demand, or use for fish and wildlife purposes.	Changes in groundwater conditions will depend on revised surface water operations. Use of non-delivered CVP water not determined at this time.	Changes in power resources will depend of revised surface water operations. Use of non-delivered CVP water not determined at this time.

TABLE II-13. CONTINUED

Alternative or Supplemental Analysis	Surface Water	Groundwater	CVP Power Resources
1d Changes as Compared to Alternative 1	**<u>Average Annual CVP Deliveries</u>** Reduction of 50,000 acre-feet in dry period (1928-1934) due to full water deliveries to refuges in critical dry years. **<u>Average Annual SWP Deliveries</u>** Dry period (1928-1934) same as Alternative 1. Average annual conditions are similar to Alternative 1, plus Increase of 30,000 acre-feet in dry period (1928-1934) average annual refuge deliveries.	Conditions are similar to Supplemental Analysis 1a.	Conditions are similar to Alternative 1.
1e Changes as Compared to Alternative 1	Conditions are similar to Alternative 1, except in dry years when site-specific transfer operations may affect surface water operations. Further site-specific analyses will be required.	Conditions are similar to Alternative 1, except in dry years when site-specific transfer operations may affect surface water operations. Further site-specific analyses will be required.	Conditions are similar to Alternative 1, except in dry years when site-specific transfers may affect power operations. Further site-specific analyses will be required.
1f Changes as Compared to Alternative 1	Conditions are similar to Supplemental Analysis 1e.	Conditions are similar to Supplemental Analysis 1e.	Conditions are similar to Supplemental Analysis 1e.
1g Changes as Compared to Alternative 1	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.
1h Changes as Compared to Alternative 1	Conditions are the same as Alternative 1.	Conditions are the same as Alternative 1.	Conditions are the same as Alternative 1.
1i Changes as Compared to Alternative 1	Conditions are the same as Alternative 1.	Conditions are the same as Alternative 1.	Conditions are the same as Alternative 1.

TABLE II-13. CONTINUED

Alternative or Supplemental Analysis	Surface Water	Groundwater	CVP Power Resources
2 Changes as Compared to the No-Action Alternative	**<u>Average Annual CVP Deliveries</u>** Reduction of 590,000 acre-feet due to actions described under Alternative 1, plus assumed purchase of about 120,000 acre-feet/year for Level 4 refuge supplies from Sacramento River Water Rights and San Joaquin River Exchange Contractors. **<u>Average Annual SWP Deliveries</u>** Potential increase of 80,000 acre-feet due to the actions described under Alternative 1, plus assumed purchase of about 20,000 acre-feet/year for Level 4 refuge supplies from SWP willing sellers south of the Delta. CVP reservoir operations and river flows as a result of (b)(2) Water Management are similar to Alternative 1 Increase April through June flows on the Stanislaus River due to acquisition of 60,000 acre-feet/year from willing sellers. Increase April through June flows on the Tuolumne River due to acquisition of 60,000 acre-feet/year from willing sellers. Increase April through June flows on the Merced River due to acquisition of 50,000 acre-feet/year from willing sellers. Acquired water was not exported from the Delta, resulting in an 80,000 acre-feet average annual increase in Delta outflow. Increase of 370,000 acre-feet in average annual refuge deliveries due to the CVP providing Level 2 deliveries and acquisition of additional Level 4 refuge water supplies.	**<u>Change in Average Regional Depth to Groundwater</u>** Sacramento River Region (west): increase depth 1%. Sacramento River Region (east): increase depth 2%. San Joaquin River Region: increase depth 3%. Tulare Lake Region (north): increase depth 4%. Tulare Lake Region (south): decrease depth 1%. **<u>Potential for Long-Term Change in Subsidence</u>** Sacramento River Region: same as No-Action Alternative. San Joaquin River Region: similar to Alternative 1. Tulare Lake Region: similar to Alternative 1.	**<u>CVP Generation</u>** Average annual reduction of 5.2%. Average annual dry period (1929-1934) reduction of 4.7%. Average monthly available capacity reduction of 1.4%. Average monthly dry period (1929-1934) available capacity reduction of 4.8%. **<u>CVP Project Use</u>** Average annual reduction of 10.2%. Average annual dry period (1929-1934) reduction of 10.6%. Average monthly on-peak capacity reduction of 7.9%. Average monthly dry period (1929-1934) on-peak capacity reduction of 9.3%. **<u>Market Value of Power</u>** Reduction in average annual energy available for sale of 3.2%. Increase in average monthly capacity with energy for sale of 2.8%, based on 90% exceedence synthetic dry year. Reduction in average monthly capacity without energy for sale of 8.4%, based on 90% exceedence synthetic dry year. Reduction in total average annual market value of 0.9%.

TABLE II-13. CONTINUED

Alternative or Supplemental Analysis	Surface Water	Groundwater	CVP Power Resources
2a Changes as Compared to Alternative 2	Average annual conditions are similar to Alternative 2 Potential need for additional CVP and SWP reservoir releases during dry years to offset potentially higher salinity water entering the Delta due to increased reverse flows in the lower San Joaquin River west of Jersey Point.	Conditions are similar to Alternative 2.	Conditions are similar to Alternative 2.
2b Changes as Compared to Alternative 2	Conditions are similar to Alternative 2, except in dry years when site-specific transfer operations may affect surface water operations. Further site-specific analyses will be required.	Conditions are similar to Alternative 2, except in dry years when site-specific transfer operations may affect groundwater operations and groundwater levels. Further site-specific analyses will be required.	Conditions are similar to Alternative 2, except in dry years when site-specific transfers may affect power operations. Further site-specific analyses will be required.
2c Changes as Compared to Alternative 2	Conditions are similar to Supplemental Analysis 2b.	Conditions are similar to Supplemental Analysis 2b.	Conditions are similar to Supplemental Analysis 2b.
2d Changes as Compared to Alternative 2	Reduction of CVP average annual deliveries due to increased water pricing are similar to Supplemental Analysis 1c. Use of non-delivered CVP water not determined at this time. Options include re-allocation to other CVP contractors, transfer by CVP contractors with reduced demand, or use for fish and wildlife purposes.	Changes in groundwater conditions will depend on revised surface water operations. Use of non-delivered CVP water not determined at this time.	Changes in power resources will depend of revised surface water operations. Use of non-delivered CVP water not determined at this time.

TABLE II-13. CONTINUED

Alternative or Supplemental Analysis	Surface Water	Groundwater	CVP Power Resources
3 Changes as Compared to the No-Action Alternative	**<u>Average Annual CVP Deliveries</u>** Reduction of 390,000 acre-feet due to actions described under Alternative 2 and export of acquired water. Purchase of 120,000 acre-feet/year for Level 4 refuge supplies from Sacramento River Water Rights and San Joaquin River Exchange Contractors. **<u>Average Annual SWP Deliveries</u>** Potential increase of 270,000 acre-feet due to ability to export acquired water. Purchase of 20,000 acre-feet/year for Level 4 refuge supplies from SWP users. North of Delta CVP reservoir operations and river flows similar to Alternative 1. Increase flows on the Stanislaus River in fall and winter months with pulse flows in April through June, due to acquisition of 200,000 acre-feet/year. Increase flows on the Tuolumne and Merced rivers in most months with pulse flows in April through June, due to acquisition of 200,000 acre-feet/year/river. Increase winter and spring flows and decrease summer and fall flows on the Calaveras River, due to acquisition of 30,000 acre-feet/year. Increase fall through spring flows on the Mokelumne River due to acquisition of 70,000 acre-feet/year. Increase spring, summer, and fall flows on the Yuba River due to acquisition of 100,000 acre-feet/year. Increase flows on the San Joaquin River at Vernalis in nearly all months due to additional releases from tributaries with pulse flows in April and May. Average annual Delta outflows increase by about 200,000 acre-feet/year Refuge deliveries are same as Alternative 2.	**<u>Change in Average Regional Depth to Groundwater</u>** Sacramento River Region (west): increase depth 1%. Sacramento River Region (east): increase depth 5%. San Joaquin River Region: increase depth 4%. Tulare Lake Region (north): increase depth 1%. Tulare Lake Region (south): decrease depth 3%. **<u>Potential for Long-Term Change in Subsidence</u>** Sacramento River Region: same as No-Action Alternative. San Joaquin River Region: less than Alternative 1. Tulare Lake Region: less than Alternative 1.	**<u>CVP Generation</u>** Average annual reduction of 5.3%. Average annual dry period (1929-1934) reduction of 5.3%. Average monthly available capacity reduction of 1.3%. Average monthly dry period (1929-1934) available capacity reduction of 4.9%. **<u>CVP Project Use</u>** Average annual reduction of 4.0%. Average annual dry period (1929-1934) increase of 1.6%. Average monthly on-peak capacity reduction of 2.8%. Average monthly dry period (1929-1934) on-peak capacity increase of 0.2%. **<u>Market Value of Power</u>** Reduction in average annual energy available for sale of 5.8%. Increase in average monthly capacity with energy for sale of 3.2%, based on 90% exceedence synthetic dry year. Reduction in average monthly capacity without energy for sale of 13.7%, based on 90% exceedence synthetic dry year. Reduction in total average annual market value of 2.2%.

TABLE II-13. CONTINUED

Alternative or Supplemental Analysis	Surface Water	Groundwater	CVP Power Resources
3a Changes as Compared to Alternative 3	Conditions are similar to Alternative 3, except in dry years when site-specific transfer operations may affect surface water operations. Further site-specific analyses will be required.	Conditions are similar to Alternative 3, except in dry years when transfers could affect groundwater conditions. Further site-specific analyses will be required.	Conditions are similar to Alternative 3, except in dry years when site-specific transfers may affect power operations. Further site-specific analyses will be required.
4 Changes as Compared to the No-Action Alternative	**<u>Average Annual CVP Deliveries</u>** Reduction of 620,000 acre-feet due to actions in Alternative 3 plus use of (b)(2) Water Management for Delta components. Purchase of about 120,000 acre-feet/year for Level 4 refuge supplies from Sacramento River Water Rights and San Joaquin River Exchange Contractors. **<u>Average Annual SWP Deliveries</u>** Average annual SWP deliveries are similar to the No-Action Alternative. Purchase of about 20,000 acre-feet/year for Level 4 refuge supplies from SWP willing sellers south of the Delta. North of Delta CVP reservoir operations and river flows as a result of (b)(2) Water Management are similar to Alternative 1. Tracy Pumping Plant exports are reduced due to (b)(2) actions in the Delta. Increases in stream flows due to acquired water are the same as Alternative 3. Acquired water was not exported from the Delta, resulting in an 780,000 acre-feet average annual increase in Delta outflow. Refuge deliveries are the same as Alternative 2.	**<u>Change in Average Regional Depth to Groundwater</u>** Sacramento River Region (west): increase depth 1%. Sacramento River Region (east): increase depth 5%. San Joaquin River Region: increase depth 5%. Tulare Lake Region (north): increase depth 5%. Tulare Lake Region (south): decrease depth 1%. **<u>Potential for Long-Term Change in Subsidence</u>** Sacramento River Region: same as No-Action Alternative. San Joaquin River Region: similar to Alternative 1. Tulare Lake Region: increase from Alternative 1.	**<u>CVP Generation</u>** Average annual reduction of 5.1%. Average annual dry period (1929-1934) reduction of 4.8%. Average monthly available capacity reduction of 1.6%. Average monthly dry period (1929-1934) available capacity reduction of 4.8%. **<u>CVP Project Use</u>** Average annual reduction of 11.3%. Average annual dry period (1929-1934) reduction of 11.5%. Average monthly on-peak capacity reduction of 10.0%. Average monthly dry period (1929-1934) on-peak capacity reduction of 9.9%. **<u>Market Value of Power</u>** Reduction in average annual energy available for sale of 2.6%. Increase in average monthly capacity with energy for sale of 2.6%, based on 90% exceedence synthetic dry year. Reduction in average monthly capacity without energy for sale of 15.9%, based on 90% exceedence synthetic dry year. Reduction in total average annual market value of 1.4%.

TABLE II-13. CONTINUED

Alternative or Supplemental Analysis	Surface Water	Groundwater	CVP Power Resources
4a Changes as Compared to Alternative 4	Conditions are similar to Alternative 4, except in dry years when site-specific transfer operations may affect surface water operations. Further site-specific analyses will be required.	Conditions are similar to Alternative 4, except in dry years when transfers could affect groundwater conditions. Further site-specific analyses will be required.	Conditions are similar to Alternative 4, except in dry years when site-specific transfers may affect power operations. Further site-specific analyses will be required.

TABLE II-14

SUMMARY OF IMPACT ASSESSMENT FOR FISHERIES AND VEGETATION AND WILDLIFE RESOURCES

Alternative or Supplemental Analysis	Fishery Resources	Vegetation and Wildlife Resources
No-Action Alternative	Improved downstream temperature conditions in the Sacramento River due to operation of the Shasta Temperature Control Device which provides increased flexibility in the maintenance and use of the cold water pool in Shasta Lake, and due to improved flows under the Bay-Delta Plan Accord.	Conservation Program implemented, and will improve conditions for federally listed, proposed, and candidate species.
1 Changes as compared to No-Action Alternative	Stream flow improvements combined with structural and other habitat restoration actions in Clear Creek and in the Sacramento, American, and Stanislaus rivers would benefit all life stages of representative fish species including chinook salmon, steelhead trout, sturgeon, American shad, and striped bass. Increases in the Trinity River fishery flow pattern would increase transport for salmon and steelhead trout. Increases in river flows and/or structural actions would improve passage and access to previously unavailable or under-used stream habitats. Conditions for downstream fish movement would decline in the Sacramento River due to decreased flows as a result of lower diversions from the Trinity River Basin. Structural actions would provide improved passage to previously unavailable or under-used stream habitats for adult, egg, and juvenile life stages of representative species in Clear Creek, the minor tributaries to the Sacramento, Yuba, and San Joaquin rivers, and the Delta. Fish screen construction or improvements would benefit representative species on the Sacramento, Feather, Yuba, Bear, American, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, and San Joaquin rivers, and in the Delta. Decreases in river water temperatures in Clear Creek, minor tributaries to the Sacramento River, the Yuba River, and Stanislaus River. Increase in water temperatures on the American River in June through September, due to reduced summer flows, would adversely affect steelhead trout. Combined effects of increased instream flows, lower instream water temperatures, habitat restoration, and structural improvements would improve food web and habitat quantity and quality in all rivers except the Merced River.	There are benefits for species through habitat acquisition, management, restoration, and studies in (b)(1) “other” program. 30,000 acres of retired agricultural land provide potential habitat for special-status species and other species associated with grassland and alkali desert scrub habitats. 18,000 acres of fallowed land provide potential habitat. Riparian restoration on the Sacramento and San Joaquin rivers and their tributaries improves habitat for dependent special-status species and other species. Improved fisheries provide additional prey for fish-eating predators. Level 2 water deliveries improve wetland management for water birds and shore birds but do not allow for optimal management. Up to 80,000 acres of agricultural fields are flooded to provide additional wetland habitat for migratory water birds and other species.

TABLE II-14. CONTINUED

Alternative or Supplemental Analysis	Fishery Resources	Vegetation and Wildlife Resources
1a Changes as compared to Alternative 1	Further reductions in exports at Delta pumping facilities during April and May decrease diversion related losses and improved species survival. Increases in Delta outflow in January through June would improve egg, larval, and juvenile life stage survival of representative species during temporary residence in the Delta, through better movement from less productive habitat in the central and south Delta towards more productive habitat near Suisun Bay Increase in Delta habitat quantity and quality due to increased Delta outflow, reduced exports, and extension of X2 2 ppt isohaline farther downstream in April and May.	Conditions are similar to Alternative 1.
1b Changes as compared to Alternative 1	The decrease in flow into the central Delta from the Sacramento River reduces juvenile life stage diversion-related losses and improves downstream fish movement in the Sacramento River. Representative species are transported towards more productive habitat near Suisun Bay, rather than entering the central Delta. Old River barrier facility would assist the outmigration of juvenile salmon from the San Joaquin River and reduce exposure to CVP and SWP pumping facilities. An increase in losses of striped bass and delta smelt rearing in the north and central Delta would result from barrier closure.	Conditions are similar to Alternative 1.
1c Changes as compared to Alternative 1	Use of non-delivered CVP water not determined at this time. Changes to fisheries conditions due to potential changes in surface water operations will require further site specific analyses.	Impacts could range from those similar to Alternative 1, to additional benefits for riparian vegetation and wildlife habitat near reservoirs and/or rivers in the Sacramento River, San Joaquin River, and Sacramento-San Joaquin Delta regions.
1d Changes as compared to Alternative 1	Conditions are similar to Alternative 1.	Conditions are the same as Alternative 1, except for additional habitat provided for water birds during dry years at federal and state refuges, and at the Grasslands Resource Conservation District.
1e Changes as compared to Alternative 1	Conditions are similar to Alternative 1, except in dry years when site specific transfer operations may affect reservoir operations, river flows, and Delta exports.	Conditions are similar to Alternative 1.

TABLE II-14. CONTINUED

Alternative or Supplemental Analysis	Fishery Resources	Vegetation and Wildlife Resources
1f Changes as compared to Alternative 1	Conditions are similar to Supplemental Analysis 1e.	Conditions are similar to Alternative 1.
1g Changes as compared to Alternative 1	Conditions are similar to Alternative 1.	Conditions are the same as Alternative 1.
1h Changes as compared to Alternative 1	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1, however, restoration of some fallowed lands to natural habitats could benefit indigenous species, including 27 special-status plant and wildlife species.
1i Changes as compared to Alternative 1	Red Bluff Diversion Dam gates would no longer be closed during the summer, thereby reducing mortality of chinook salmon and steelhead trout that migrate in downstream rearing habitats. Restoration of the river reach affected by Lake Red Bluff would create additional spawning and rearing habitat, and reduce predation losses.	Conditions are the same as Alternative 1.

TABLE II-14. CONTINUED

Alternative or Supplemental Analysis	Fishery Resources	Vegetation and Wildlife Resources
2 Changes as compared to No-Action Alternative	Benefits to fisheries would be similar to Alternative 1, plus River water temperature conditions would improve due to increased April through June flows on the Tuolumne, Merced, and Stanislaus rivers. Increases in river flows in the Stanislaus, Tuolumne, Merced, and lower San Joaquin rivers would promote downstream movement of juvenile life stage species in these rivers. Greater flows from the San Joaquin River towards Suisun Bay would further improve Delta flow conditions, reduce diversion losses, and facilitate the movement of organisms into more productive habitat. The combined effects of the actions in Alternative 2 would further improve habitat quality and quantity in the Bay-Delta and in the Stanislaus, Tuolumne, Merced, and lower San Joaquin rivers. The combined affects would also provide further improvement in food web support in the Bay-Delta and in the Stanislaus, Tuolumne, Merced, and lower San Joaquin rivers.	Conditions are the same as Alternative 1, except 55,000 acres of fallowed land provide additional potential habitat. Increased spring flows on the tributaries to the San Joaquin River improve riparian habitat for riparian-dependent species, including special status species along the San Joaquin River. Further improvements in fisheries provide additional prey for fish-eating predators. Level 4 water deliveries allow improved wetland habitat management.

TABLE II-14. CONTINUED

Alternative or Supplemental Analysis	Fishery Resources	Vegetation and Wildlife Resources
2a Changes as compared to Alternative 2	The decrease in flow into the central Delta from the Sacramento River reduces juvenile life stage diversion-related losses and improves downstream fish movement in the Sacramento River. Representative species are transported towards more productive habitat near Suisun Bay, rather than entering the central Delta. Old River barrier facility would assist the outmigration of juvenile salmon from the San Joaquin River and reduce exposure to CVP and SWP pumping facilities. Increase in losses of striped bass and delta smelt rearing in the north and central Delta would result from barrier closure.	Conditions are similar to Alternative 2.
2b Changes as compared to Alternative 2	Conditions are similar to Alternative 2, except in dry years when site specific transfer operations may affect reservoir operations, river flows, and Delta exports.	Conditions are similar to Alternative 2.
2c Changes as compared to Alternative 2	Conditions are similar to Supplemental Analysis 2b.	Conditions are similar to Supplemental Analysis 2b.
2d Changes as compared to Alternative 2	Use of non-delivered CVP water not determined at this time. Changes to fisheries conditions due to potential changes in surface water operations will require further site specific analyses.	Conditions are similar to Supplemental Analysis 1c.

TABLE II-14. CONTINUED

Alternative or Supplemental Analysis	Fishery Resources	Vegetation and Wildlife Resources
3 Changes as compared to No-Action Alternative	Benefits to fisheries would be similar to Alternative 2, plus Further improvements in temperature conditions on the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers, due to increased spring stream flows in combination with habitat restoration actions, would benefit rearing juvenile and fry chinook salmon and steelhead trout. Reductions in diversions on the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers would benefit migrating juvenile chinook salmon and steelhead trout. Overall conditions affecting diversion losses in the Delta would further improve due to increased Delta outflow, even though there are increased Delta exports of acquired water in August through May. Reductions in flow fluctuations on the Yuba and Mokelumne rivers would reduce stranding and benefit egg, fry, and juvenile life stages of chinook salmon and steelhead trout. Pulse flows on the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced, and San Joaquin rivers would primarily benefit outmigration of of fall-run juvenile chinook salmon. Further increases in spring and summer net Delta channel flows toward Suisun Bay would increase movement of larval and juvenile striped bass, delta smelt, longfin smelt, and juvenile chinook salmon and steelhead trout toward more productive habitat. The combined effects of the actions in Alternative 3 would further improve habitat quality and quantity in the Bay-Delta and in the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, and lower San Joaquin rivers. The combined effects would also provide further improvement in food web support in the Bay-Delta and in the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, and lower San Joaquin rivers.	Conditions are the same as Alternative 2, except 137,000 acres of fallowed land provide potential habitat. Conservation easements could be acquired on 15% of fallowed land in the San Joaquin River Region. Increased spring flows on the tributaries to the San Joaquin River improve riparian habitat for riparian-dependent species along the San Joaquin River. Further improvements in fisheries provide additional prey for fish-eating predators.

TABLE II-14. CONTINUED

Alternative or Supplemental Analysis	Fishery Resources	Vegetation and Wildlife Resources
3a Changes as compared to Alternative 3	Conditions are similar to Alternative 3, except in dry years when site specific transfer operations may affect reservoir operations, river flows, and Delta exports.	Conditions are similar to Alternative 3.
4 Changes as compared to No-Action Alternative	Benefits to fisheries water would be similar to Alternative 3, plus Reductions in Delta exports and the corresponding increase in Delta outflow, due to the Delta (b)(2) actions and acquired water, shift the distribution of Delta species downstream into more productive habitat and away from the influence of Delta diverions. The Delta Cross Channel would be closed for Delta (b)(2) actions in November through January of wetter years facilitating the outmigration of juvenile chinook salmon and steelhead trout down the Sacramento River. This would help improve survivial and reduce their movement into the central Delta where they are exposed to increased diversions and predation. Increases in Delta outflow in all months would shift estuarine salinity downstream increasing habitat availability for Sacramento splittail, delta smelt, longfin smelt, and striped bass. Food web support in the Delta would increase due to reduced diversions that entrain food web organisms and nutrients. Also, the downstream shift in estuarine salinity would increase production of prey and benefit rearing life stages of all representative species.	Conditions are the same as Alternative 3, except 160,000 acres of fallowed land provide potential habitat. Conservation easements could be acquired on 15% of fallowed land in the San Joaquin River Region. Further improvements in fisheries provide additional prey for fish-eating predators.
4a Changes as compared to Alternative 4	Conditions are similar to Alternative 4, except in dry years when site specific transfer operations may affect reservoir operations, river flows, and Delta exports.	Conditions are similar to Alternative 4.

TABLE II-15

SUMMARY OF IMPACT ASSESSMENT FOR RECREATION, FISH/WILDLIFE/RECREATION ECONOMICS, AND CULTURAL RESOURCES

Alternative or Supplemental Analysis	Recreation	Fish, Wildlife, and Recreation Economics	Cultural Resources
No-Action Alternative	Conditions are similar to Affected Environment.	$145 million per year in recreation-related expenditure at reservoirs and refuges in the Sacramento River Region, and about $85 million per year in the San Joaquin River and Tulare Lake Region combined. Additional, unquantified expenditure and benefits to river recreation in the Sacramento River Region, and to ocean recreation related to anadromous fisheries.	Conditions are similar to Affected Environment.
1 Changes as compared to No-Action Alternative	Lower surface elevations on Pitt River and Sacramento River arms of Shasta Lake constrain boating during the off season. Higher surface elevation at Lake Oroville and Folsom Lake reduces constraints on boating and shoreline activities during the peak and off-peak seasons. Flows maintained within optimal range for boating more frequently on the upper Sacramento River during the peak season. Flows on the American River more frequently below optimum level for swimming during the peak season. Opportunities increased for wildlife observation, hunting, and fishing at refuges Lower surface elevation at New Melones Reservoir constrains boating and increases the frequency when boat ramps are unusable and restricts shoreline recreation opportunities. Flows on the lower Stanislaus River are maintained above the minimum level for boating and swimming more frequently during the peak season.	Small increase in recreation-related expenditures (less than 3%) at reservoirs and rivers. About 25% increase in expenditure at refuges resulting from greater use. Additional, unquantified expenditure and benefit to fisheries and recreational use.	Cultural resources at New Melones Reservoir are potentially exposed to vandalism during periods of reservoir drawdown, which are more extreme than under No-Action Alternative. There is the potential for flooding of or increased erosion of cultural resources at wildlife refuges in the Sacramento River and San Joaquin River regions. Cultural resources in the Sacramento River, San Joaquin River, and Sacramento-San Joaquin Delta regions are potentially effected by the construction and operation of new facilities and the modification of existing facilities for anadromous fisheries habitat restoration.

TABLE II-15. CONTINUED

Alternative or Supplemental Analysis	Recreation	Fish, Wildlife, and Recreation Economics	Cultural Resources
1a Changes as compared to Alternative 1	Conditions are the same as Alternative 1.	Conditions are similar to Alternative 1.	Conditions are the same as Alternative 1.
1b Changes as compared to Alternative 1	Conditions are the same as Alternative 1, except the barriers at Georgiana Slough and Old River could delay or restrict recreational boat access to portions of the Delta.	Conditions are similar to Alternative 1.	Conditions are the same as Alternative 1.
1c Changes as compared to Alternative 1	Conditions similar to Alternative 1.	Potential reallocation of water for other uses could change quantity and timing of releases from reservoirs and flow in streams, with potential impacts on fisheries, recreational use, and benefits.	Impacts could range from those similar to Alternative 1, to the potential increased risk of exposure of cultural resources near reservoirs and/or rivers in the Sacramento River and San Joaquin River regions.
1d Changes as compared to Alternative 1	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.	Conditions are the same as Alternative 1.
1e Changes as compared to Alternative 1	Conditions are similar to Alternative 1.	Impacts of water transfers on fish, wildlife, and recreation benefits depends on the timing and location of flows affected by water transfers. Negative impacts could occur if flow is reduced in a stream during a period of high recreational use. These would be offset to some extent by increased flows during other periods. Overall impact is uncertain.	Conditions are similar to Alternative 1, except the fallowing of agricultural land could reduce risk of exposure of cultural resources due to cultivation.
1f Changes as compared to Alternative 1	Conditions are the same as Alternative 1.	Conditions are similar to Supplemental Analysis 1e.	Conditions are similar to Alternative 1.
1g Changes as compared to Alternative 1	Conditions are the same as Alternative 1.	Conditions are similar to Alternative 1.	Conditions are the same as Alternative 1.

TABLE II-15. CONTINUED

Alternative or Supplemental Analysis	Recreation	Fish, Wildlife, and Recreation Economics	Cultural Resources
1h Changes as compared to Alternative 1	Conditions are the same as Alternative 1.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.
1i Changes as compared to Alternative 1	Conditions are the same as Alternative 1, except flatwater recreation is eliminated at Lake Red Bluff.	Conditions are similar to Alternative 1, but recreational expenditures and benefits associated with Lake Red Bluff would be substantially reduced. Some of this expenditure could shift to other uses or sites within the region. Fisheries may benefit.	Conditions are the same as Alternative 1.
2 Changes as compared to No-Action Alternative	Conditions are the same as Alternative 1, except opportunities are increased over Alternative 1 for wildlife observation, hunting, and fishing at wildlife refuges in the San Joaquin River and Tulare Lake regions.	Impacts in CVP streams and reservoirs are similar to Alternative 1. Estimated increases of 70% in expenditure and benefits to refuge wildlife recreation occur due to Level 4 water deliveries. The purchase of (b)(3) water for instream flow provides potential increases in benefits related to streamflow and fisheries.	Conditions are the same as Alternative 1, except for the potential reduced risk of exposure of cultural resources in the San Joaquin River and Tulare Lake regions due to impacts from cultivation.
2a Changes as compared to Alternative 2	Average annual conditions are the same as Alternative 2, except the barriers at Georgiana Slough and Old River could delay or restrict recreational boat access to portions of the Delta.	Conditions are similar to Alternative 2.	Conditions are the same as Alternative 2.
2b Changes as compared to Alternative 2	Conditions are similar to Alternative 2.	Conditions are similar to Supplemental Analysis 1e.	Conditions are similar to Alternative 2, except the fallowing of agricultural land could reduce risk of exposure of cultural resources due to cultivation.
2c Changes as compared to Alternative 2	Conditions are similar to Alternative 2.	Conditions are similar to Supplemental Analysis 1e.	Conditions are similar to Supplemental Analysis 2b.

TABLE II-15. CONTINUED

Alternative or Supplemental Analysis	Recreation	Fish, Wildlife, and Recreation Economics	Cultural Resources
2d Changes as compared to Alternative 2	Conditions are similar to Alternative 2.	Changes are similar to those described under Supplemental Analysis 1c.	Conditions are similar to Supplemental Analysis 2c.
3 Changes as compared to No-Action Alternative	Conditions are the same as Alternative 2.	Impacts are similar to those described for Alternative 2. The purchase of additional (b)(3) water for instream flow provides potential increases in benefits related to streamflow and fisheries.	Conditions are the same as Alternative 2 Vandalism on cultural resources on the Stanislaus River is potentially increased due to an increase in the number of recreational visitors. The risk of exposure of cultural resources in the San Joaquin River Region is potentially reduced due to impacts from cultivation.
3a Changes as compared to Alternative 3	Conditions are similar to Alternative 3.	Conditions are similar to Supplemental Analysis 1e.	Conditions are similar to Alternative 3, except the fallowing of agricultural land could reduce risk of exposure of cultural resources due to cultivation.
4 Changes as compared to No-Action Alternative	Conditions are the same as Alternative 3.	Impacts are similar to those described for Alternative 3.	Conditions are the same as Alternative 3, except for the potential reduced risk of exposure of cultural resources in the Sacramento River due to impacts from cultivation.
4a Changes as compared to Alternative 4	Conditions are similar to Alternative 4.	Conditions are similar to Supplemental Analysis 1e.	Conditions are similar to Alternative 4, except the fallowing of agricultural land could reduce risk of exposure of cultural resources due to cultivation.

TABLE II-16

SUMMARY OF IMPACT ASSESSMENT FOR AGRICULTURAL ECONOMICS AND LAND USE, MUNICIPAL WATER COSTS, REGIONAL ECONOMICS, AND SOCIAL ANALYSIS

Alternative or Supplemental Analysis	Agricultural Economics and Land Use	Municipal Water Costs	Regional Economics	Social Analysis
No-Action Alternative	6.6 million irrigated acres and $10.2 billion of gross revenue from irrigated acres in Central Valley and San Felipe Division.	Similar to DWR Bulletin 160-93, plus South Coast would develop supplies and increase price to meet 2020 average demand. All municipal water use regions would impose conservation and develop supplies in dry years.	1991 economic data provided as basis for comparison.	Jobs in municipalities would increase with population projections. Agricultural jobs would remain predominantly seasonal and may increase. Demand for social services would remain constant.
1 Changes as compared to No-Action Alternative	Reduction of 50,000 acres of irrigated land and $76 million in annual gross revenue, due to Land Retirement Program and reduction in water delivery. Increase in annual CVP and groundwater cost of $46 million, due to water pricing changes and additional groundwater pumping. Increased financial risk due to reduced reliability of CVP water supply. Impacts are concentrated on CVP water service contractors, especially in the Delta export delivery areas.	CVP M&I water supplies are reduced, and restoration payments ($6.4 million on average) and conservation costs increase price and reduce water use. Most of the impact is on CVP contractors with no other supplies. Increased SWP supplies reduce water costs and retail price. Most benefit is in the Central and South Coast Region.	Annual statewide loss of $183 million output, $80 million personal income, and 2,790 jobs. Adverse impacts concentrated in the CVP water service areas, with some benefits to South Coast Region. Adverse impacts are partially offset by increases in economic activity during the period of construction of restoration actions.	Annual statewide loss of $183 million output, $80 million personal income, and 2,790 jobs. Primary loss in San Joaquin River Region (2,400 jobs) due to changes primarily in agriculture. May have minimal impact if uniformly distributed. May have significant impact if all near one community.

TABLE II-16. CONTINUED

Alternative or Supplemental Analysis	Agricultural Economics and Land Use	Municipal Water Costs	Regional Economics	Social Analysis
1a Changes as compared to Alternative 1	Additional reduction in CVP water supply is replaced by additional 80,000 acre-feet of groundwater pumping in Central Valley, 2,000 acres of land fallowed in San Felipe Division, and about $4 million annual loss of agricultural net revenue.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1, with some additional negative impacts in CVP water service areas due to higher cost of pumping groundwater.	Conditions are similar to Alternative 1.
1b Changes as compared to Alternative 1	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.
1c Changes as compared to Alternative 1	Up to 570,000 acre-feet of CVP water could be unaffordable and not used. Impacts would include up to 56,000 acres of land out of production in Sacramento River Region, 337,000 acre-feet of additional groundwater pumped in the San Joaquin River and Tulare Lake regions, and a large aggregate increase in the cost of CVP water. All impacts would fall on CVP water service contractors.	Conditions are similar to Alternative 1, except that M&I payments into the Restoration Fund are increased to $11.5 million annually.	Large additional losses of jobs and income in the Sacramento River Region due to land out of production. Additional losses in San Joaquin River Region due to higher cost of pumping groundwater.	Large additional losses of jobs and income in the Sacramento River Region due to land out of production.
1d Changes as compared to Alternative 1	Reduced CVP delivery largely in the San Joaquin River Region, replaced by additional groundwater pumping.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1, with small additional negative impacts in CVP water service areas due to higher cost of pumping groundwater.	Conditions are similar to Alternative 1.

TABLE II-16. CONTINUED

Alternative or Supplemental Analysis	Agricultural Economics and Land Use	Municipal Water Costs	Regional Economics	Social Analysis
1e Changes as compared to Alternative 1	Up to 150,000 acre-feet would be sold in an average year, primarily from the Tulare Lake Region. This would fallow about 40,000 acres and provide revenue to sellers of about $18 million. Under a dry condition without CVPIA transfers, up to 1 million acre-feet could be transferred, with over half of this from the Sacramento River Region. Under this alternative, substantially less water would be sold from the Sacramento River Region and more from regions south of Delta, due to CVP water available for transfer. The price of water, and the revenue to sellers, would decline substantially due to the availability of CVP water for transfer.	M&I users in the Sacramento Valley and San Joaquin regions do not participate in water transfer markets. In average years, the Bay Area purchases very little water in the average condition. In the Central and South Coast, 105,000 acre-feet are purchased in the average condition at a cost of $38 million delivered ($1 million savings over no CVPIA transfer scenario) In dry years, the Bay Area purchases about 180,000 acre-feet at a cost of $60 million delivered to retail users ($30 million savings over no CVPIA transfer scenario). In the Central and South Coast, 363,000 acre-feet are purchased in the dry condition at a cost of $172 million delivered ($37 million savings over no CVPIA transfer scenario).	Impacts on the local economy of areas selling water would be similar in direction to those resulting from (b)(3) water acquisition: land fallowed to provide water for transfer would result in losses of jobs and income, offset by a (usually) smaller increase in economic activity generated by spending revenue received for selling water. Regions buying water generally have positive impacts. Water bought can support economic activity at a lower cost than developing or using more expensive alternative supplies. See summary of impacts of Alternatives with Water Transfers.	Average conditions are similar to Alternative 1.
1f Changes as compared to Alternative 1	Results would be similar to Supplemental Analysis 1e, except that non-CVP water would be purchased rather than CVP water, due to the additional $50 per acre-foot fee on CVP water transfers. Also, Restoration Fund revenues may be higher in dry years. Local, within-region transfers of CVP water would likely be eliminated due to the $50 fee.	Quantities purchased would be similar to Supplemental Analysis 1e, but almost no CVP water would be purchased and costs would be higher due to the additional fee imposed on CVP water transferred.	Conditions are similar to Supplemental Analysis 1e.	Average conditions are similar to Alternative 1.
1g Changes as compared to Alternative 1	Up to 24,000 acre-feet of CVP water could be unaffordable and not used. Some land would go out of production in the Sacramento River Region but most of the water would be replaced with additional groundwater pumping.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1, with some additional negative impacts in Sacramento River Region CVP water service areas due to higher cost of pumping groundwater.	Conditions are similar to Alternative 1.

TABLE II-16. CONTINUED

Alternative or Supplemental Analysis	Agricultural Economics and Land Use	Municipal Water Costs	Regional Economics	Social Analysis
1h Changes as compared to Alternative 1	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.
1i Changes as compared to Alternative 1	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.
2 Changes as compared to No-Action Alternative	Impacts to CVP delivery areas are similar to Alternative 1. An additional 40,000 acres of irrigated land could be idled due to the purchase of (b)(3) water for instream flow and Level 4 refuge supply. Revenue received for water augments the sellers' farm income.	Same as Alternative 1.	Annual statewide loss of $241 million output, $100 million personal income, and 3,550 jobs. Adverse impacts concentrated in the CVP water service areas, and some benefits to South Coast Region. Impacts from land fallowing due to (b)(3) water acquisition are somewhat offset by revenue from water sold. Adverse impacts are partially offset by increases in economic activity during the period of construction of restoration actions.	Annual statewide loss of $241 million output, $100 million personal income, and 3,550 jobs, mostly in the San Joaquin River Region. Increases in recreation jobs.
2a Changes as compared to Alternative 2	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 1.	Conditions are similar to Alternative 2.	Conditions are similar to Alternative 2.

TABLE II-16. CONTINUED

Alternative or Supplemental Analysis	Agricultural Economics and Land Use	Municipal Water Costs	Regional Economics	Social Analysis
2b Changes as compared to Alternative 2	Results are similar to those described under Supplemental Analysis 1e, except that (b)(3) water acquisition in the San Joaquin River Region would increase the price of water for transfer. Some water transfer purchases are shifted to Sacramento River and Tulare Lake Regions.	Changes are similar to those described under Supplemental Analysis 1e, except that under average condition transfers to the Central and South Coast cost about $41 million ($2 million increase over no CVPIA transfer scenario). In dry years, the Bay Area would purchase 180,000 acre-feet at a cost of $60 million. In the Central and South Coast, the same amount would be purchased at a cost of $181 million delivered ($28 million savings over no CVPIA transfer scenario).	Conditions are similar to Supplemental Analysis 1e.	Average conditions are similar to Alternative 2.
2c Changes as compared to Alternative 2	Changes are similar to those described under Supplemental Analysis 1f.	Changes are similar to those described under Supplemental Analysis 1f.	Conditions are similar to Supplemental Analysis 1e.	Average conditions are similar to Alternative 2.
2d Changes as compared to Alternative 2	Changes are similar to those described under Supplemental Analysis 1c.	Changes are similar to those described under Supplemental Analysis 1c.	Changes are similar to those described under Supplemental Analysis 1c.	Changes are similar to those described under Supplemental Analysis 1c.
3 Changes as compared to No-Action Alternative	Impacts to CVP delivery areas are less than those described under Alternative 1, due to pumping and delivery of some (b)(3) water to CVP contractors. A total of about 172,000 acres of irrigated land could be idled due to a combination of the Land Retirement Program, reduction in CVP water delivery, and purchase of (b)(3) water for refuges and instream flow. Revenue received for water augments the sellers' farm income.	Similar to Alternative 1, except SWP supplies increase.	Annual statewide loss of $143 million output, $26 million personal income, and 2,060 jobs. Adverse impacts in CVP water service areas, and large benefits to South Coast Region. Impacts from land fallowing due to (b)(3) water acquisition are somewhat offset by revenue from water sold. Adverse impacts are partially offset by increases in economic activity during the period of construction of restoration actions.	Annual statewide loss of $143 million output, $26 million personal income, and 2,060 jobs. Job gains in municipal areas with increased water supplies. Significant job losses in the San Joaquin River Region (3,000 jobs).

TABLE II-16. CONTINUED

Alternative or Supplemental Analysis	Agricultural Economics and Land Use	Municipal Water Costs	Regional Economics	Social Analysis
3a Changes as compared to Alternative 3	Changes are similar to those described under Supplemental Analysis 1e, except that water purchased is about 10 percent less. This occurs because higher CVP and SWP delivery in Alternative 3 results in a lower level of demand for transfers.	In the average condition, changes are similar to those described under Supplemental Analysis 1e. In dry years, the Bay Area would purchase the same as under Supplemental Analyses 1e at a cost of $108 million ($18 million over the cost of a no CVPIA transfer scenario). In the Central and South Coast, the same amount would be purchased at a cost of $175 million delivered ($22 million savings over no CVPIA transfer scenario).	Conditions are similar to Supplemental Analysis 1e.	Average conditions are similar to Alternative 3.
4 Changes as compared to No-Action Alternative	Impacts to CVP delivery areas are greater than those described under Alternative 1, due to the use of (b)(2) water for Delta restoration actions. A total of about 200,000 acres of irrigated land could be idled due to a combination of the Land Retirement Program, reduction in CVP water delivery, and purchase of (b)(3) water for refuges and instream flow. Revenue received for water augments the sellers' farm income.	Similar to Alternative 1, except SWP supplies are similar to No-Action Alternative. Some additional shortages are imposed on CVP Municipal users.	Annual loss of $457 million output, $194 million personal income, and 6,540 jobs. Adverse impacts concentrated in CVP water service areas. Impacts from land fallowing due to (b)(3) water acquisition are somewhat offset by revenue from water sold. Adverse impacts are partially offset by increases in economic activity during the period of construction of restoration actions.	Annual loss of $457 million output, $194 million personal income, and 6,540 jobs. Job losses primarily in the San Joaquin River Basin (3,800 jobs) and municipal areas.
4a Changes as compared to Alternative 4	Changes are similar to those described under Supplemental Analysis 1e, except that the price of water is increased due to (b)(3) water acquisition and greater demand for transfers due to use of (b)(2) water in the Delta.	Changes are similar to those described under Supplemental Analysis 2b. In dry years, the Bay Area would purchase 190,000 acre-feet at a cost of $110 million. In the Central and South Coast, the same amount would be purchased at a cost of $193 million delivered ($16 million savings over no CVPIA transfer scenario).	Conditions are similar to Supplemental Analysis 1e.	Average conditions are similar to Alternative 4.

TABLE II-17

SUMMARY OF ADVERSE IMPACTS AND MITIGATION MEASURES POTENTIAL

Adverse Impact	Alternatives	Potential Mitigation Measures
Restoration Fund charges to CVP water and power users	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	No reasonable mitigation
Reduction in CVP water service deliveries	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	Implement methods to increase CVP yield
Reduction in groundwater levels and associated increase in subsidence	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	Implement methods to increase CVP yield Raise affected structures or regrade property to allow for proper drainage. Develop groundwater management plan
Adverse impacts to fish due to increased temperatures in the American River	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	Modify outlet works on Folsom Dam
Adverse impacts to fish due to increased temperatures in the Merced River	Alternative 1, Supplemental Analyses 1a - 1i	Relocate diversions to allow increased flow in critical portion of river
Adverse impacts to fish due to reduction in flows in the Sacramento River	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	No reasonable mitigation
Reduction in CVP power generation and shift of power generation to months where the value of power is lower, and increase total cost of power	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	No reasonable mitigation
Potential increase in mosquito abundance	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	Provide additional abatement
Increases in potential for disturbance to Cultural Resources due to increased exposure at refuges and along rivers with increased flows due to increased flooding of areas and expanded recreational opportunities.	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	Develop mitigation measures per Section 106 consultation with the Advisory Council and State Historic Preservation Office

TABLE II-17. CONTINUED

Adverse Impact	Alternatives	Potential Mitigation Measures
Increases in potential for disturbance to Cultural Resources due to increased exposure at New Melones Reservoir in periods of drawdown	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	Develop mitigation measures per Section 106 consultation with the Advisory Council and State Historic Preservation Office
Increases in potential for disturbance to Cultural Resources due to potential disturbance at sites with habitat restoration projects	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	Prior to construction of any facilities, Interior will comply with Section 106 of the National Historic Preservation Act to account for the effect on historic properties
Potential periodic reductions in swimming opportunities in the American River due to high flows,	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	No reasonable mitigation
Potential periodic reductions in boating and shoreline use opportunities in portions of Shasta Lake and New Melones Reservoir	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	Construct new boat ramps and facilities for beach use
Barriers at Georgiana Slough and Old River could affect boating opportunities	Supplemental Analyses 1b and 2a	Construct boat passage facilities
Elimination of flatwater recreation at Lake Red Bluff	Supplemental Analysis 1i	No reasonable mitigation
Reduction in jobs due to reduction in irrigated acreage	Alternatives 1, 2, 3, and 4 Supplemental Analyses 1a - 1i, 2a - 2d, 3a, and 4a	Job training
Orchard damage due to Stanislaus River flows above 1,500 cfs	Alternatives 3 and 4 Supplemental Analyses 3a and 4a	Obtain Easement

ALTERNATIVES CONSIDERED BUT ELIMINATED FROM FURTHER CONSIDERATION

During the preparation of the Draft PEIS, many alternatives and components of alternatives were considered. Some of the components were eliminated based upon information gathered as part of interim implementation of portions of the CVPIA. For example, changes were made to methods to implement seasonal flooding of rice fields due to information collected from interim implementation of the program by Interior and/or the State.

In addition, several alternatives were considered to acquire water to fully meet target flows identified in the Draft AFRP Working Paper for instream and Delta flows. The results of this preliminary analysis is presented in the Evaluation of Preliminary Alternatives Technical Appendix. Three alternatives were considered but eliminated from further analysis due to the application of criteria to determine if the alternatives were reasonable to implement. The preliminary evaluation indicated that either water was not physically available to meet the goals of the alternative, or that the cost of the alternative was extremely high for further consideration at a programmatic level. Portions of the preliminary alternatives are included in the Draft PEIS alternatives. Other portions of the preliminary alternatives may be considered at a future time.

Other alternatives suggested during the scoping phase were eliminated from consideration because the actions would have required an analysis that would be beyond the purpose of this Draft PEIS. These alternatives included elimination of hatcheries to reduce competition between natural and hatchery fish, increased use of hatcheries to improve fish populations, reductions in sport and commercial harvest of salmon to improve fish populations, removal of dams to restore natural habitat, and artificial methods to transport fish from spawning areas to the ocean to reduce predation. Many of these actions would require evaluation by other agencies and could not be implemented under the CVPIA or other Interior authorizations. Some of the evaluations will be considered under the Evaluations to be completed by the AFRP, including the evaluation of the need to revise harvest regulations on both sport and commercial fishing.

Some alternatives were evaluated in more detail than others before being eliminated from further consideration. For example, three alternatives were evaluated based upon preliminary information developed by AFRP. The preliminary information included recommendations based upon scientific information that had not been screened for reasonableness of implementation. These alternatives were named Alternatives 3, 4, and 5. They were subsequently replaced with the current Alternatives 3 and 4 which are based upon AFRP target flows that have been subjected to reasonableness screening. It is possible that at some future time, the target flows may exceed the flows used in the Draft PEIS alternatives. Information from the analysis of the initial Alternatives 3, 4, and 5 could be used to define those future actions. The results of the analysis of initial Alternatives 3, 4, and 5 are included in the Development of the Preliminary Alternatives Technical Appendix.

SELECTION OF PREFERRED ALTERNATIVE

This Draft PEIS does not identify a Preferred Alternative. Reclamation has not determined a Preferred Alternative and will use the information and comments gathered during the public review of the Draft PEIS to develop a preferred alternative. The Final EIS will identify Reclamations's Preferred Alternative.

It is expected that the Preferred Alternative will be developed for various elements of the alternatives and supplemental analyses presented in the Draft PEIS. The Draft PEIS alternatives include over 40 separate actions that could be combined into hundreds of permutations. For the Draft PEIS, these actions were combined into 19 alternatives/supplemental analyses to provide the decision maker with information of how different factors would be affected by changes in fish and wildlife actions, water facilities operations, and water pricing and contract provisions.

The alternatives are evaluated in this manner to provide “bookends” to the anlaysis and to identify the most conservative set of impacts that could occur fore the different boundary conditions. Therefore, the decision maker can select the boundary conditions for the preferred alternative from the array of different alternatives evaluated in the Draft PEIS.

Another reason that alternatives were developed as “bookends” and the menu approach for development of the preferred alternative is appropriate is because many of the programs addressed in CVPIA require partners. For example, water sales require participation of willing sellers and many of the habitat restoration actions require willing participants either for permission of for financial participation.

It should be noted that actions that require willing sellers cannot be implemented without the participation of the willing sellers. Interior cannot and will not force water users to sell or transfer their water. If there are not willing participants, that portion of the action cannot be implemented.

CHAPTER III

AFFECTED ENVIRONMENT

Chapter III

AFFECTED ENVIRONMENT

This chapter presents a summary of historical and recent conditions for resource areas and issues of interest evaluated in the Draft PEIS. The resources and issues included in this section were identified through a review of NEPA guidance documents, and through the scoping process described in Chapter VII, Consultation and Coordination. The resources and issues described are as follows.

- Surface Water Supplies and Facilities Operations
- Groundwater
- Fishery Resources
- Agricultural Economics and Land Use
- Municipal and Industrial Land Use and Demographics
- Vegetation and Wildlife Resources
- CVP Power Resources
- Recreation
- Fish, Wildlife, and Recreation Economics
- Regional Economics
- Municipal and Industrial Water Use and Costs
- The Delta as a Source of Drinking Water
- Mosquitos
- Social Conditions
- Cultural Resources
- Air Quality
- Soils
- Visual Resources

SURFACE WATER SUPPLIES AND FACILITIES OPERATIONS

The Central Valley of California is a vast, oblong valley in the interior of the state, extending 400 miles north-to-south and about 50 miles east-to-west. The Central Valley is flanked on the east by the Cascade and Sierra Nevada mountain ranges, and on the west by the Coast Range. Three major drainage areas are present in the Central Valley. The Sacramento River Basin comprises the northern third of the Central Valley, and yields approximately 35 percent of the total outflow of all rivers in the state. The 250-mile-long San Joaquin Valley, which is much drier that the Sacramento River Basin, comprises the southern two-thirds of the Central Valley and is hydrologically divided between the San Joaquin River Basin and the Tulare Lake Basin. The San Joaquin River watershed includes lands that drain to the San Joaquin River and ultimately flow into the Delta. The Tulare Lake Basin watershed includes lands that primarily drain into the Tulare Lake bed or the Buena Vista Lake bed.

Extensive water supply, hydroelectric, and flood control efforts during the past century have resulted in the construction of dams and reservoirs that now control the flow on nearly all major streams in the Central Valley. Figure III-1 shows major rivers and streams that drain Central Valley watersheds and major dams that affect streamflows.

SURFACE WATER IN THE SACRAMENTO RIVER BASIN

The Sacramento River Basin, shown in Figure III-2, encompasses over 24,000 square miles in the northern portion of the Central Valley. Drainage is provided by the Sacramento River, which flows generally north to south from its source near Mount Shasta to the Delta, and receives contributing flows from numerous major and minor streams and rivers that drain the east and west sides of the basin.

Elevations in the northern portion of the Sacramento River Basin range from over 14,000 feet in the headwaters of the Sacramento River to approximately 1,065 feet at Shasta Lake. In this area, total annual precipitation averages between 60 and 70 inches and is as high as 95 inches in the Sierra Nevada and Cascade mountains. The floor of the Sacramento Valley is relatively flat, with elevations ranging from about 60 to 300 feet above sea level. This area is characterized by hot, dry summers and mild winters. Precipitation is relatively light, ranging from 15 to 20 inches per year as far north as Red Bluff, falling mostly as rain. The mountainous areas bordering the valley reach elevations of over 5,000 feet and receive much more precipitation, with snow prevalent at higher elevations. Areas at elevations above 5,000 feet receive an average of 42 inches of precipitation per year, and as much as 90 inches falls at Lassen Peak.

The upper portion of the Sacramento River is fed by tributary flows from numerous small creeks, primarily those draining the western slopes of the Cascade and Sierra Nevada mountains. The volume of flow increases as the river progresses southward, and is increased considerably by the contribution of flows from the Feather River and the American River watersheds. Accordingly, the Sacramento River is characterized in two sections: the upper section from its source to just above its confluence with the Feather River, and the lower section from the confluence with the Feather River to the Delta.

Upper Sacramento River

Flows in the upper Sacramento River are regulated by the CVP Shasta Dam (completed in 1945) and re-regulated approximately 15 miles downstream at Keswick Dam (completed in 1950). The portion of the river above Shasta Dam drains about 6,650 square miles and produces average annual runoff of 5.7 million acre-feet. As the Sacramento River nears Red Bluff, flows become more influenced by the inflow from major tributary streams, including Clear, Cow, Bear, Cottonwood, Battle, and Paynes creeks.

Prior to the construction of Shasta Dam, monthly flows in the upper Sacramento River reflected the runoff patterns associated with winter precipitation and spring snow melt. Peak flows generally occurred during the months of February, March, and April. Following the construction of Shasta Dam, average monthly flows during March and April were reduced and average flows during the summer irrigation months were increased. Since 1964, a portion of the flow from the Trinity River Basin has been exported to the Sacramento River Basin through CVP facilities.

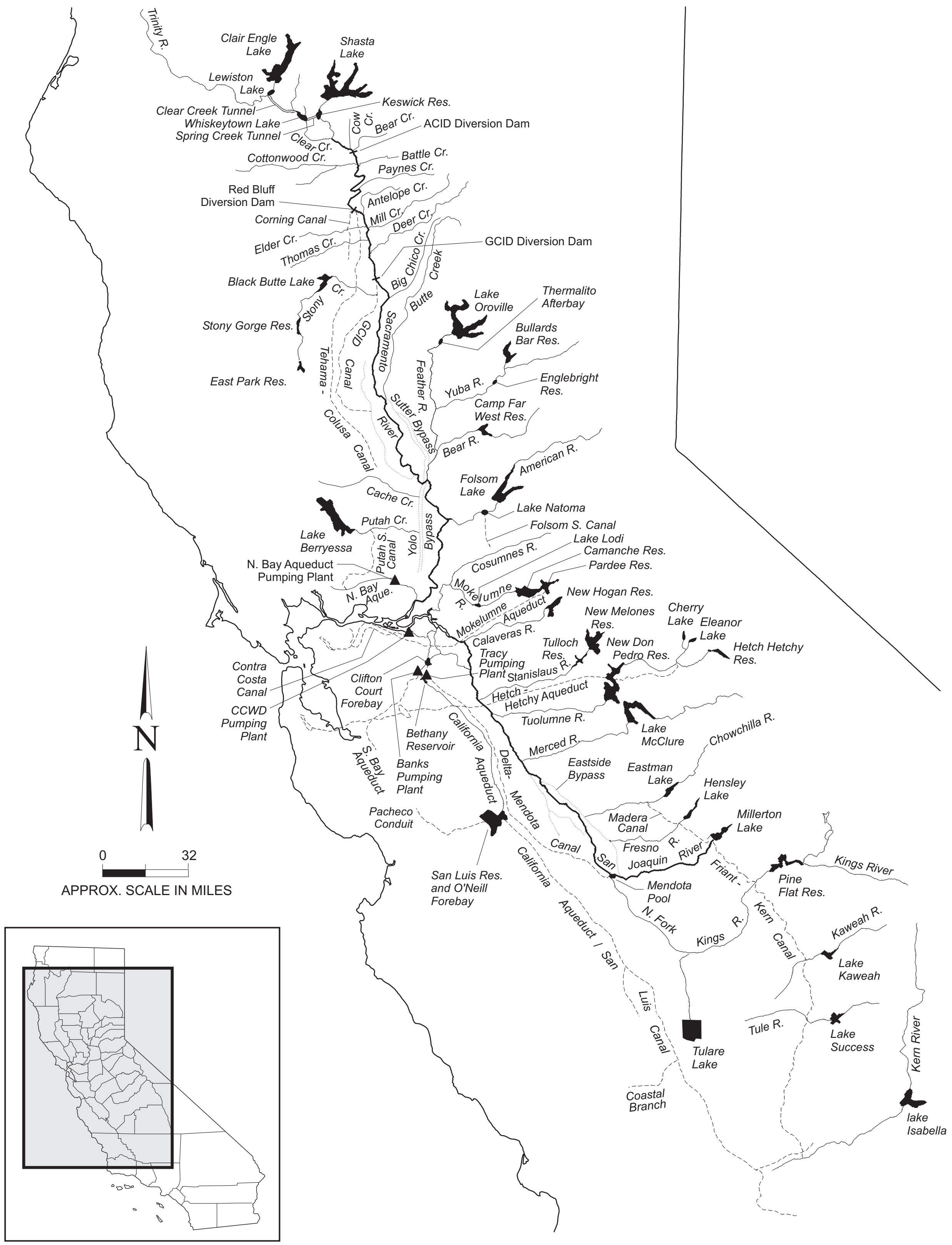


FIGURE III-1

MAJOR WATER FACILITIES IN THE CENTRAL VALLEY

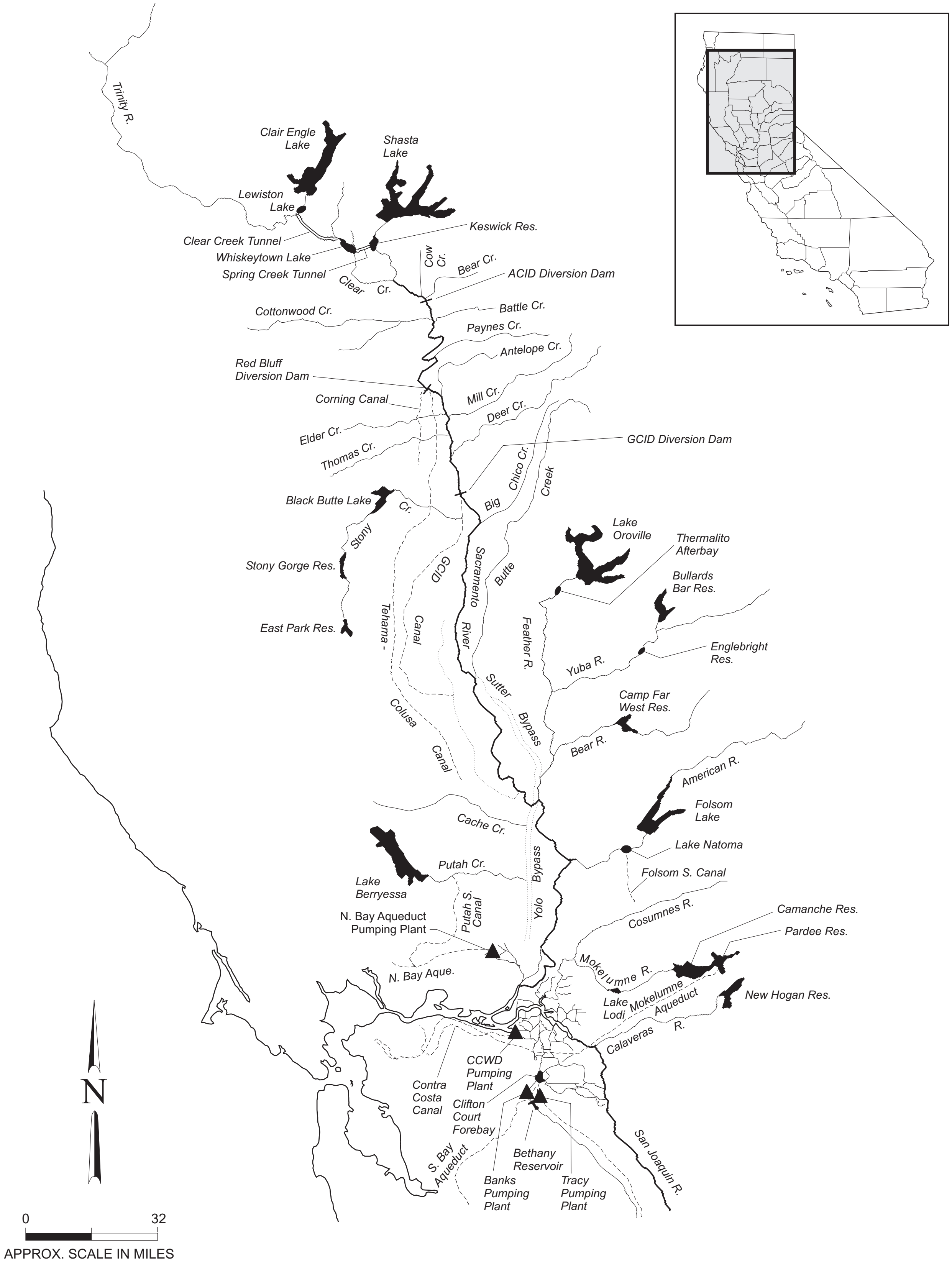


FIGURE III-2

SACRAMENTO RIVER BASIN

An average of 1,269,000 acre-feet of water has been diverted from Whiskeytown Lake to Keswick Reservoir annually (1964-1992), about 17 percent of the flows in the Sacramento River measured at Keswick.

Major water diversions on the Sacramento River include the Anderson Cottonwood Irrigation District (ACID) Diversion Dam, the Glen Colusa Irrigation (GCID) District Diversion Dam, and the Red Bluff Diversion Dam (RBDD).

Lower Sacramento River And Tributaries

The lower Sacramento River is identified as the reach that extends from Knights Landing, just above the confluence with the Feather River, to Freeport, just below the point where the Sacramento River enters the Delta. The drainage area of the Sacramento River upstream of Freeport encompasses more than 24,000 square miles. The historical average annual flow on the Sacramento River at Freeport is approximately 16.7 million acre-feet, more than twice the average annual flow measured above the confluence of the Feather River over the same time period. This increase in flow in the lower Sacramento River is primarily due to the addition of the Feather and American river flows.

Feather River and Tributaries. The Feather River, with a drainage area of 3,607 square miles on the east side of the Sacramento Valley, is the largest tributary to the Sacramento River below Shasta Dam, with a median historical unimpaired runoff of 3.8 million acre-feet. This total flow is provided by the Feather River and tributaries, which include the Yuba and Bear rivers. Flows on the Feather River are regulated by Oroville Dam, the lowermost reservoir on the river, which began operation in 1967 as part of the SWP. Oroville Reservoir has a storage capacity of approximately 3.5 million acre-feet. Prior to the construction of Oroville Dam, flows in the Feather River reflected natural runoff conditions, with peak flows in the months of March, April, and May. Following the construction of Oroville Dam, the average monthly flow pattern was modified to provide reduced flows during the spring months and increased flows during summer months.

Water released from Oroville Dam is diverted approximately 5 miles downstream at the Thermalito Diversion into the Thermalito Power Canal, thence to the Thermalito Forebay, and finally into the Thermolito Afterbay. Between the Thermolito Diversion Dam and the Thermalito Afterbay, flows in the Feather River are maintained at a constant 600 cubic feet per second (cfs). This 8-mile section of the river is often referred to as the “low flow” section. The Thermolito Afterbay serves the dual purposes of an afterbay to re-regulate releases to the Feather River from the hydroelectric plants and a warming basin for irrigation water that will be diverted to rice fields. Consequently, the water temperatures in the approximately 14-mile section of the Feather River below Thermalito Afterbay, commonly referred to as the “high flow” section, are often higher than water temperatures in the “low flow” section.

The Yuba River is a major tributary to the Feather River, historically contributing over 40 percent of the flow, on a total annual basis, as measured at Oroville. The Yuba River originates in the Sierra Nevada, drains approximately 1,339 square miles of the eastern Sacramento Valley, and flows into the Feather River near the town of Marysville.

American River. The American River originates in the mountains of the Sierra Nevada range, drains a watershed of approximately 1,895 square miles, and enters the Sacramento River at RM 60 in the City of Sacramento. The American River contributes approximately 15 percent of the total flow in the Sacramento River. The watershed ranges in elevation from 23 feet to over 10,000 feet, and receives approximately 40 percent of its flow from snowmelt runoff.

Prior to construction of Folsom Dam, monthly flows were generally highest during the months of April and May, and approached zero in the late summer. In wet years, high spring flows often resulted in downstream flooding in the Sacramento area. Since the construction of Folsom Dam, the extreme flows in wet years have been reduced, and higher flows have been provided during dry periods. This operation has resulted in improved flood protection to downstream areas.

SURFACE WATER IN THE SAN JOAQUIN RIVER BASIN

The San Joaquin River Basin, shown in Figure III-3, extends from the Delta in the north to the north fork of the Kings River in the south, encompassing about 32,000 square miles in the northern part of the San Joaquin Valley, roughly from Fresno to Stockton. The climate of the San Joaquin River Basin is semiarid, characterized by hot, dry summers and mild winters, except at the highest altitudes, where distinct wet and dry seasons prevail. Most of the precipitation falls from November to April, with rain at the lower elevations and snow in the higher regions. On the valley floor, precipitation decreases from north to south, ranging from 14 inches in Stockton to 8 inches at Mendota.

The primary sources of surface water to the basin are rivers that drain the western slope of the Sierra Nevada Range. Each of these rivers, the San Joaquin, Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes, drain large areas of high elevation watershed that supply snowmelt runoff during the late spring and early summer months. Historically, peak flows occurred in May and June and flooding occurred in most years along all of the major rivers. When flood flows reached the valley floor, they spread out over the lowlands, creating several hundred thousand acres of permanent tule marshes and more than 1.5 million acres of seasonally flooded wetlands.

The three northernmost streams, the Calaveras, Mokelumne, and Cosumnes rivers, flow into the San Joaquin River within the boundaries of the Delta. Streams on the west side of the basin are intermittent, and their flows rarely reach the San Joaquin River. Natural runoff from westside sloughs is augmented with agricultural drainage.

The San Joaquin River originates in the Sierra Nevada at an elevation over 10,000 feet and flows into the San Joaquin Valley at Friant. The river then flows to the center of the valley floor, where it turns sharply northward and flows through the San Joaquin Valley to the Delta. Along the valley floor, the San Joaquin River receives additional flow from the Merced, Tuolumne, and Stanislaus rivers.

The upper San Joaquin River section, upstream of the confluence with the Merced River, was historically characterized by the runoff of the San Joaquin River. During the past 100 years, development in this area has resulted in groundwater overdraft conditions, and the river loses much of its flow through percolation. The lower San Joaquin River, from the confluence with

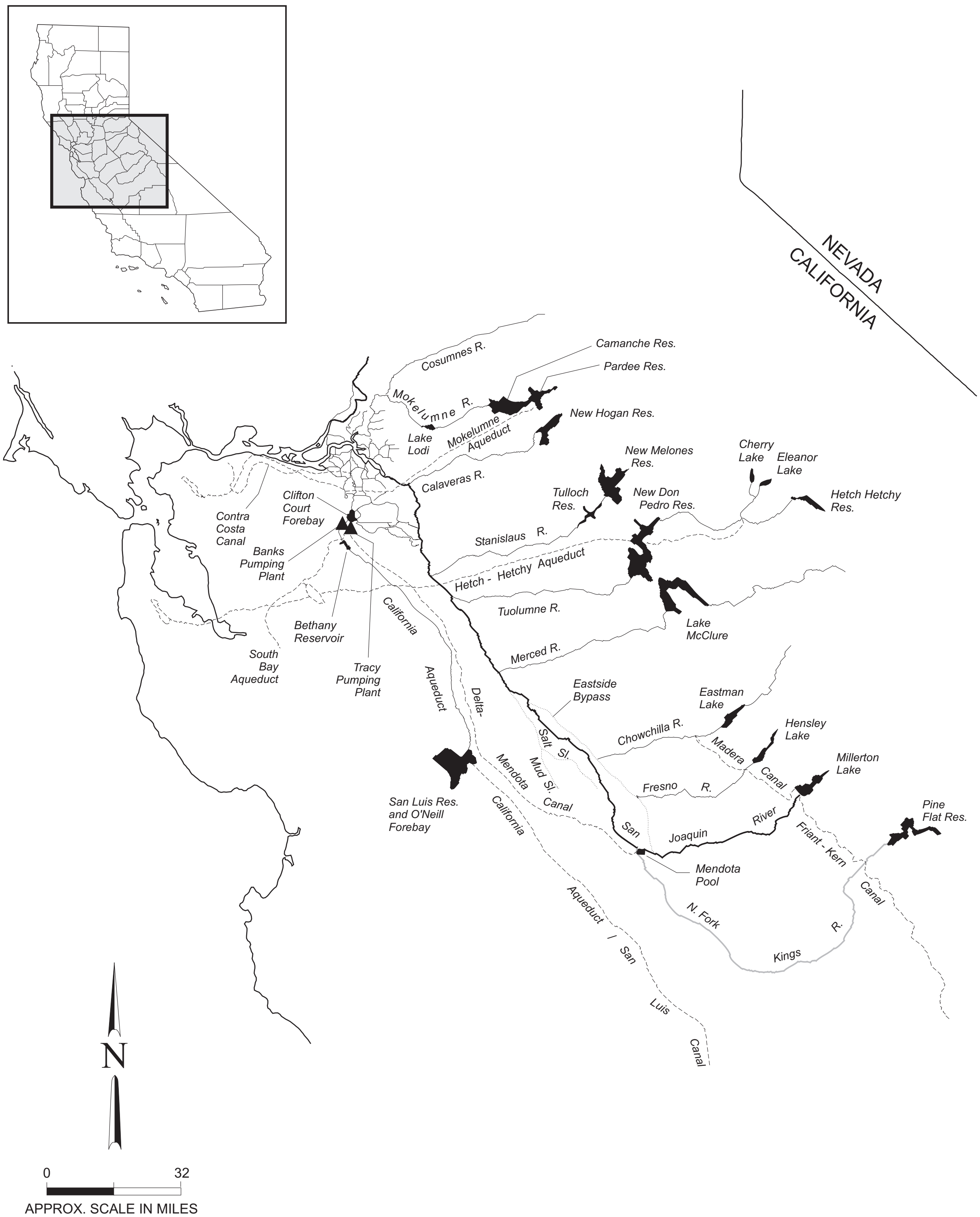


FIGURE III-3

SAN JOAQUIN RIVER BASIN

the Merced River to the Delta, is characterized by the combination of flows from tributary streams, major rivers, and agricultural drainage water.

Upper San Joaquin River and Tributaries

Flows in the upper San Joaquin River are regulated by the CVP Friant Dam, which was completed in 1941 to store and divert water to the Madera and Friant-Kern canals for irrigation and municipal and industrial (M&I) water supplies in the eastern portion of the San Joaquin Valley. In the reach between Friant Dam and the Gravelly Ford, flow is influenced by releases from Friant Dam, with minor contributions from agricultural and urban return flows. Releases from Friant Dam are generally limited to those required to satisfy downstream water rights and instream flows. Millerton Lake, formed by Friant Dam, has a capacity of 520,000 acre-feet. Above Friant Dam, the San Joaquin River drains an area of approximately 1,676 square miles and has an annual average unimpaired runoff of 1.7 million acre-feet. The median historical unimpaired runoff is 1.4 million acre-feet, with a range of 0.4 to 4.6 million acre-feet. Several reservoirs in the upper portion of the San Joaquin River watershed, including Mammoth Pool and Shaver Lake, are primarily used for hydroelectric power generation. The operation of these reservoirs affects the inflow to Millerton Lake.

Following completion of Friant Dam in 1941, the most of the annual flow has been diverted to the Friant-Kern and Madera canals. Average monthly releases from Friant Dam to the San Joaquin River since 1941 have included minimum releases to satisfy water rights above Gravelly Ford, and flood control releases.

Lower San Joaquin River and Tributaries

The lower San Joaquin River is the section of river from the confluence with the Merced River (below Fremont Ford) to Vernalis, which is generally considered the southern limit of the Delta. The drainage area of the San Joaquin River above Vernalis includes approximately 13,356 square miles, of which approximately 2,100 square miles are drained by Fresno Slough (James Bypass). Little water is contributed from the upper San Joaquin River, except during flood events. Flow patterns in the lower San Joaquin River are therefore primarily governed by the tributary inflows from the Merced, Tuolumne, and Stanislaus rivers.

Merced River. The Merced River originates in the Sierra Nevada, drains an area of approximately 1,273 square miles east of the San Joaquin River, and produces an average unimpaired runoff of approximately 1 million acre-feet.

Agricultural development in the Merced River watershed began in the 1850s, and significant changes have been made to the hydrologic system since that time. The enlarged New Exchequer Dam, forming Lake McClure with a capacity of 1,024,000 acre-feet, was completed in 1967 and now regulates releases to the lower Merced River. New Exchequer Dam is owned and operated by the Merced Irrigation District for power production, irrigation, and flood control. Releases from Lake McClure pass through a series of powerplants and smaller diversions and are re-regulated at McSwain Reservoir. Below McSwain Dam, water is diverted to Merced Irrigation District at the Pacific Gas and Electric Company (PG&E) Merced Falls Dam and further downstream at the Crocker Huffman Dam.

Tuolumne River. The Tuolumne River originates in the Sierra Nevada Mountains, drains a watershed of approximately 1,540 square miles, and produces an average unimpaired runoff of approximately 1.95 million acre-feet.

Flows in the lower portion of the Tuolumne River are controlled primarily by the operation of New Don Pedro Dam, which was constructed in 1971 jointly by Turlock Irrigation District (TID) and Modesto Irrigation District (MID) with participation by the City and County of San Francisco. The 2.0-million-acre-foot reservoir stores water for irrigation, hydroelectric generation, fish and wildlife enhancement, recreation, and flood control purposes. The districts divert water to the Modesto Main Canal and the Turlock Main Canal a short distance downstream from New Don Pedro Dam at La Grange Dam.

The City and County of San Francisco operates several water supply and hydroelectric facilities within the Tuolumne River Basin upstream of New Don Pedro Reservoir. O'Shaughnessy Dam on the main stem of the Tuolumne River, completed in 1923, impounds approximately 0.4 million acre-feet of water in Hetch Hetchy Reservoir. The 460-square-mile drainage area is entirely within the boundaries of Yosemite National Park. Water from Hetch Hetchy is used primarily to meet the M&I water needs of the City and County of San Francisco and to provide instream flows in the Tuolumne River below O'Shaughnessy Dam. Two other storage facilities upstream of Hetch Hetchy Reservoir, Lake Eleanor and Cherry Lake, are operated for hydropower and water supply purposes. The combined capacity of these two reservoirs is about 0.4 million acre-feet. The City and County of San Francisco owns 0.6 million acre-feet of storage in New Don Pedro Reservoir, which allows them to meet part of their release obligations to the districts by exchanging stored water for water diverted upstream at Hetch Hetchy.

Stanislaus River. The Stanislaus River originates in the Sierra Nevada Mountains, drains a watershed of approximately 900 square miles, and produces an average unimpaired runoff of approximately 1.2 million acre-feet. Snowmelt runoff contributes the largest portion of the flows in the Stanislaus River, with the highest monthly flows in May and June.

Flow control in the lower Stanislaus River is provided by the New Melones Reservoir, which has a capacity of 2.4 million acre-foot, and is operated by Reclamation as part of the CVP. Releases from New Melones Reservoir are re-regulated downstream by Tulloch Reservoir. Prior to the construction of New Melones Dam, average monthly flows in the Stanislaus River were generally uniform between January and June, with peak flows in May. As a result of limited storage capacity in facilities on the river, average monthly flows in August and September approached zero in many years. Following construction of New Melones Dam, average monthly flows included peak flows in March, with releases in all months.

The main water diversion point on the Stanislaus River is Goodwin Dam, which provides for delivery to Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID). Goodwin Dam is also used to divert water into the Goodwin Tunnel for deliveries to Central San Joaquin Water Conservation District and the Stockton East Water District.

San Joaquin River at Vernalis. Flows in the San Joaquin River at Vernalis are affected by the operation of upstream facilities on the San Joaquin, Merced, Tuolumne, and Stanislaus rivers, as well as by deliveries to the Mendota Pool from the Delta-Mendota Canal and overflows from the Kings River in the Tulare Lake Region. Prior to the construction of major dams on the San Joaquin River and its tributaries, average monthly flows peaked during May and June in response to snowmelt runoff. Between 1941 and 1978, flows were altered from natural conditions in response to the operations of Friant, New Exchequer, New Don Pedro, and New Melones dams. New Melones Dam, the most recently constructed dam in the San Joaquin River Basin, was completed in 1978. Since that time, average monthly flows in the San Joaquin River at Vernalis have been more uniform throughout the year, with maximum flows less than historical levels.

Calaveras River. The Calaveras River originates in the Sierra Nevada Mountains, and produces a median unimpaired runoff of 130,000 acre-feet drains an area of approximately 363 square miles. It enters the San Joaquin River near the City of Stockton. The Calaveras River watershed is almost entirely below the effective average snowfall level (5,000 feet), and receives nearly all of its flow from rainfall. As a result, nearly all of the annual flow occurs between November and April. The major water management facility on the Calaveras River is New Hogan Dam and Lake, constructed in 1963 by the U.S. Army Corp of Engineers (COE) with a storage capacity of 317,000 acre-feet, and operated by the COE and Stockton East Water District.

Mokelumne River. The Mokelumne River originates in the Sierra Nevada Mountains, drains a watershed of approximately 661 square miles, and produces a median unimpaired runoff of approximately 696,000 acre-feet. It is a major tributary to the Delta, entering the lower San Joaquin River northwest of Stockton.

Three major reservoirs influence streamflow in the Mokelumne River. The uppermost reservoir, Salt Springs Reservoir, is owned by PG&E and is located on the North Fork of the Mokelumne River. It has a storage capacity of 141,900 acre-feet and began operation in 1963. Pardee and Camanche reservoirs are located on the main stem of the Mokelumne and are both owned and operated by the East Bay Municipal Utility District (EBMUD). Pardee, completed in 1929, has storage capacity of 209,900 acre-feet. Water is exported from the Mokelumne River watershed to the EBMUD service area via the Mokelumne River Aqueduct, which receives water directly from Pardee Reservoir. Camanche Reservoir, with a storage capacity of 430,800 acre-feet, is located downstream of Pardee Dam. Water is released from Camanche Reservoir to maintain downstream water requirements and to provide flood protection on the Mokelumne River.

Approximately 82 diversions were identified along the Mokelumne River (DWR Bulletin 130-68). Except for the Mokelumne Aqueduct diversion, the most significant diversion in the watershed occurs at Woodbridge Dam, which diverts water into the Woodbridge Canal for irrigation of land south and west of the Town of Woodbridge.

Cosumnes River. The Cosumnes River originates in the lower elevations of the Sierra Nevada Mountains, drains a watershed of approximately 537 square miles. It enters the Mokelumne River within the Delta near the Town of Thornton. Because of the low elevation of its headwaters, the Cosumnes River receives most of its water from rainfall. The only major water supply facilities in the Cosumnes River watershed are components of the Sly Park Unit of the CVP. The water supply provided by the Sly Park Unit is used by El Dorado Irrigation District (EID) and is not integrated into the CVP operations.

Surface Water Quality in the San Joaquin River Basin

Surface water quality in the San Joaquin River Basin is affected by several factors, including natural runoff, agricultural return flows, biostimulation, construction, logging, grazing, operations of flow regulating facilities, urbanization, and recreation. In addition, irrigated crops grown in the western portion of the San Joaquin Valley have accelerated the leaching of minerals from soils, altering water quality conditions in the San Joaquin River system.

Water quality in the San Joaquin River varies considerably along the stream's length. Above Millerton Lake and downstream towards Mendota Pool, water quality is generally excellent. The reach from Gravelly Ford to Mendota Pool (about 17 miles) is frequently dry except during flood control releases because all water released from Millerton Lake is diverted upstream to satisfy water rights agreements, or percolates to groundwater. During the irrigation season, most of the water released from the Mendota Pool to the San Joaquin River is imported from the Delta via the Delta-Mendota Canal, and generally has higher concentrations of total dissolved solids (TDS) than water in the upper reaches of the San Joaquin River. Most of the water released from the Mendota Pool to the San Joaquin River is diverted at or above Sack Dam for agricultural uses. Between Sack Dam and the confluence with Salt Slough, the San Joaquin River is often dry. From Salt Slough to Fremont Ford, most of the flow in the river is derived from irrigation returns carried by Salt and Mud sloughs. This reach typically has the poorest water quality of any reach of the river.

As the San Joaquin River progresses downstream from Fremont Ford, water quality generally improves at successive confluences, specifically at those with the Merced, Tuolumne, and Stanislaus rivers. In the relatively long reach between the Merced and Tuolumne rivers, however, mineral concentrations tend to increase due to agricultural drainage water, other wastewaters, and effluent groundwater (DWR, 1965). TDS in the San Joaquin River near Vernalis has historically ranged from 52 milligrams per liter (mg/l) (at high stages) to 1,220 mg/l during the 1951-1962 period (DWR, 1965). During the mid to late 1960s, San Joaquin River water quality continued to decline. In 1972, the State Water Resources Control Board (SWRCB) included a provision in Decision 1422 (D-1422) that Reclamation maintain average monthly concentrations of TDS in the San Joaquin River at Vernalis of 500 mg/l as a condition of the operating permit for New Melones Reservoir on the Stanislaus River.

SURFACE WATER IN THE SACRAMENTO-SAN JOAQUIN DELTA

The Delta, shown in Figure III-4, lies at the confluence of the Sacramento and San Joaquin rivers. It occupies the area of lowest elevation in the Central Valley, extending from the confluence of the two rivers inland as far as Sacramento and Stockton. In its original state, the Delta area included swamp and overflow lands that are some of the most fertile peat soils in the state.

Much of the land within the Delta lies below sea level and was reclaimed between 1850 and 1930 through the construction of levees around the numerous islands, creating a network of navigable river channels, sloughs, and dredger cuts. Currently, the Delta encompasses approximately 1,153 square miles, with over 700 miles of channels and sloughs and over 1,000 miles of levees. Runoff from Central Valley rivers flows through a maze of channels and

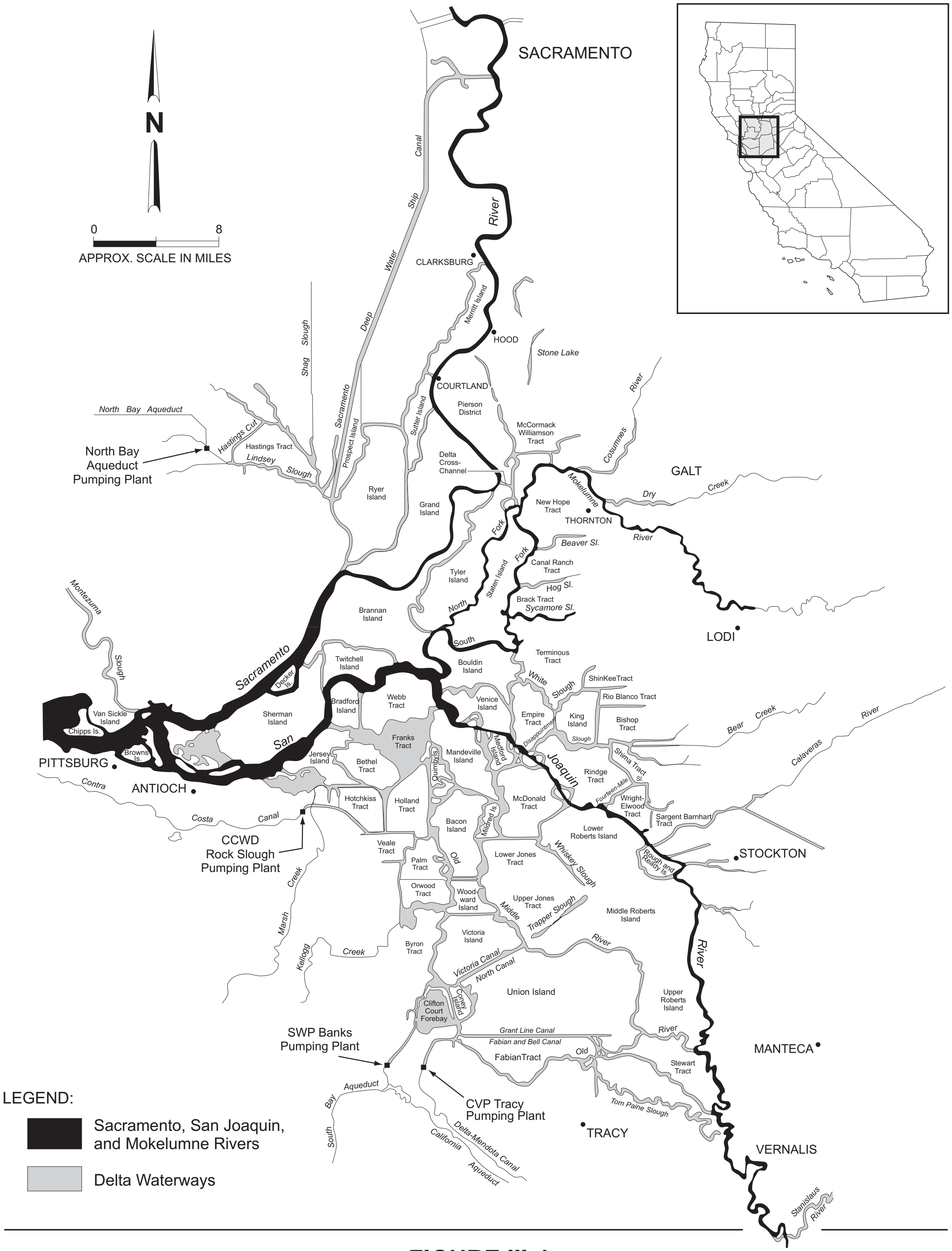


FIGURE III-4

SACRAMENTO-SAN JOAQUIN DELTA

waterways that surround 57 major reclaimed islands and nearly 800 unleveed islands (Water Education Foundation, 1992). On the average, about 21 million acre-feet of water, or about 42 percent of the surface water in California, reaches the Delta. Actual flow varies widely from year to year, and within the year as well. In 1977, a year of extraordinary drought, inflow to the Delta totaled 5.9 million acre-feet. In 1983, an extremely wet year, annual inflow was about 70 million acre-feet. Approximately 50,000 acres of the Delta is covered by surface water, and approximately 520,000 acres of Delta land is used for agriculture.

A significant portion of the water from California's northern streams is transported through the Delta for use in the San Joaquin River Region, the Tulare Lake Region, and in Southern California. Delta channels have been modified to allow transport of this water and to reduce the effects of pumping on the direction of flows and salinity intrusion. The conveyance of water from the Sacramento River southward through the Delta is aided by the CVP Delta Cross Channel (DCC), a man-made gated channel that conveys water from the Sacramento River to the Mokelumne River. Other water diversions in the Delta include the Contra Costa Canal, the North Bay Aqueduct, and over 1,800 agricultural diversions for in-Delta use.

The hydraulic characteristics of the Delta are influenced by inflows from tributary streams, tidal influence from the Pacific Ocean, and water diversions within the Delta. Accordingly, water quality in the Delta is highly variable. It is strongly influenced by inflows from the rivers, as well as by intrusions of seawater into the western and central portions of the Delta during periods of low outflow that may be affected by high export pumping. The concentrations of salts and other materials in the Delta are affected by river inflows, tidal flows, agricultural diversions, drainage flows, wastewater discharges, water exports, cooling water intakes and discharges, and groundwater accretions.

Delta channels are typically less than 30 feet deep, unless dredged, and vary in width from less than 100 feet to more than 1 mile. Although some channels are edged with riparian and aquatic vegetation, steep mud or riprap covered levees border most channels. To enhance flow and aid in levee maintenance, vegetation is often removed from the channel margins. The tidal currents carry large volumes of seawater back and forth through the San Francisco Bay-Delta Estuary with the tidal cycle. The mixing zone of salt and fresh water can shift 2 to 6 miles daily depending on the tides, and may reach far into the Delta during periods of low inflow.

Major CVP facilities in the Delta include the Tracy Pumping Plant, completed in 1951, which pumps water from Old River to the Delta-Mendota Canal; the Contra Costa Pumping Plant, completed in 1948, which pumps water from Rock Slough into the Contra Costa Canal; and the DCC, which was completed in 1951 and permits the diversion of water from the Sacramento River to the Mokelumne River, facilitating efficient transfer of water across the Delta to project pumps in the southern Delta. The SWP also operates and maintains facilities in the Delta. These include the Barker Slough Pumping Plant in the north Delta, which pumps water into the North Bay Aqueduct, and the Harvey O. Banks Delta Pumping Plant, which pumps water from Clifton Court Forebay in the southern Delta into the California Aqueduct.

Currently, salinity problems, which occur primarily during years of below normal runoff, are largely associated with the high concentration of salts carried by the San Joaquin River into the Delta. Operation of the state and federal export pumping plants near Tracy draws higher quality

Sacramento River water across the Delta and restricts the area of higher salinity water to the southeast portion of the Delta. Localized problems resulting from irrigation returns occur elsewhere such as in dead-end sloughs. Elevated salinity levels in the western Delta result primarily from the intrusion of saline waters from the San Francisco Bay system.

CVP FACILITIES AND OPERATIONS

The CVP is the largest surface water storage and delivery system in California, with a geographic scope covering 35 of the state's 58 counties. The project includes 20 reservoirs, with a combined storage capacity of approximately 11 million acre feet; 8 powerplants and 2 pump-generating plants, with a combined generation capacity of approximately 2 million kilowatts; 2 pumping plants; and approximately 500 miles of major canals and aqueducts. The CVP supplies water to more than 250 long-term water contractors in the Central Valley, the Santa Clara Valley, and the San Francisco Bay Area. Figure III-5 shows the locations of CVP facilities, rivers that are controlled or affected by the operation of CVP facilities, and the CVP service area.

Historically, approximately 90 percent of the CVP water has been delivered to agricultural users, including prior water rights holders. Total annual contracts exceed 9 million acre-feet, including over 1 million acre-feet of Friant Division Class II supply, which is generally available in wet years only. At present, increasing quantities of water are being provided to municipal customers, including the cities of Redding, Sacramento, Folsom, Tracy, and Fresno; most of Santa Clara County; and the northeastern portion of Contra Costa County.

CVP operations are influenced by general operating rules, regulatory requirements, and facility-specific concerns and requirements. This section summarizes the operations of the CVP, beginning with a description of factors that influence operations decisions, descriptions of regulatory requirements, and specific operating constraints at CVP facilities. The section concludes with a discussion of CVP contract types and criteria used to determine annual water delivery levels to CVP contractors.

General Criteria For The Operation of CVP Facilities

In the development of operations decisions, criteria related to reservoir operations, downstream conditions, and water rights in the Delta must be considered. This section describes how these issues generally influence CVP operational decisions.

Reservoir Operating Criteria. Inflow and release requirements are the principal elements influencing reservoir storage. Operational decisions must consider not only conditions at an individual reservoir, but also downstream conditions and conditions at other project reservoirs. The possibility of using multiple water sources for some requirements adds flexibility to project operations and complexity to operations decisions. Storage space south of the Delta that can only be filled with water exported from the Delta is a major operational consideration involving the geographic distribution of water in storage. Other factors that influence the operation of CVP reservoirs include flood control requirements, carryover storage objectives, lake recreation, power production capabilities, cold water reserves, and pumping costs.

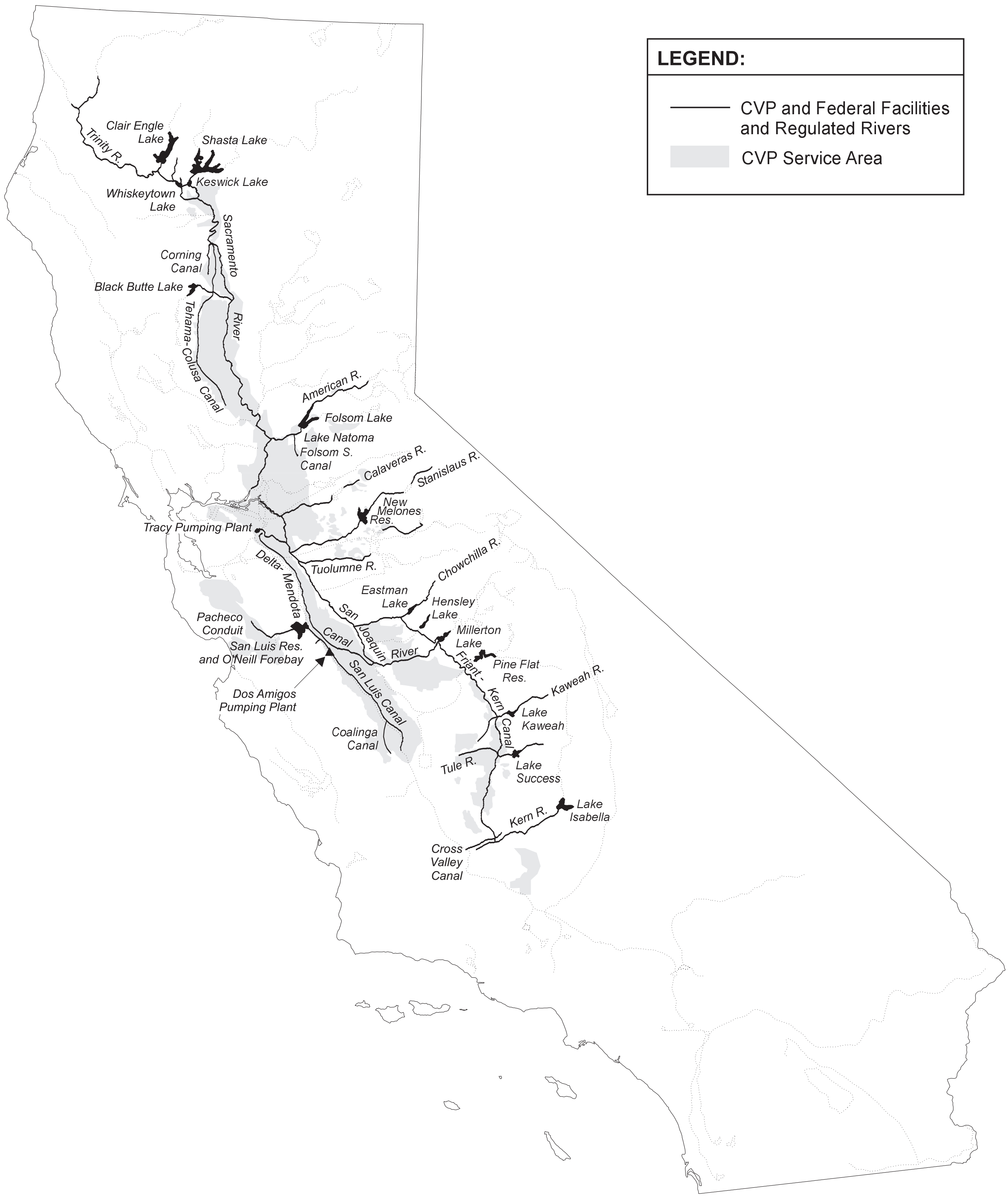


FIGURE III-5

CENTRAL VALLEY PROJECT AND OTHER RELATED FEDERAL FACILITIES

The COE is responsible for determining flood control operational requirements at most CVP reservoirs. If CVP reservoir storage exceeds COE requirements, water must be released at rates of flow defined in the COE's flood control manuals. These manuals require lower reservoir storage levels in the fall in anticipation of inflow from winter precipation. To avoid excess releases at the end of the summer, releases in excess of minimum flow requirements are made over the course of the summer such that reservoir storage levels are at or below maximum flood control levels in the fall.

Streamflow Criteria. Streams below CVP dams support both resident and anadromous fisheries, recreation, and water diversions. While resident fisheries are slightly affected by release fluctuations, the anadromous fisheries (e.g., salmon and steelhead) are the most sensitive and are present year-round in CVP streams. Maintaining water conditions favorable to spawning, incubation, rearing, and outmigration of the young anadromous fish is one of the main objectives. CVP operations are coordinated to anticipate and avoid streamflow fluctuations during spawning and incubation whenever possible.

In the management of releases prescribed by the COE for flood control, CVP operators have some latitude in controlling the magnitude and duration of the releases, based on criteria for downstream public safety and levee stability. Flood control releases are typically accomplished through a series of stepped increases defined by such factors as powerplant capability, minor flooding of adjacent lands, erosion, and channel capacity. Flood releases are established at the lowest step of the progression that will satisfy the requirements for evacuating storage, maximizing public safety, and minimizing the downstream effect of flood releases.

Regulations And Agreements That Affect CVP Operations

The operation of the CVP is, and has historically been, affected by the provisions of several regulatory requirements and agreements. Prior to the passage of CVPIA, the operation of the CVP was affected by SWRCB Decisions 1422 and 1485, and the Coordinated Operations Agreement (COA). Decisions 1422 and 1485 identify minimum water flow and water quality conditions at specified locations, which are to be maintained in part through the operation of the CVP. The COA specifies the responsibilities shared by the CVP and SWP for meeting the requirements of D-1485.

Beginning in 1987, a series of actions by the SWRCB, U.S. Environmental Protection Agency (USEPA), the National Marine Fisheries Services (NMFS), and the U.S. Fish and Wildlife Service (Service) affected interim water flow and water quality standards in the Delta. However, at the time CVPIA was enacted (October, 1992), the water quality standard in the Delta remained D-1485, and the CVP and SWP were operated in accordance with the COA to maintain this requirement.

In 1990 and 1991, SWRCB issued Water Rights Orders 90-05 and 91-01 modifying Reclamation's water rights for the Sacramento River. The orders include temperature objectives for the Sacramento River and requesting Reclamation to operate Keswick and Shasta dams and the Spring Creek powerplants to meet a daily average water temperature of 56 degrees Fahrenheit at RBDD in the Sacramento River during critical periods when higher temperature would be harmful to the anadromous fishery.

In 1993, NMFS in formal consultation issued a Long-Term Winter-Run Chinook Salmon Biological Opinion, which addresses modifications to the long-term CVP operational plan to avoid jeopardizing the continued existence of the Sacramento River winter-run chinook salmon. Also in 1993, the Service released a biological opinion and included restrictions on Delta smelt and associated habitat of operational actions by the CVP and SWP. This biological opinion was revised in 1994 and in 1995.

In December 1994, representatives of the state and federal governments and urban, agricultural and environmental interests agreed to the implementation of a Bay-Delta protection plan through the SWRCB, in order to provide ecosystem protection for the Bay-Delta Estuary. The Draft Bay-Delta Water Control Plan, released in May 1995, superseded D-1485. The coordinated operations of the CVP and SWP continue to be based on the COA.

Operations of CVP Divisions and Facilities

The facilities included in CVP divisions north of the Delta, including the Trinity, Shasta, and Sacramento River divisions, are shown schematically in Figure III-6. These divisions are known collectively as the Northern CVP System. Facilities in CVP divisions south of the Delta are shown in Figure III-7. Of these, the Delta, West San Joaquin, and San Felipe divisions are known collectively as the Southern CVP System. Both the Eastside and Friant divisions are operated independently of the remainder of the CVP, due to the nature of their water supplies and service areas. The Northern and Southern CVP Systems are operated as an integrated system, and demands for water and power can be met by releases from any one of several facilities. Demands in the Delta and south of the Delta can be met by the export of excess water in the Delta, which can result from releases from northern CVP reservoirs. As a result, operational decisions are based on a number of physical and hydrological factors that tend to change depending on conditions.

Trinity River Division. The Trinity River Division, completed in 1964, includes facilities to collect and regulate water in the Trinity River, as well as facilities to transfer portions of the collected water to the Sacramento River Basin. Specific facilities in the Trinity River Division include Trinity Dam and Powerplant; Clair Engle Lake; Lewiston Dam, Lake, and Powerplant; Clear Creek Tunnel; Whiskeytown Dam and Lake; Spring Creek Debris Dam and Reservoir; and the Cow Creek Unit.

Trinity Dam on the Trinity River was completed in 1962, forming Clair Engle Lake, with a maximum storage capacity of approximately 2.4 million acre-feet. All releases from Trinity Dam are re-regulated downstream at Lewiston Lake to meet downstream flow, in-basin diversion, and downstream temperature requirements. Lewiston Reservoir provides a forebay for the trans-basin transfer of water through the Clear Creek Tunnel and the Judge Francis Carr Powerplant into Whiskeytown Lake on Clear Creek.

Water stored in Whiskeytown Lake includes exports from the Trinity River as well as runoff from the Clear Creek drainage area. Releases from Whiskeytown Lake are either passed through the Spring Creek Powerplant and discharged into Keswick Reservoir on the Sacramento River or released to Clear Creek to meet downstream flow and diversion requirements.

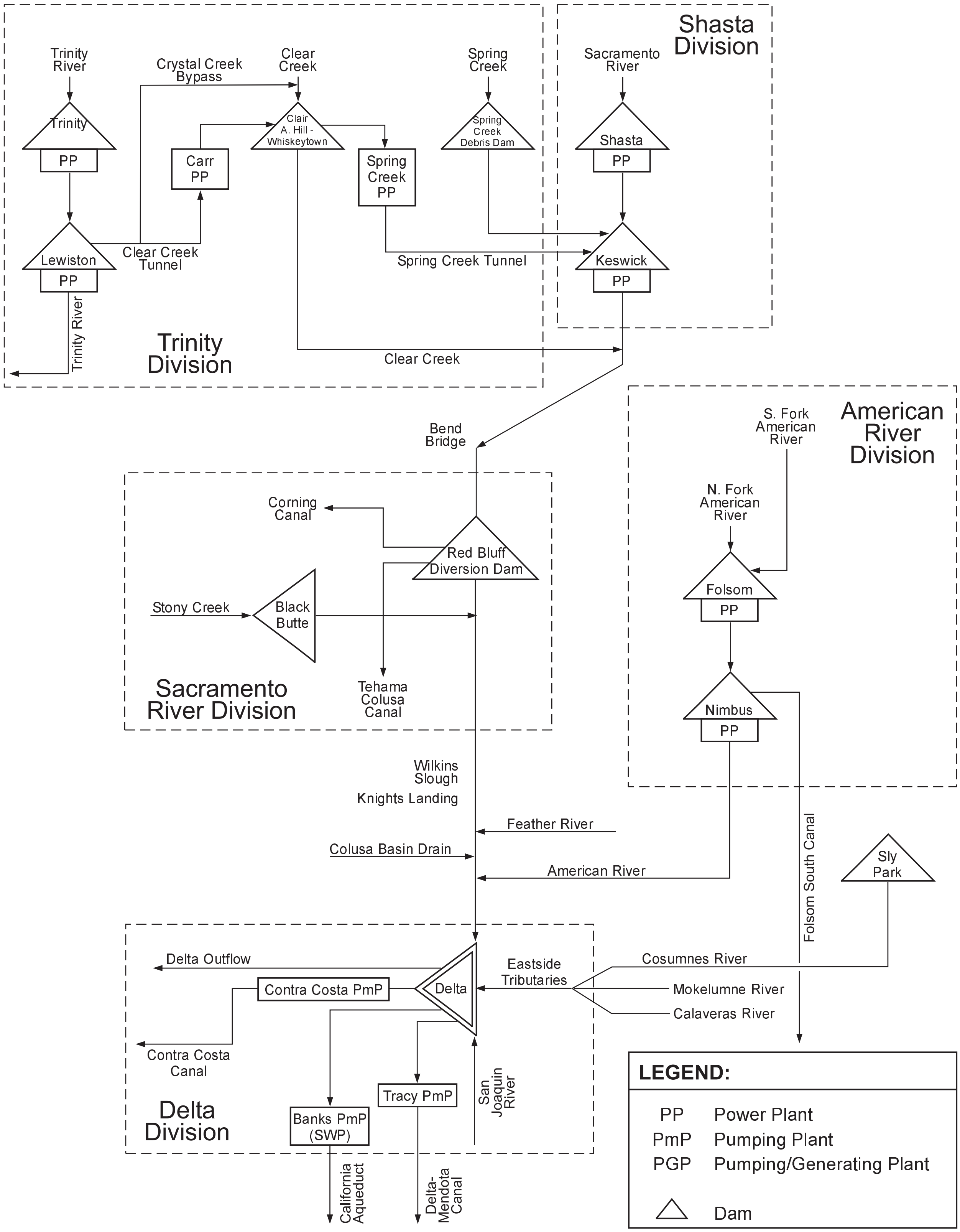


FIGURE III-6

CENTRAL VALLEY PROJECT FACILITIES NORTH OF THE DELTA

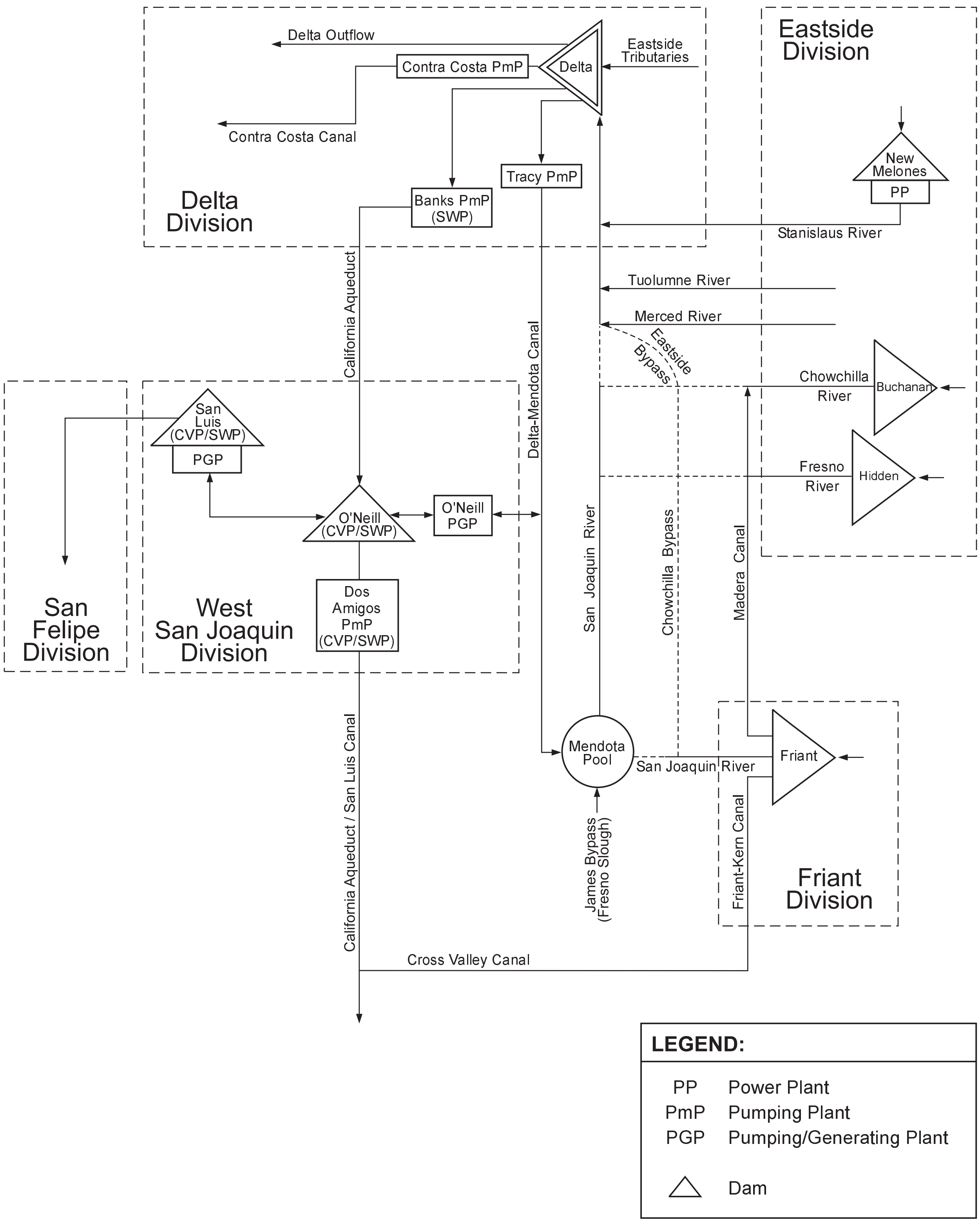


FIGURE III-7

CENTRAL VALLEY PROJECT FACILITIES SOUTH OF THE DELTA

The mean annual inflow to Clair Engle Lake is about 1.2 million acre-feet, a large percentage of which is diverted to the Central Valley. Clair Engle Lake is operated to satisfy required fishery releases to the Trinity River, while attempting to fill the lake by the end of June to maximize power production during the summer and fall. During the winter months, Clair Engle Lake storage is regulated within the capacity of Trinity, Lewiston, Spring Creek, Judge Francis Carr, and Keswick powerplants, as well as Reclamation's Safety of Dams criteria.

Shasta and Sacramento River Divisions. The Shasta Division of the CVP includes facilities that provide conservation of water on the Sacramento River for flood control, navigation maintenance, conservation of fish in the Sacramento River, protection of the Delta from intrusion of saline ocean water, irrigation and M&I water supplies, and hydroelectric generation. The Sacramento River Division includes facilities for the diversion and conveyance of water to CVP contractors on the west side of the Sacramento River.

Shasta Dam is located on the Sacramento River at the confluence of the Sacramento, McCloud, and Pit rivers. Keswick Reservoir serves as an afterbay for releases from Shasta Dam and for discharges from the Spring Creek Powerplant. As a condition of the Winter-Run Chinook Salmon Biological Opinion, Reclamation maintains a minimum flow of 3,250 cfs in the Sacramento River below Keswick Dam from October 1 through March 31. This minimum instream flow is to provide safe rearing and downstream passage of winter-run chinook salmon and to reduce stranding of juveniles.

The RBDD, on the Sacramento River approximately 2 miles southeast of Red Bluff diverts water to the Corning and Tehama-Colusa canals. Completed in 1964, the dam is a gated structure with fish ladders at each abutment. The gates are lowered from May 15 to September 15 for diversion into the Tehama-Colusa Canal. When the gates are lowered, the impounded water creates Lake Red Bluff.

Flood control releases from Keswick Dam are adjusted for local runoff entering the Sacramento River between Keswick and Bend Bridge so that the flow at Bend Bridge does not exceeded 100,000 cfs Releases from Keswick Dam also are regulated in the spring months to reduce adverse effects on orchard located in areas prone to seepage. During non-flood control operations, releases from Keswick are made to maintain minimum flows of 5,000 cfs at Chico Landing. This level was originally established to support navigation but has been used as a basis to set pump intakes. Therefore, even though navigation has diminished, navigation flows cannot be reduced without affecting the pumping capabilities of the water users.

American River Division. The American River Division includes facilities that provide conservation of water on the American River for flood control, fish and wildlife protection, recreation, protection of the Delta from intrusion of saline ocean water, irrigation and M&I water supplies, and hydroelectric generation. Initially authorized facilities in the American River Division are Folsom Dam, Lake and Powerplant; Nimbus Dam and Powerplant; Lake Natoma; and the Sly Park Unit. The Sly Park unit facilities are locate dint he Cosumnes River basin. The Auburn-Folsom South Unit includes the Foresthill Divide subunit and the Folsom South Canal.

Delta Division. Delta Division facilities provide for the transport of water through the Sacramento-San Joaquin River and the San Francisco Bay-Delta Estuary, and the delivery of water to CVP contractors in eastern Contra Costa County and the San Joaquin Valley. The Delta Division is operated in conjunction with the SWP through the COA to meet the requirements of in-Delta riparian water rights holders and Delta water quality standards adopted by the SWRCB to protect beneficial uses of the Delta.

The DCC is a controlled diversion channel located between the Sacramento River and Snodgrass Slough, a tributary of the Mokelumne River in the Delta. The original and primary purpose of the DCC was to provide passage of Sacramento River water to the Tracy Pumping Plant. The Contra Costa Canal, one of the first CVP facilities, was completed in 1948 to serve agricultural users in eastern and central Contra Costa County. Since that time, urban growth and municipal demands have replaced nearly all of the original agricultural uses.

The Tracy Pumping Plant and Delta-Mendota Canal convey water to the Mendota Pool on the San Joaquin River west of Fresno, and deliver water to San Joaquin River Exchange Contractors and CVP water service contractors in the San Joaquin Valley. A portion of the water conveyed through the Delta-Mendota Canal is pumped into the O'Neill Forebay and then into the joint federal-state San Luis Reservoir. Water stored in San Luis Reservoir meets contract requirements for agricultural irrigation on the west side of the San Joaquin Valley through the San Luis Canal and to deliver water to urban contractors in the Santa Clara Valley and Hollister Unit of the San Felipe Project.

Beneficial uses in the Delta are protected by the SWRCB May 1995 draft water quality control plan and the DCC gate operations specified in the NMFS 1993 Long-Term Winter-Run Chinook Salmon Biological Opinion. To accomplish these objectives, CVP and SWP operators must consider the current water supply and hydrologic conditions; current water quality conditions; and potential impacts to fisheries, recreation, and power.

West San Joaquin Division. The West San Joaquin Division of the CVP consists of the San Luis Unit, and includes federal as well as joint federal and State of California water storage and conveyance facilities to provide for delivery of water to CVP contractors in the San Joaquin Valley and in the San Felipe Division. Facilities in the West San Joaquin Division are San Luis Dam and Reservoir, O’Neill Dam and Forebay, the San Luis Canal, Coalinga Canal, Los Banos and Little Panoche Detention dams and reservoirs, and the San Luis Drain.

San Luis Dam and Reservoir are located on San Luis Creek near Los Banos. The reservoir, with a capacity of 2.0 million acre-feet, is a pumped-storage reservoir primarily used to store water exported from the Delta. It is a joint federal and State of California facility that stores CVP and SWP water. Water from San Luis Reservoir is released for delivery to CVP and SWP contractors served by the San Luis Canal, through the Pacheco Tunnel to serve the San Felipe Unit of the CVP, and to the Delta-Mendota Canal to serve CVP water service and San Joaquin River Exchange contractors on the west side of the San Joaquin Valley.

O'Neill Dam and Forebay are located on San Luis Creek downstream of San Luis Dam along the SWP California Aqueduct. The forebay is used as a hydraulic junction point for state and federal waters. CVP water is lifted from the Delta-Mendota Canal to the O’Neill Forebay by the O'Neill Pumping-Generating Plant. The San Luis Canal, a joint federal and state (CVP/SWP) facility, conveys water southeasterly from O'Neill Forebay along the west side of the San Joaquin Valley for delivery to CVP and SWP contractors.

The CVP operation of the San Luis Unit requires coordination with the SWP since some of the facilities are joint state and federal facilities. Like the CVP, the SWP also has water demands it must meet with limited water supplies and facilities. Coordinating the operations of the two projects avoids inefficient situations such as one entity pumping water into San Luis Reservoir at the same time the other is releasing water.

San Felipe Division. The San Felipe Division provides CVP water to Santa Clara and San Benito counties, through conveyance facilities from San Luis Reservoir. Specific facilities include the Pacheco Tunnel and Conduit, the Hollister Conduit, San Justo Dam and Reservoir, and the Santa Clara Conduit. The Pajaro Valley, in southern Santa Cruz County, was originally authorized to receive irrigation water to reduce seawater intrusion caused by groundwater pumping. Although studies to reduce seawater intrusion and determine conveyance requirements have continued, no facilities have yet been constructed in the Pajaro Valley to receive the authorized water deliveries.

Eastside Division. The Eastside Division of the CVP includes water storage facilities on the Stanislaus River (New Melones Dam, Reservoir, and Powerplant), Chowchilla River (Buchanan Dam and Eastman Lake), and Fresno River (Hidden Dam and Hensley Lake). All of the dams and reservoirs in this division were constructed by the COE. Upon completion in 1980, the operation of New Melones was assigned to Reclamation to provide flood control, satisfy water rights obligations, provide instream flows, maintain water quality conditions in the Stanislaus River and in the San Joaquin River at Vernalis, and provide deliveries to CVP contractors.

The operating criteria for New Melones Reservoir are governed by water rights, instream fish and wildlife flow requirements, instream water quality, Delta water quality, CVP contracts, and flood control considerations. Flows in the lower Stanislaus River serve multiple purposes. These include providing water for instream water rights obligations, meeting instream fishery flow requirements, maintaining instream water conditions of dissolved oxygen, and maintaining water quality conditions in the San Joaquin River at Vernalis, in accordance with D-1422 and the SWRCB May 1995 draft water quality control plan. Water is also released from New Melones Reservoir to meet, to the extent available, the San Joaquin River flow requirements in the SWRCB May 1995 draft water quality control plan.

Friant Division. The Friant Division includes facilities to collect and convey water from the San Joaquin River to provide a supplemental water supply to areas along the east side of the southern San Joaquin River Basin and the Tulare Basin. The delivery of CVP water to this region augments groundwater and local surface water supplies in an area that has historically been subject to groundwater overdraft. The Friant Division is an integral part of the CVP, but is hydrologically independent and, therefore, operated separately from the other divisions of the CVP. The water supply to this division was made available through an agreement with San Joaquin River water rights holders, who entered into exchange contracts with Reclamation for delivery of water through the Delta-Mendota Canal. Major facilities of the Friant Division include Friant Dam and Millerton Lake, the Madera Canal, and the Friant-Kern Canal.

Flood control releases from Millerton Lake may be used to satisfy portions of deliveries to the Mendota Pool Contractors and the San Joaquin River Exchange Contractors on the San Joaquin River below Mendota Pool. Millerton Lake operations are coordinated with operations of the Delta-Mendota Canal in the Delta Division to use all available Millerton Lake flood control releases before additional water is delivered to Mendota Pool. During wet hydrologic periods, overflow from the Kings River may also enter the San Joaquin River Basin at the Mendota Pool through the Fresno Slough.

CVP Water Users

During development of the CVP, the United States entered into long-term contracts with many of the major water rights holders in the Central Valley. In part, the CVP is operated to satisfy downstream water rights, meet the obligations of the water rights contracts, and deliver project water to CVP water service contractors.

Many of the CVP water rights originated from applications filed by the state in 1927 and 1938 to advance the California Water Plan. After the Federal Government was authorized to build the CVP, those water rights were transferred to Reclamation, who made applications for the additional water rights needed for the CVP. In granting water rights, the SWRCB sets certain conditions within the permits to protect prior water rights, fish and wildlife needs, and other prerequisites it deems in the public interest.

Sacramento River Water Rights Contractors. Sacramento River Water Rights Contractors are contractors who for the most part claim water rights on the Sacramento River. With the control of the Sacramento River by Shasta Dam, these water right claimants entered into contracts with Reclamation. Most of the agreements established the quantity of water the contractors are allowed to divert from April through October without payment to Reclamation, and are provided a supplemental CVP supply allocated by Reclamation.

San Joaquin River Exchange Contractors. San Joaquin River Exchange Contractors are contractors who receive CVP water from the Delta at the Mendota Pool. Under the Exchange Contracts, the parties agreed to not exercise their San Joaquin River water rights in exchange for a substitute CVP water supply from the Delta. These exchanges allowed for water to be diverted from the San Joaquin River at Friant Dam under the water rights of the United States for storage at Millerton Lake.

The purchase contract dealt primarily with riparian water rights. When the United States purchased these rights, they were “extinguished” and thereby made water available for storage and diversion at Friant. Under the exchange contract, the parties agreed not to exercise their rights in exchange for a substitute water supply from the Delta. This also made water available for storage and diversion at Friant. However, under the exchange contract, no transfer of water rights occurred, and Reclamation is responsible for delivering water to these contractors in accordance with these agreements.

CVP Water Service Contractors. Before construction of the CVP, many irrigators on the west side of the Sacramento Valley, on the east and west sides of the San Joaquin Valley, and in the Santa Clara Valley relied primarily on groundwater. With the completion of CVP facilities in these areas, the irrigators signed agreements with Reclamation for the delivery of CVP water as a supplemental supply. Several cities also have similar contracts.

CVP water service contracts are between the United States and individual water users or districts and provide for an allocated supply of CVP water to be applied for beneficial use. In addition to CVP water supply, a water service contract can include a supply of water that recognizes a previous water right. The purposes of a water service contract are to stipulate provisions under which a water supply is provided, to produce revenues sufficient to recover an appropriate share of capital investment, and to pay the annual operations and maintenance costs of the project.

In the Friant Division, a two-class system of water service contracts is employed to support the conjunctive use of surface water and groundwater that has long been a practice in the San Joaquin River and Tulare Lake basins. Class I contracts relate to “dependable supply,” typically assigned users with limited access to good quality groundwater. Class II contracts are generally held by water users with access to good quality groundwater that can be used during periods of surface water deficiency. Groundwater recharge and recharge/exchange agreements are frequently employed in the management of Class II water supplies.

Criteria for Water Deliveries to CVP Contractors

The criteria for deliveries to CVP contractors consider available water supplies and superior obligations on the use of the available water. Decision-making criteria are similar in most units and divisions of the CVP. The criteria applicable to CVP contractors served by the North System (Trinity, Shasta, Sacramento River, and American River divisions) and the South System (Delta, West San Joaquin, and San Felipe divisions) are similar. The criteria applied to establish water delivery deficiencies in the Friant Division are somewhat different, because this division is operated to provide water supplies for conjunctive use. In addition, the criteria for operations of New Melones Reservoir and contract deliveries on the Stanislaus River are affected by conditions unique to the Stanislaus River watershed.

Shasta Criteria. Shortage conditions for providing water to the Sacramento River Water Rights Contractors and the San Joaquin River Exchange Contractors are based on the “Shasta Criteria.” The Shasta Criteria is used to establish when a water year is considered critical, based on inflow to Shasta Lake.

As defined by the Shasta Criteria, when inflows to Shasta Lake fall below the defined thresholds, the water year is defined as critical, and water deliveries to the contractors may be reduced. A year is critical when the full natural inflow to Shasta Lake for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year) is equal to or less than 3.2 million acre-feet. This is considered a single-year deficit. A year is also critical when the accumulated difference (deficiency) between 4 million acre-feet and the full natural inflow to Shasta Lake for successive previous years, plus the forecasted deficiency for the current water year, exceeds 800,000 acre-feet.

Criteria for Deliveries to CVP Contractors in the North and South Systems. Except in times of water shortages, the CVP makes available the amounts of water specified in the terms of its water rights and water service contracts in the CVP North and South systems. Water availability for delivery to the Sacramento River Water Rights Contractors is based on the Shasta Criteria which, as described above, reduce deliveries to 75 percent of the contract amount during critical years. Water availability for delivery to San Joaquin River Exchange Contractors and to Medota Pool Contractors is approximately based on the Shasta Criteria. Water availability for delivery to CVP water service contractors during periods of insufficient water supply is determined based on a combination of operational objectives, hydrologic conditions, and reservoir storage conditions. Reclamation is required to allocate shortages among water service contractors within the same service area, as individual contracts and CVP operational capabilities permit.

Criteria for Deliveries to CVP Contractors in the Friant Division. The determination of annual water supply from the Friant Division is done independently of other CVP divisions. In February, Reclamation estimates the water supply for the coming contract year based on hydrologic conditions, storage in upstream reservoirs, and assumptions based on statistical analysis of historic records.

Criteria for Deliveries to CVP Contractors in the Eastside Division. Reclamation has had difficulty meeting all of the demands on New Melones Reservoir. This difficulty became apparent during the period of 1987-1992 when New Melones Reservoir was drawn down to approximately 80,000 acre-feet by 1992. Numerous unanticipated operational factors influenced the drawdown of New Melones during this period. These include the severity of drought conditions from 1989 through 1992, the effect of return flow water quality in the San Joaquin River at Vernalis, and low flows on the Merced and Tuolumne rivers. During the drought period, many Stanislaus River stakeholder meetings were convened to coordinate management of limited water supplies.

SWP FACILITIES AND OPERATIONS

SWP facilities capture and store water on the Feather River, to deliver water to service areas in the Feather River Basin, the San Francisco Bay area, the San Joaquin Valley, the Tulare Basin, and Southern California. Lake Oroville, with a storage capacity of approximately 3.5 million acre-feet, regulates the Feather River for release to Sacramento River and the Delta. The water is diverted by various facilities of the SWP for delivery to contractors or salinity control.

The SWP operates two diversion facilities in the Delta. The North Bay Aqueduct diverts water from the north Delta near Cache Slough for agricultural and municipal uses in Napa and Solano counties. In the southern portion of the Delta, the Banks Delta Pumping Plant lifts water into the California Aqueduct from the Clifton Court Forebay. The California Aqueduct is the state's largest and longest water conveyance system, beginning at the Banks Pumping Plant and extending to Lake Perris south of Riverside, in Southern California. Water in the California Aqueduct flows to O'Neill Forebay, from which a portion of the flow is lifted to the joint CVP/SWP San Luis Reservoir for storage. From O'Neill Forebay, the joint-use portion of the aqueduct, San Luis Canal, extends south to the southern end of the San Joaquin Valley. The SWP portion of the aqueduct continues over the Tehachapi Mountains to the South Coast Region.

SWP Water Users

Currently, the SWP has contracted a total of 4.23 million af for delivery in San Joaquin River Region, the Central Coast Region, and the San Francisco and South Coast regions. Of this amount, about 2.5 million acre-feet is designated for the Southern California Transfer Area, nearly 1.36 million acre-feet to the San Joaquin Valley, and the remaining 0.37 million acre-feet to the San Francisco Bay area, the Central Coast Region, and the Feather River area.

Feather River Settlement Contractors. The Feather River Settlement Contractors are water users who hold riparian and senior appropriative rights on the Feather River. As the SWP was built, the state entered into contractual agreements with these existing water rights holders (e.g., water rights settlements). In general, agreements established the quantity of water the contractor is permitted to divert under independent senior water rights on a monthly basis and outlined supplemental SWP supply allocated by the State. Contract shortages are applied based on hydrologic conditions and storage in Lake Oroville.

SWP Contract Entitlements. Contracts executed in the early 1960s established the maximum annual water amount (entitlement) that each long-term contractor may request from the SWP. The annual quantities, specified ion “Table A ” in DWR Bulletin 132, reflect each contractor’s projected annual water needs at the time the contracts were signed. SWP delivers water to agricultural and M&I water contractors based on the criteria established in the 1996 Monterey Agreement, which applies equal deficiency levels to all contractors.

GROUNDWATER

For over 100 years, groundwater has been used to support agricultural and municipal demands throughout California. In the Central Valley, groundwater development has been used extensively for agricultural supply, and in some area remains the sole water supply. The Friant Division, one of the initial features of the CVP, was developed specifically to supplement groundwater resources in the eastern portion of the San Joaquin Valley with surface water from the San Joaquin River.

The Central Valley regional aquifer system of California is a 400-mile long, northwest-trending asymmetric trough averaging 50 miles in width, as shown in Figure III-8. Historically, groundwater resources have been extensively developed in the Sacramento, San Joaquin, and Tulare Lake regions. Prior to development of the CVP, overdraft conditions had occurred as a result of extensive groundwater development and the reliance on groundwater during drought years because of limited surface water supplies. In some areas of the Central Valley, regional groundwater levels declined by more than 300 feet during the 1940s and 1950s. The development of surface water supplies in the 1950s and 1960s reduced reliance on groundwater and helped control the rapid rate of groundwater level decline. However, the long-term effects of groundwater use have resulted in regional land subsidence.

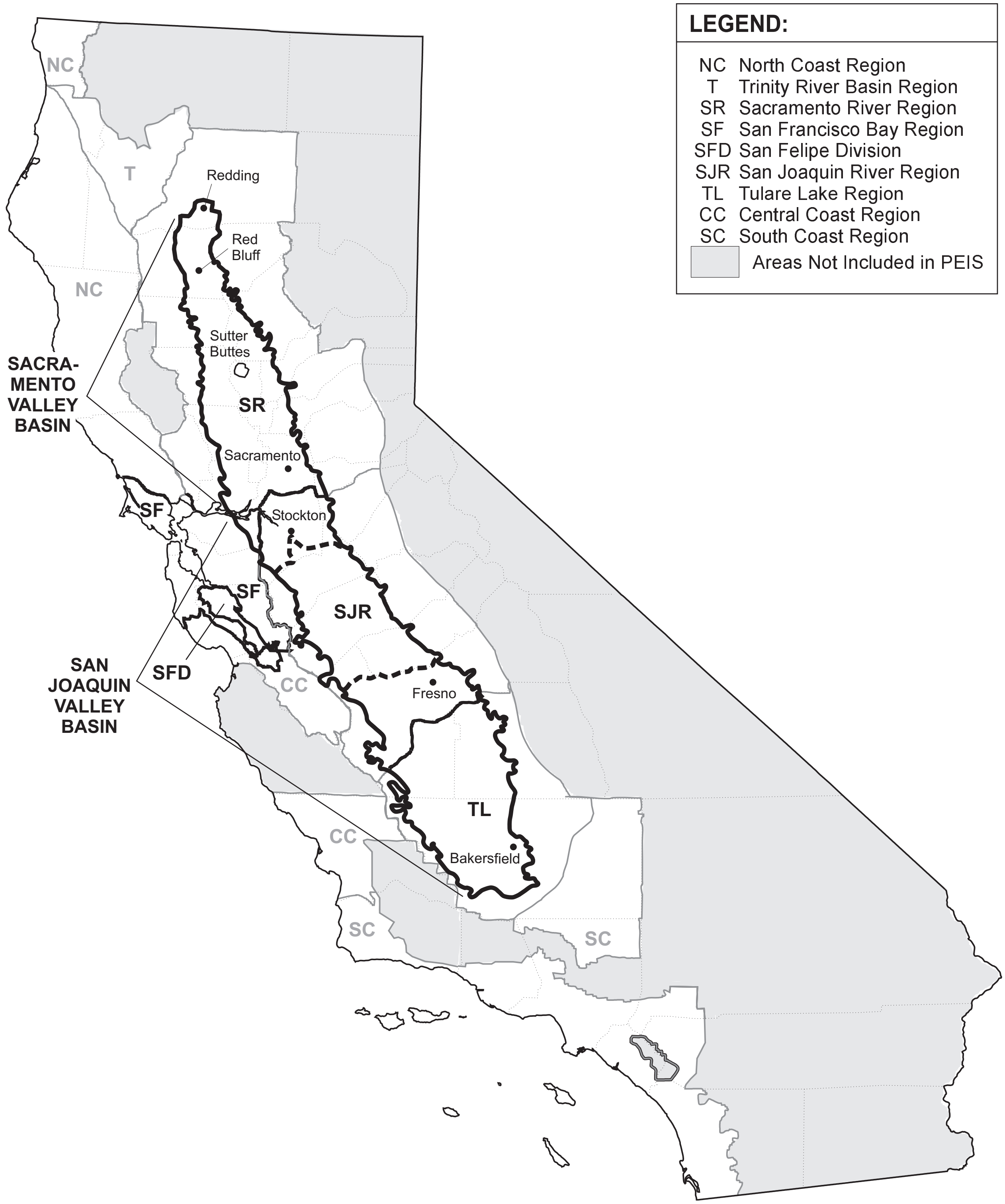


FIGURE III-8
GROUNDWATER STUDY AREA

The largest occurrence of land subsidence in the world induced by human activity occurs in the Central Valley of California (Bertoldi et al., 1991). The areal extent of land subsidence, shown in Figure III-9, generally coincides with areas where groundwater levels have declined significantly as a result of historical overdraft conditions. Overdraft conditions occur when groundwater pumping exceeds perennial yield on a sustained basis. The perennial yield of an aquifer, as defined by DWR, is the amount of groundwater that can be extracted without lowering groundwater levels over the long term, assuming a specific level of water management activity. If water management activities change, groundwater recharge will be altered, which will alter the estimate of perennial yield.

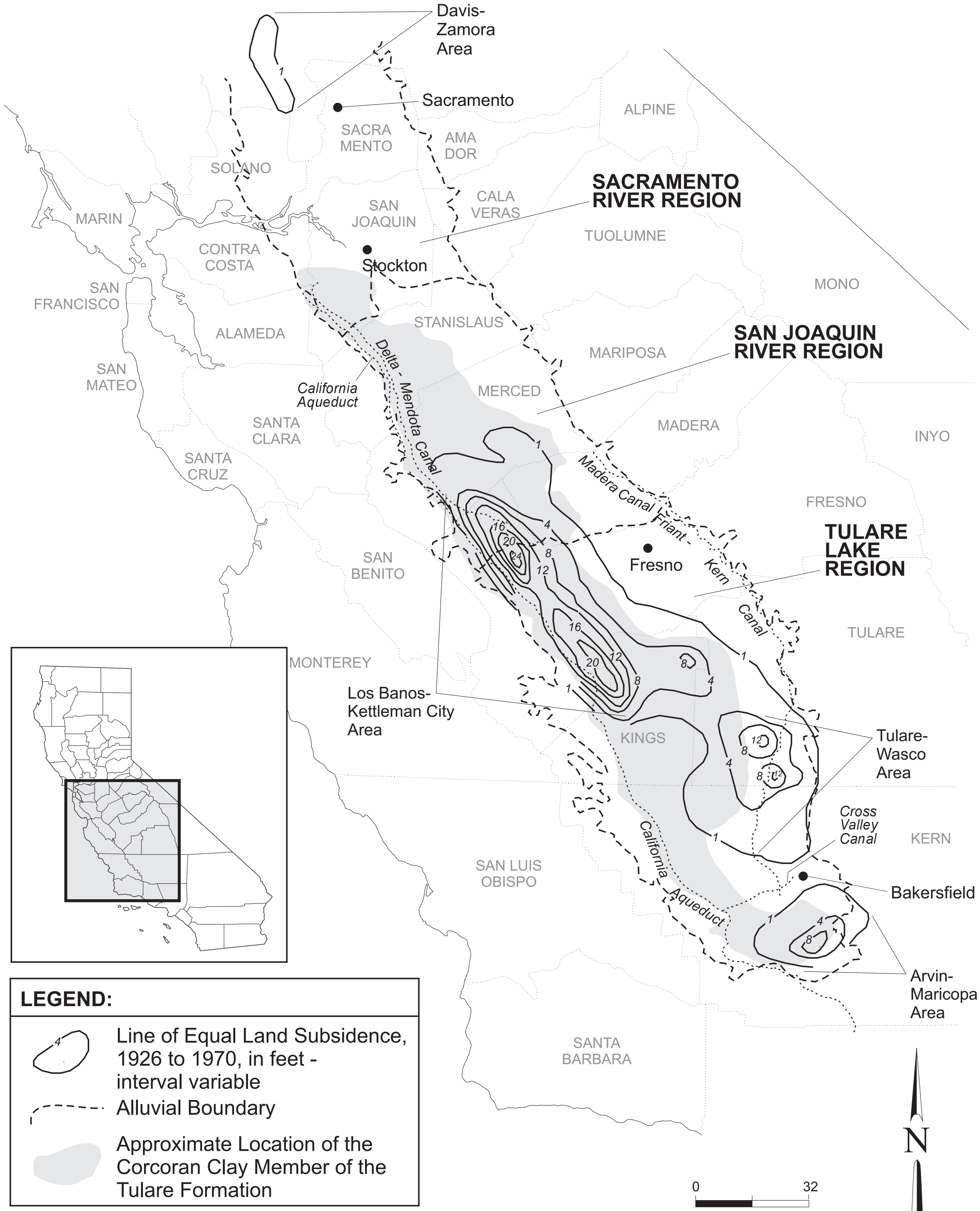
The extensive agricultural development in the Central Valley has resulted in areas where groundwater has become degraded from salts, pesticides, or fertilizer. Areas of poor shallow groundwater drainage are often associated with high concentrations of salts. Areas near rivers that are subject to seepage commonly are waterlogged during high flows.

SACRAMENTO RIVER BASIN

The northern third of the Central Valley regional aquifer system is located in the Sacramento River Region. This region extends from north of Redding to the Delta in the south. DWR identifies this portion of the Central Valley Aquifer as the Sacramento Valley and Redding basins, which cover over 5,500 square miles. This discussion refers to these basins collectively as the Sacramento Valley Basin.

In the Sacramento Valley Basin, a long-term dynamic link between the groundwater and surface water system has been maintained on a regional basis. The greatest gains to streams from groundwater occurred during the 1940s when groundwater storage was highest in the Sacramento Valley basin. Discharge to streams was lowest during and immediately following the 1976 to 1977 drought and during the 1987 to 1992 drought periods. In some areas of the southern portion of the Sacramento Valley Region where groundwater levels have continued to decline, such as in Sacramento County, streams that formerly gained flow from the subsurface now lose flow through seepage to adjacent groundwater systems.

Aquifer recharge to the Sacramento Valley Basin has historically occurred from deep percolation of rainfall, the infiltration from stream beds, and subsurface inflow along basin boundaries. Most of the recharge for the Central Valley occurs in the north and east sides of the valley where the precipitation is the greatest. With the introduction of agriculture to the region, aquifer recharge was augmented by deep percolation of applied agricultural water and seepage from irrigation distribution and drainage canals. The basin has an estimated perennial yield of 2.4 million acre-feet, and recent groundwater pumping in the Sacramento Valley basin was estimated to be near this perennial yield, suggesting that regional overdraft conditions are not prevalent (DWR, 1994). One exception is the southwestern portion of the region in the Sacramento County area,, where overdraft conditions have occurred in recent years.



Source: Adapted from Williamson et al., 1989.

FIGURE III-9

AREAL EXTENT OF LAND SUBSIDENCE IN THE CENTRAL VALLEY DUE TO GROUNDWATER LEVEL DECLINE

Land subsidence due to groundwater level declines has been identified in the southwestern part of the Sacramento River Region, near Davis and Zamora. By 1973 land subsidence in this area had exceeded approximately 1 foot, and was reported to be approximately 2 feet east of Zamora and west of Arbuckle (Lofgren and Ireland, 1973). Land subsidence monitoring has continued since 1973, and some localized land subsidence was reported in the Davis-Zamora area during the 1988-1992 drought period (Dudley, 1995). Groundwater quality is generally excellent; however, areas of local groundwater contamination or pollution exist.

High water tables contribute to subsurface drainage problems in several areas of the Sacramento Valley Basin. High water tables in portions of Colusa County, particularly along the Sacramento River, periodically impair subsurface drainage functions of the Colusa Basin Drain and other local drainage facilities. In many reaches of the Sacramento River, flows are confined to a broad, shallow man-made channel with stream bottom elevations higher than adjacent ground surface elevations. During extended periods of high streamflows, seepage-induced water logging can occur on adjoining farmlands, particularly in areas where local groundwater is in contact with the river.

SAN JOAQUIN RIVER REGION

The southern two-thirds of the Central Valley regional aquifer system, which covers over 13,500 square miles extending from just south of the Delta to just south of Bakersfield, is referred to as the San Joaquin Valley Basin. For purposes of the PEIS analysis, this basin is divided into the San Joaquin River Region and the Tulare Lake Region. Much of the western portion of this area is underlain by the Corcoran Clay Member that divides the groundwater system into two major aquifers: a confined aquifer below the clay and a semi-confined aquifer above the clay.

Aquifer recharge to the semi-confined upper aquifer historically occurred from stream seepage, deep percolation of rainfall, and subsurface inflow along basin boundaries. With the introduction of irrigated agriculture into the region, recharge was augmented with deep percolation of applied agricultural water and seepage from the distribution systems. Recharge of the lower confined aquifer results from subsurface inflow from the valley floor and foothill areas to the east of the eastern boundary of the Corcoran Clay Member. Present information indicates that the clay layers, including the Corcoran Clay, are not continuous in some areas, and some seepage from the semi-confined aquifer above occurs through the confining layer.

The interaction of groundwater and surface water in the San Joaquin River Region has historically resulted in net gains to the streams. This condition existed on a regional basis until the mid 1950s. Since that time, groundwater level declines have resulted in some stream reaches losing flow through seepage to the groundwater systems below. Where the hydraulic connections have been maintained, the amount of seepage has varied as groundwater levels and streamflows have fluctuated. These dynamics have changed on a regional basis in eastern San Joaquin and Merced counties and in western Madera County. Other localized areas have also undergone similar changes.

Annual groundwater pumping in the San Joaquin River Region exceeds recent estimates of perennial yield by approximately 200,000 acre-feet (DWR, 1994). This overdraft condition exists, in part, in all the subbasins of the region. Historically, land subsidence resulting primarily from groundwater level declines has been a significant problem in the southern half of the San Joaquin Valley. From 1920 to 1970, approximately 5,200 square miles of irrigated land in the valley registered at least 1 foot of land subsidence (Ireland, 1986). Most of the vast acreage affected by land subsidence lies in the Tulare Lake Region discussed below. By the mid 1970s the use of imported surface water in the western and southern portions of San Joaquin Valley essentially halted the progression of land subsidence. During the 1976-1977 and 1987-1992 droughts, however, land subsidence was again observed in areas previously affected because of renewed high groundwater pumping rates.

Groundwater zones commonly used along portions of the western margin of the valley have high concentrations of TDS, ranging from 500 mg/l to greater than 2,000 mg/l (Bertoldi et al., 1991). The concentrations in excess of 2,000 mg/l commonly occur above the Corcoran Clay layer. These high levels have impaired groundwater for irrigation and municipal uses in the western portion of San Joaquin County.

Inadequate drainage and accumulating salts have been persistent problems along the west side and in parts of the east side of the San Joaquin River Region for more than a century. The most extensive drainage problems occur on the west side of the San Joaquin River and Tulare Lake regions, as shown in Figure III-10. In some portions of the San Joaquin River Region, natural drainage conditions are inadequate to remove the deep percolation to the water table. This occurs because vertical conductivity is low and therefore, limits downward drainage of infiltrated water. In addition, horizontal hydraulic conductivity is low and inhibits downslope subsurface drainage. Shallow groundwater levels often rise into the root zone, and subsurface drainage must be supplemented by constructed facilities for irrigation to be sustained.

In the lower reaches of the San Joaquin River and in the vicinity of its confluence with major tributaries, high periodic streamflows and local flooding combined with high groundwater levels have resulted in seepage-induced waterlogging to low-lying farmland. In the western portion of the Stanislaus River watershed, groundwater pumping has historically been used for control of high groundwater and seepage conditions. Along the San Joaquin River from the confluence with the Tuolumne River through the southern portion of the Delta, seepage-induced waterlogging damage to low-lying farmland occurs during periods of high flows, such as during flood control operations in the spring. The seepage-induced waterlogging prevents cultivation of the land until the summer months and can affect annual crop production levels.

TULARE LAKE REGION

The southern part of the San Joaquin Valley Basin, referred to here as the Tulare Lake Region, is a basin of interior drainage. Much of the western portion of this area is underlain by the Corcoran Clay Member that divides the groundwater system into two major aquifers: a confined aquifer below the clay and a semi-confined aquifer above the clay.

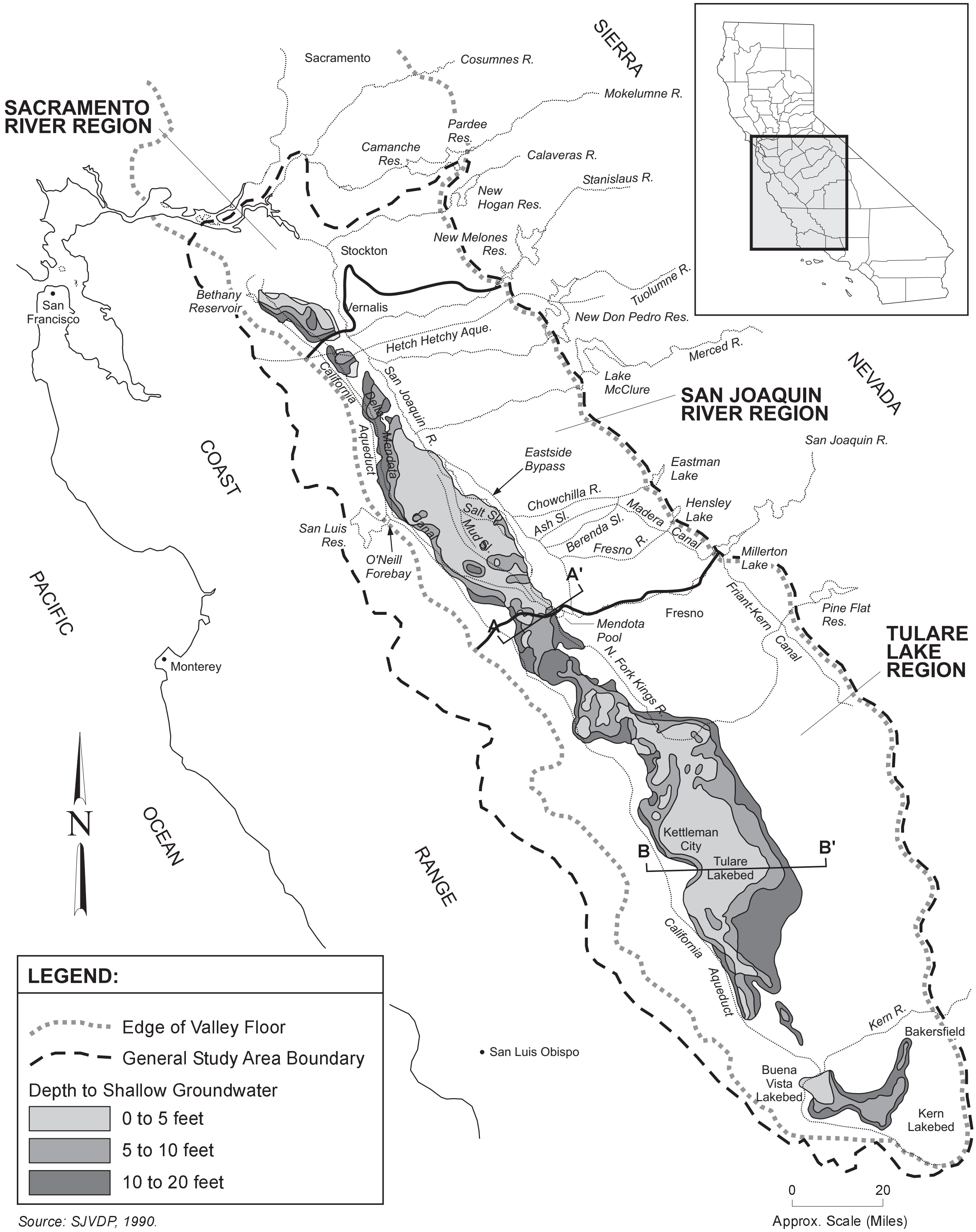


FIGURE III-10

AREAS OF SHALLOW GROUNDWATER, 1987

Groundwater quality conditions in the Tulare Lake Region are similar to those of the San Joaquin River Region. The subsurface drainage problems associated with the west side of the San Joaquin Valley extend from north to south in the Tulare Lake Region. The conditions of high groundwater levels in the shallow groundwater zone are similar to those discussed for the San Joaquin River Region, except that no regional seepage problems are associated with high groundwater tables in the Tulare Lake Region.

SAN FRANCISCO BAY REGION

Imported surface water from the CVP San Felipe Division is provided to areas in Santa Clara and San Benito counties to supplement available supplies. Historically, these areas have been subject to groundwater mining, resulting in a decline in groundwater levels that led to land subsidence and seawater intrusion. The delivery of CVP surface water supplies to the San Felipe Division is intended to reduce the use of groundwater.

Groundwater resources in parts of Alameda and Contra Costa counties are limited by availability of supply and poor water quality. In areas of limited groundwater supply, this has resulted in reliability problems, excessive groundwater level declines and land subsidence, increased pumping costs, and further degradation of water quality conditions. The introduction of imported CVP surface water supplies has supplemented the limited supplies.

FISHERY RESOURCES

Anadromous species addressed by the CVPIA include chinook salmon, steelhead trout, white and green sturgeon, striped bass, and American shad. Although striped bass and American shad are introduced species, both are abundant and contribute substantially to California’s recreational fishery. These fish populate portions of Central Valley streams and rivers during freshwater stages of their life cycles. Other species selected for analysis include delta smelt, longfin smelt, Sacramento splittail, and reservoir fishes.

FACTORS THAT AFFECTED HISTORICAL FISHERY RESOURCES

Native species have declined in abundance and distribution, and several introduced species have become well established. Habitat loss and modification, species introductions, and over fishing are the major factors affecting fisheries resources within the Draft PEIS study area.

Major modifications of the aquatic ecosystem began during the first major settlement of California that followed the 1849 gold rush. Dredging and hydraulic mining for gold produced enormous quantities of sediments that were deposited downstream, altering fish habitats in streams, rivers, the Delta, and San Francisco Bay. In the late 1800s and early 1900s, agricultural development and flood control construction of over 1,000 miles of levees eliminated much of the original marshland and riparian habitat supporting the aquatic ecosystem. Debris control, flood control, and water supply projects developed by federal, state, local, and private entities included dams that blocked fish access to the upper portions of most major rivers in the Central Valley.

Water storage and diversions greatly altered natural river and Delta flow patterns, while fish entrainment at water diversions affected unknown numbers of juvenile fish.

Agricultural, grazing, mining, logging, navigation, and urban development activities degraded water quality in almost all fish habitats. Agricultural drainage increased salinity and concentrations of pesticides and other toxic substances in both the rivers and Delta. Early cities, towns, and homesteads discharged untreated sewage into rivers, sloughs, and bays, causing eutrophication and oxygen depletion. Industries discharged toxic substances into the rivers and bays. Removal of riparian vegetation increased sedimentation and water temperature in small streams used by chinook salmon and trout for spawning and rearing.

WATER SUPPLY DEVELOPMENT

Early dams and diversions built by miners and farmers prior to 1939 obstructed hundreds of miles of habitat and blocked upstream fish passage. Debris dams were constructed in the late 1800s and early 1900s on the American and Yuba rivers to block downstream transport of mining sediments; however, these dams also blocked chinook salmon and steelhead trout migrations. The Anderson Cottonwood Irrigation District (ACID) diversion dam, constructed in 1917 on the upper Sacramento River near Redding, created a seasonal barrier to migrating chinook salmon. By the 1920s, a large portion of the Central Valley chinook salmon and steelhead trout spawning areas had been cut off by dams and other human-made barriers. Many of the smaller dams were eventually fitted with fish ladders, some of which moderately increased passage.

Beginning with the Baird Hatchery in 1872, hatcheries were constructed to augment chinook salmon production. However, the hatcheries replaced only a limited portion of the production that was lost from dams and other impacts. Dams may have blocked sturgeon, striped bass, and American shad migration; however, these species were probably only marginally affected because they generally do not ascend the rivers upstream of the dam sites. In some instances, diversions, especially for irrigation, entrained and caused mortality of millions of juvenile chinook salmon, steelhead trout, and other fish species. Diversions also dewatered sections of streams preventing migrating adult chinook salmon and steelhead trout from reaching spawning habitat.

Most of the factors adversely affecting fish habitats before 1940 continue today. The principal exceptions are uncontrolled hydraulic mining, which was banned in 1884, and discontinued gill net fishing in the Delta and Bay. The CVP, SWP, and several large local water supply projects, which include some of the largest dams, diversions, and canals in the Central Valley, profoundly altered fish habitats.

The many large dams of the CVP, SWP, and local water supply agencies permanently blocked access to the best chinook salmon and steelhead trout spawning and rearing habitat in the Central Valley. Small dams had previously disrupted adult migration and spawning life stages of chinook salmon and steelhead trout on most Central Valley streams and rivers; however, several of the small dams were fitted with fish ladders and provided some passage.

Shasta and Keswick dams, built on the Sacramento River in 1944 and 1950, respectively, blocked approximately 190 miles of spawning habitat on the upper Sacramento, Pit, and McCloud river drainages. The Red Bluff Diversion Dam (RBDD), built in the mid-1960s on the Sacramento River 60 miles downstream of Keswick Dam, was fitted with fish ladders but never the less caused delays of at least several days to upstream migrants. The CVP Nimbus and Folsom dams blocked approximately 61 miles of spawning habitat on the American River. A like amount of spawning habitat on the Feather River was blocked by the construction of the SWP Oroville Dam. The CVP Friant Dam on the San Joaquin River blocked access to approximately 35 miles of upstream spawning habitat, and drastically reduced flows in the section of the San Joaquin River downstream to the confluence with the Merced River.

Large dams constructed by local water districts, power companies, and the COE blocked passage to spawning reaches of other major rivers in the Central Valley. The dams also blocked recruitment of spawning gravels from upstream sources to the downstream portions of rivers used for chinook salmon and steelhead trout spawning. Gravel mining also reduced available spawning habitat.

Reservoir operations also altered the temperature regime in the rivers downstream. For a period after the large dams were constructed, reservoirs were kept relatively full and, where physically possible, cold water was released from the hypolimnion providing cooler summer temperatures in the downstream reaches. Fall-run chinook salmon populations responded to the colder flows and began to spawn earlier than historical chinook salmon runs. During dry periods, the reservoirs are typically drawn down to meet water demands, resulting in warm water releases and corresponding mortalities. Winter-run chinook salmon and steelhead trout, which are either spawning or rearing during the spring and summer, are exposed to conditions that historically they would have avoided and consequently have been especially harmed by the warm water temperatures encountered during incubation and rearing life stages.

CVP and SWP export facilities in the South Delta modify fish habitat. These facilities greatly alter flow patterns in the Delta and cause entrainment and mortality of juvenile life stages of all resident and anadromous species. Additional diversions by agricultural and M&I interests in the Delta and in the Sacramento and San Joaquin rivers entrain a large number of juvenile fish annually. During spring, many emigrating juvenile chinook salmon and steelhead trout are exposed to high mortality through entrainment at improperly screened and/or unscreened irrigation diversions and pumping facilities.

COMMERCIAL AND SPORT FISHING

Exotic species were first introduced in the Sacramento-San Joaquin River system shortly after the gold rush. Most of those species were introduced to improve fishing or to provide forage for game species. Striped bass were brought in from the Atlantic coast in 1879 and 1882, and the population quickly multiplied to millions of adults. American shad were introduced from New York between 1871 and 1881 and were well established by 1879. Largemouth and smallmouth bass, catfishes, and sunfishes were also introduced.

The first organized commercial fishery in the Sacramento-San Joaquin River system was developed between 1848 and 1850. Chinook salmon were taken in gill nets and seines in the rivers, the Delta, and the Bay; sardines, herring, and flatfishes were captured with seines in the Bay. Following the gold rush, commercial fishing expanded rapidly and from 1873 to 1910; more than 20 canneries processed 5 million pounds of chinook salmon annually from the Sacramento and San Joaquin River system, as shown in Figure III-11. The values in Figure III-11 may reflect changes in fish population, demand for canned salmon, price fluctuations for harvested fish, and affects of workers during war periods.

The ocean salmon fishery developed in the 1890s and early 1900s largely replaced the river fishery and may have further contributed to the depletion of chinook salmon stocks. Since 1970, the commerical and sport ocean harvest of chinook salmon has maintained a harvest rate index of between 50 and 80 percent, as shown in Figure III-12. During the 1980s, the availability of improved navigation and fish detection technologies, combined with the effect of increased hatchery production, dramatically increased the annual catch-per-unit-effort for California ocean salmon fisheries. Commercial and sport fisheries for striped bass also developed in the late 1800s and early 1900s, but striped bass abundance did not decline until the mid-1900s. Commercial striped bass fishing was banned in 1935.

OCEAN CONDITIONS

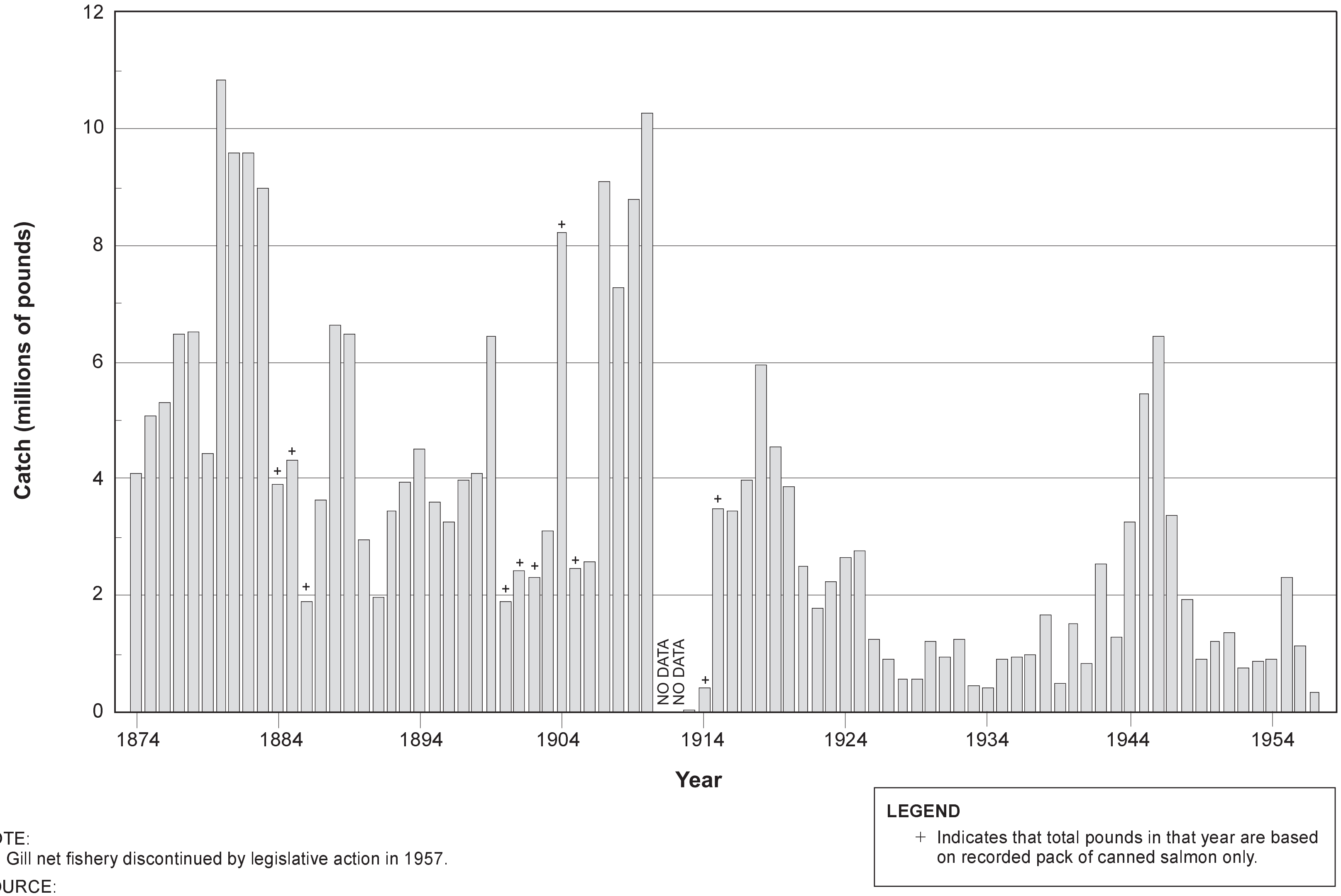
Variations in ocean and atmospheric conditions can affect the growth of anadromous fish species during their ocean life stage. A major ocean condition, referred to as El Nino, can significantly alter the availability of nutrients. El Nino is a disruption of the ocean-atmosphere system in the tropical Pacific. In normal, non-El Nino conditions, the trade winds blow toward the west across the tropical Pacific, and cause the accumulation of warm surface water in the western Pacific Ocean. This results in the upwelling of cold water from deeper levels in the eastern Pacific Ocean, off the coast of South America. The cold water is rich in nutrients, and supports high levels of primary productivity, diverse marine ecosystems, and major fisheries.

During El Nino conditions, the trade winds decrease in the central and western Pacific. This reduces the efficiency of upwelling of nutrient-rich cool water to the eutrophic zone. The result is a rise in surface water temperature and a drastic decline in primary productivity, which adversely affects higher trophic levels of the food chain, including commercial fisheries.

FISH SPECIES IN THE CENTRAL VALLEY

Chinook Salmon

Life History of Chinook Salmon. As an anadromous species, chinook salmon migrate to sea as juveniles and typically return to inland waterways as adults to spawn. Four separate races of Central Valley chinook salmon have been identified, the fall, late-fall, winter, and spring runs, based on the timing of upstream migration. While in freshwater, adult chinook salmon rarely feed as they change from an adult ocean-phase salmon to an adult spawning-phase salmon. All adult chinook salmon die after spawning.

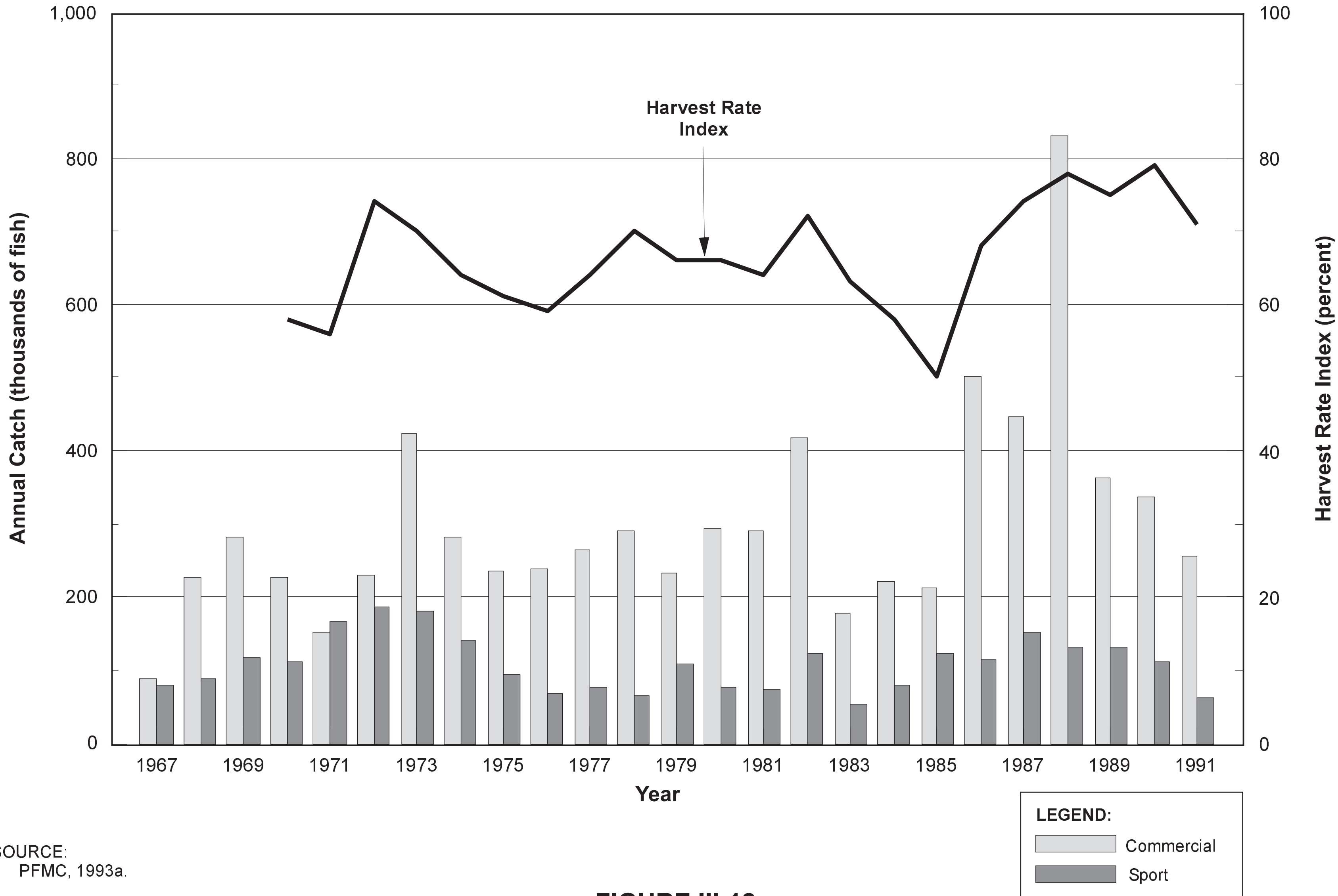


NOTE:
Gill net fishery discontinued by legislative action in 1957.

SOURCE:
Skinner, 1962.

FIGURE III-11

SACRAMENTO-SAN JOAQUIN RIVER COMMERCIAL GILL NET SALMON LANDINGS (1874-1957)



SOURCE:
PFMC, 1993a.

FIGURE III-12

ANNUAL HARVEST RATE INDEX AND LANDINGS FOR CALIFORNIA COMMERCIAL AND SPORT OCEAN CHINOOK SALMON FISHERIES (1967-1991)

In general, Central Valley chinook salmon appear to exhibit fall-run or spring-run behavior. A fall-run life history pattern is characterized by juveniles that migrate seaward during their first year of life after spending two to five months in freshwater. Spring-run behavior is that of chinook salmon that remain in freshwater for at least one year before emigrating to the sea.

Chinook salmon generally spend two to four years maturing in the ocean before returning to their natal streams to spawn. Some chinook salmon spend up to 6 or 7 years in the ocean. Most chinook salmon in the Sacramento and San Joaquin river systems mature at two or three years of age, although few of the two-year-old fish are able to spawn successfully. A smaller proportion of fish mature at four or more years of age.

Chinook salmon require cold, well-oxygenated freshwater streams with suitable gravel for reproduction. Female chinook salmon deposit their eggs in redds, which they excavate in the gravel bottom in areas of relatively swift water. The eggs are fertilized by one or more males.

Eggs generally hatch in approximately six to nine weeks, depending on water temperature, with newly emerged fry remaining in the gravel for another two to four weeks until the yolk is absorbed. Maximum survival of incubating eggs and larvae occurs at water temperatures between 41 and 56 degrees Fahrenheit.

After emerging, chinook salmon fry begin to feed and grow in the stream environment, seeking shallow, nearshore habitat with low water velocities, and move to progressively deeper, faster water as they grow. In streams, chinook salmon fry feed mainly on drifting terrestrial and aquatic insects, but zooplankton become more important in the lower river reaches and estuaries. Throughout this early life stage, the fry require cool, well-oxygenated water.

The upper Sacramento River and its tributaries supports all freshwater life stages of chinook salmon during all months of the year, although some runs have limited stream usage. Different life stages of all four races of chinook salmon (i.e. fall-, late fall-, winter-, and spring-run) may be present at all times because of overlapping run timing, spawning periods, and early life stages unique to each run.

The San Joaquin River and its main tributaries, the Merced, Tuolumne, and Stanislaus rivers, support fall-run chinook salmon. Table III-1 summarizes the timing of chinook salmon runs and steelhead trout by life stage in the Sacramento and San Joaquin river basins, and the general timing in the Delta.

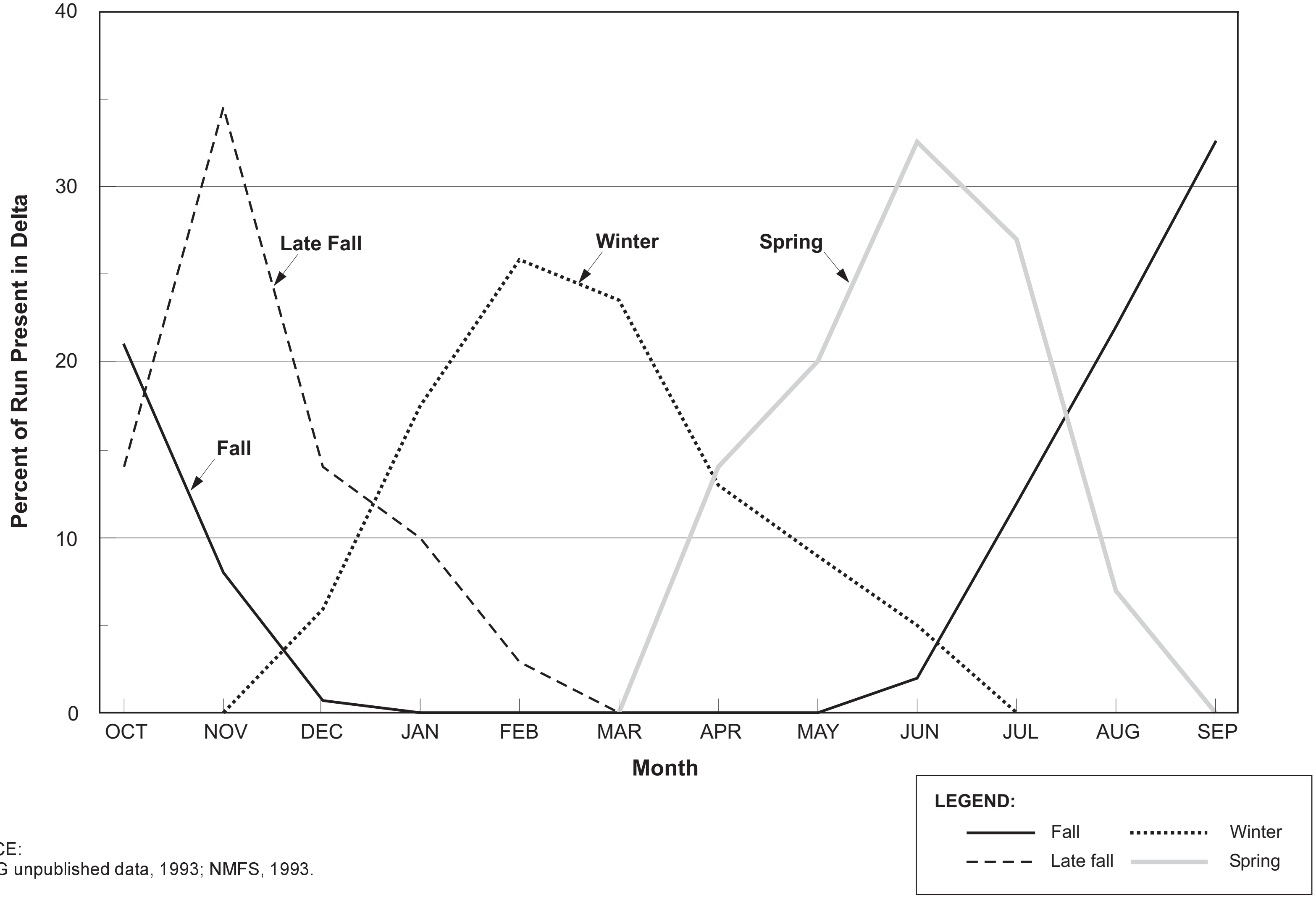
Stock Abundance and Distribution

Sacramento River. Figure III-13 illustrates the monthly proportion of each run of chinook salmon present in Delta during their migration into the Sacramento and San Joaquin river systems. The values represents month-to-month data not continuous data. The timing of spawning, incubation, and rearing of fry and juveniles varies by run, as shown in Figure III-14. The values in Figure III-14 are from several sources. The values in Figure III-14 are represented as specific points in time when life stages occur. In the Delta, the actual presence of fish blends over a longer period of time and is not as defined..

TABLE III-1

OCCURRENCE OF CHINOOK SALMON AND STEELHEAD TROUT BY LIFE STAGE IN THE CENTRAL VALLEY

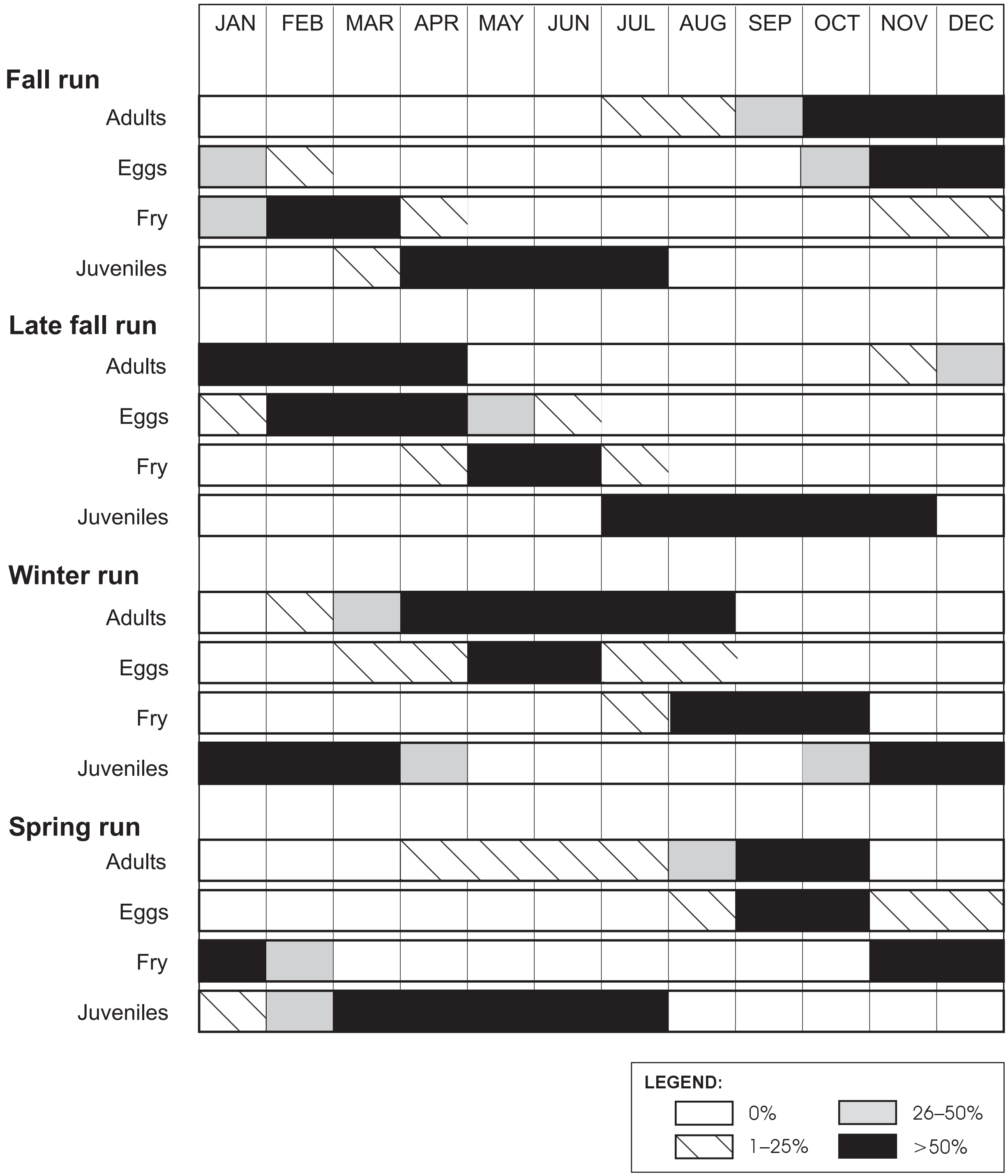
Life Stage	Sacramento River Basin	San Joaquin River Basin	Sacramento-San Joaquin Delta
Fall-run Chinook Salmon			
Adult migration	July-December	July-December	June-December
Incubation	October-February	October-February	not present
Fry / juvenile rearing	November-April	November-April	March-May
Juvenile emigration	March-June	March-June	March-July
Late Fall-run Chinook Salmon			
Adult migration	November-April	November-March	October-February
Incubation	January-June	December-May	not present
Fry / juvenile rearing	April-July	January-November	May-July
Juvenile emigration	April-December	October-December	April-December
Winter-run Chinook Salmon			
Adult migration	February-August	not present	November-June
Incubation	March-August	not present	not present
Fry / juvenile rearing	July-October	not present	October-April
Juvenile emigration	October-March	not present	January-June
Spring-run Chinook Salmon			
Adult migration	April-October	not present	March-August
Incubation	August-December	not present	not present
Fry / juvenile rearing	November-February	not present	November-May
Juvenile emigration	October-June	not present	October-June
Steelhead Trout			
Adult migration	August-March	August-March	August-March
Incubation	December-April	December-April	not present
Fry / juvenile rearing	January-December	January-December	not present
Juvenile emigration	December-May	December-May	December-May



SOURCE:
DFG unpublished data, 1993; NMFS, 1993.

FIGURE III-13

MONTHLY ABUNDANCE OF ADULT CHINOOK SALMON, BY EACH SPAWNING RUN IN THE SACRAMENTO-SAN JOAQUIN DELTA



NOTES:
Adults are in cumulative percent.
Other life stages are the percent of year's brood.

FIGURE III-14

OCCURRENCE OF CHINOOK SALMON BY LIFE STAGE IN THE SACRAMENTO RIVER BASIN

Annual estimates of spawning escapement (i.e., the total number of adult chinook salmon [age two and older] that "escape" the ocean fishery and return to spawn) of fall-run chinook salmon in the mainstem Sacramento River steadily declined during the 1950s and 1960s and the decline has continued to the present. Counts of chinook salmon passing the RBDD on the Sacramento River since 1967 provide an indication of overall trends in late fall-, winter-, and spring-run chinook salmon abundance in the upper Sacramento River. The number of late fall-run chinook salmon in the mainstem Sacramento River passing the RBDD has declined from the late 1960s to present.

Winter-run chinook salmon spawning escapement suffered a precipitous decline from an average of approximately 70,000 to 80,000 adults in the late 1960s to estimated run sizes of approximately 500 or fewer in recent years. Estimated run sizes in 1992 and 1993 were 1,180 and 341, respectively. The low return in 1989 prompted listing of the winter-run chinook salmon as an endangered species by the State of California and as a threatened species by the Federal Government. Another record low spawning escapement in 1991 prompted review and subsequent reclassification of the winter-run chinook salmon to endangered status under the federal Endangered Species Act (ESA).

San Joaquin River. Before extensive water development began on the San Joaquin River and its tributaries, spring-run chinook salmon were the most abundant race. The abundance of spring-run chinook salmon on the Stanislaus, Tuolumne, and Merced rivers was considerably reduced by 1930 as a result of dam construction on these rivers. Large spring runs migrating past the Merced River confluence were eliminated after 1947 following construction of Friant Dam, which blocked access to historical holding and spawning habitat and reduced flows in the San Joaquin River below the dam.

The fall-run chinook salmon population has declined since the 1940s but persists as a small but fluctuating population below major dams on the Merced, Tuolumne, and Stanislaus rivers. The fall-run had been virtually extirpated from the maintstem San Joaquin River upstream from the location of Friant Dam by local water development activities long before construction of that dam. Low returns of fall-run chinook salmon to these tributaries are attributed to low San Joaquin River flows, elevated water temperature, poor water quality, and diversions.

Spawning escapement levels of fall-run chinook salmon on the Merced, Tuolumne, and Stanislaus rivers show considerable annual variability. Peak abundance generally follows high spring runoff years, and spawning escapement is generally small following below normal or dry runoff years. The Merced River fall run has been partially sustained by production of yearling fall-run chinook salmon at the Merced River Fish Hatchery since 1970. The hatchery contributes less than 5 percent to San Joaquin River chinook salmon stock.

Hatcheries. Five hatcheries produce chinook salmon in the Central Valley. The three largest fish hatcheries (Coleman National, Feather River, and Nimbus) are located in the Sacramento River Basin; smaller hatcheries are found on the Mokelumne and Merced rivers in the San Joaquin River Basin. Most of these hatcheries were constructed between 1940 and 1970 as mitigation for specific dams or water projects. Only Nimbus and Coleman fish hatcheries had significant production prior to 1967. Total Central Valley hatchery production of chinook salmon nearly doubled from approximately 200,000 pounds to approximately 400,000 pounds during the period between 1967 and 1984.

Traditionally, Central Valley hatcheries have released fish directly into the river. To reduce downstream mortality, some of the hatcheries have trucked fish to locations nearer the ocean. Increases in survival due to this practice have depended on the timing of release, river temperature, ocean conditions, and fish size. Fish released downstream have a higher tendency to stray to other than their natal streams when they return as adults than fish released in the immediate vicinity of the hatcheries.

Factors Affecting Abundance

Upstream Migration. Higher flows and lower water temperatures in the fall stimulate upstream migration of fall-run chinook salmon. Conversely, low flows and higher water temperatures may inhibit or delay migration to spawning areas.

During upstream migration, adult chinook salmon primarily use their sense of smell to find their natal stream. The operation of water supply projects that affect flow conditions in the Delta can adversely affect upstream migration. For example, chinook salmon destined for the Sacramento River that are drawn into the central Delta may be delayed by the longer migration distance and greater number of channels that must be negotiated there. Similarly, large volumes of Sacramento River water and reverse flows in the lower San Joaquin River can inhibit or delay migration of San Joaquin River spawners.

For many years, attraction flows from the Merced River have proved inadequate during October, resulting in straying of adult chinook salmon into agricultural drainage ditches, primarily Mud and Salt sloughs. Barriers (electrical and physical) were installed across the San Joaquin River upstream of the Merced River confluence in 1992 to prevent chinook salmon migration into these sloughs and to help guide them into the Merced.

Streamflow. Adequate streamflow conditions are necessary to provide suitable rearing habitat and maintain instream water temperature. In the Merced and Tuolumne rivers, streamflow reductions after April and May result in poor survival conditions for chinook salmon juveniles that remain in these tributaries beyond these months. High mortality may occur from reduced rearing habitat, adverse water temperatures, and increased predation.

Juvenile chinook salmon and steelhead trout emigrating down the San Joaquin River and through the southern Delta frequently encounter low flows, adverse high temperatures, and high diversion rates. Recent evaluations have focused on the effectiveness of releasing short-duration, high-amplitude flows (i.e., pulsed flows) from tributary streams in conjunction with reduced Delta exports.

Water Quality. Water temperature affects the timing of chinook salmon adult migration and spawning life stages, although the migratory response to water temperature may differ among chinook salmon races. Upstream migrations of fall-run chinook salmon generally coincide with decreasing water temperatures in the fall. Water temperatures during upstream migration usually range between 51 degrees Fahrenheit and 67 degrees Fahrenheit (Bell, 1973). Hallock et al. (1970) found that chinook salmon initiated migration into the lower San Joaquin River as water temperatures declined from 72 degrees Fahrenheit to 66 degrees Fahrenheit.

Low dissolved oxygen levels (less than 5 parts per million) and adverse high water temperatures (greater than 66 degrees Fahrenheit) in the San Joaquin River near Stockton delayed or blocked the migration of adult chinook salmon during the 1960s (Hallock et al., 1970). Since 1964, fall migration problems have been reduced by improved wastewater treatment and the annual installation of a physical barrier at the head of Old River. In dry years, the barrier directs most of the San Joaquin River flow down the main channel of the San Joaquin River past Stockton. Despite these efforts, low dissolved oxygen levels recurred during the 1987-1992 drought period.

Diversion Dams. On the Sacramento River, the ACID and Red Bluff diversion dams have caused fish passage problems since their construction. The operation of these dams results in delay and blockage of winter-, spring-, and fall-run chinook salmon to upstream spawning areas. Dam operations also cause stranding of juveniles and adults and dessication of redds. A fish ladder at the ACID diversion dam, completed in 1927 and still in place today, does not effectively attract and convey upstream migrating chinook salmon (Reclamation, 1983a). An additional fishway was recently constructed at the ACID diversion dam, but its passage effectiveness has not yet been evaluated.

Delta Diversions. Annual losses of chinook salmon at the CVP and SWP Delta export facilities have ranged from 400,000 to 800,000 in recent years, assuming 75 percent mortality in Clifton Court Forebay. Salvage records from the SWP pumping plant indicate chinook salmon fry and emigrating juveniles (smolts) are entrained year-round, but levels generally peak in late winter and spring when fall-run chinook salmon pass through the Delta.

Unknown numbers of chinook salmon are also entrained in other Delta diversions, including more than 1,800 unscreened agricultural diversions, the Contra Costa Canal, the City of Vallejo diversion, and several industrial diversions in the western Delta.

Commercial and Sport Fishing. Commercial and sport fishing also affects abundance. Total commercial and sport landings ranged from 358,000 pounds in 1983 to 1,489,000 pounds in 1988 and averaged 707,000 pounds annually. Since 1988, total landings have decreased to levels near the historical minimum for the entire period of record.

Hatchery-Produced Fish. Concern is growing that the release of large numbers of hatchery fish can threaten wild fish populations. Potential impacts include direct competition between wild and hatchery fish for food and other resources, genetic dilution of wild fish stocks by hatchery fish spawning with wild fish, and increased fishing pressure on wild stocks due to hatchery production. Because of increased survival from eggs to smolts under hatchery conditions, fewer adults are needed to maintain a hatchery run. Consequently, a harvest rate based on hatchery fish will tend to overharvest wild fish in a mixed fishery of wild and hatchery stocks (Hilborn, 1992). Current harvest rates of Central Valley chinook salmon are high enough to adversely affect the natural production in some rivers.

Accurate estimates of the Central Valley hatchery contribution to ocean chinook salmon landing have not been developed because of the lack of a consistent hatchery marking program in California. The U.S. Fish and Wildlife Service (Service) (1988) estimated that 21 percent of the smolts passing Chipps Island in 1988 were of hatchery origin. Cramer et al. (1990) estimated that hatchery fish composed approximately one-third of the spawning escapement to the American and Feather rivers. This fraction is significantly lower than previous estimates developed by Dettman and Kelley (1987).

Steelhead Trout

Historically, steelhead trout (*Oncorhynchus mykiss*) spawned and reared in the most upstream portions of the upper Sacramento River and most of its perennial tributaries. Throughout the Central Valley, water and land development has led to a 95 percent reduction (from 6,000 to 300 river miles) in spawning and rearing habitat (Reynolds et al., 1993). Because of modified and unnatural flow and temperature regimes throughout the basin, steelhead trout can be found as adults in freshwater in every month of the year.

As an anadromous species, steelhead trout migrate to sea as juveniles and typically return to inland waterways as two- to four-year-old adults to spawn. Upstream migration occurs in August through March. Adult steelhead trout rarely feed while they are in freshwater. Unlike chinook and other Pacific salmon, all steelhead trout do not die after spawning, and a small portion survive to become repeat spawners.

Natural spawning of steelhead trout in the Sacramento River system has been greatly reduced by dams and other barriers to their historical spawning grounds. As a result, steelhead trout are highly dependent on hatchery production to maintain their populations. Spawning in the Sacramento River Basin takes place primarily in December through April, with most spawning from January through March.

The timing of upstream steelhead trout migration coincides with the timing of upstream migration of fall-, late fall-, and winter-run chinook salmon. Consequently, flow, water temperature, and passage-related factors affecting upstream migration of adult steelhead trout in the Sacramento River system are similar to those affecting chinook salmon.

White Sturgeon

The white sturgeon is the largest freshwater or anadromous fish species in North America. With a life span of up to 100 years, sturgeon can grow to over 1,300 pounds. Historically, white sturgeon populations ranged from Alaska to central California (Scott and Crossman, 1973); however, the major spawning populations are now limited to the Fraser River (British Columbia, Canada), the Columbia River (Washington), and the Sacramento-San Joaquin River system. Compared to chinook salmon and steelhead trout, little is known of white sturgeon life history.

In the Sacramento-San Joaquin system, some of the mature adult sturgeon move upstream to freshwater environments to spawn during late winter and early spring. After hatching, juvenile sturgeon rear in fresh or slightly brackish waters, dispersing downstream with the river currents.

Subadults commonly rear in river sloughs, estuaries, or bays during summer and may move into deeper freshwater areas upstream, into the marine environment, or remain in the estuary in fall and winter.

Only a fraction of the adult sturgeon population migrates upstream to spawn each year. The timing and extent of upstream migration are probably triggered by both biotic (i.e., sexual maturation) and abiotic (i.e., temperature, flow, and photoperiod) factors.

Green Sturgeon

The biology of the green sturgeon (*Acipenser medirostris*) is even less understood than that of the while sturgeon. Little is known about abundance and distribution, life history, or factors affecting abundance. Green sturgeon are a minor component of the sturgeon populations in the Central Valley; ratios of adult green sturgeon to white sturgeon during tagging studies in the Delta have ranged from 1:39 to 1:164 (Mills and Fisher, 1993). Green sturgeon spend less time in estuaries and freshwater than do white sturgeon, but make extensive ocean migrations. Juvenile fish have been collected in the Sacramento River near Hamilton City, and in the Delta and San Francisco Bay. Adults and juveniles have been observed near RBDD in late winter and early spring. Juveniles inhabit the Bay-Delta estuary until they are approximately four to six years old, when they migrate to the ocean. (Kohlhorst et al., 1991.)

Striped Bass

Striped bass (*Morone saxatilis*) are native to the east coast of the United States. Several hundred juvenile striped bass were taken from rivers in New Jersey and introduced to California waters between 1879 and 1882, and the population quickly multiplied to several million adult bass.

Striped bass inhabit fresh and ocean waters. They require tidal or riverine habitat for spawning, with turbulence and currents sufficient to keep the eggs suspended off the bottom. Estuarine habitat with high invertebrate population densities is needed to support larval and early juvenile life stages of bass. Adult bass thrive in water bodies supporting large populations of forage fishes.

When striped bass inhabit rivers, juvenile chinook salmon and carp are key prey species. In the Delta, adult bass prey primarily on threadfin shad, American shad, and young striped bass. Anchovies, chinook salmon, delta smelt, and shrimp are seasonal prey items in the lower Delta and Suisun Bay. In San Pablo and San Francisco bays, anchovies, bay shrimp, and shiner perch are the primary prey items.

Historical population data show a decline in the population abundance of striped bass. The decline is a result of increased mortality and reduced reproduction. Factors that may contribute to increased mortality include: fishing, entrainment in diversions, exposure to toxic materials, habitat loss, reduced Delta inflow and outflow, altered Delta flow patterns, dredging and spoil disposal, diseases and parasites, and introduction of exotic species. Reduced reproduction results from the production of fewer fertile eggs each year, which can be attributed to a reduction in the abundance, size, and health of female striped bass.

American Shad

American shad (*Alosa sapidissima*) are also native to the east coast of the United States and were introduced to California in 1871. Currently, American shad are found on the Pacific Coast from Todos Santos Bay in Baja California northward to Alaska. In California, anadromous shad populations are found seasonally in the Sacramento, Feather, Yuba, American, Mokelumne, Stanislaus, and San Joaquin rivers, the Delta, and the Klamath, Russian, and Eel rivers.

In the Sacramento River drainage, shad migrate up the Sacramento River as far upstream as the RBDD, the Feather River as far upstream as Oroville, the Yuba River as far upstream as Daguerre Point Dam, and the American River as far upstream as Nimbus Dam. Smaller shad runs occur in the Mokelumne River, Stanislaus River, sloughs of the south Delta, and the San Joaquin River (Stevens, 1972; Moyle, 1976).

With only a few exceptions, American shad are anadromous, spending most of their lives in the ocean and returning as adults to spawn in freshwater rivers. Spawning occurs in riverine habitats, and moderate currents are needed to keep the eggs suspended above the bottom. The young may migrate downstream to the ocean soon thereafter or may rear for several months in the major rivers and Delta before moving farther downstream.

Since the early 1900s, the shad population is believed to have declined gradually. Evidence suggests that this decline is attributable primarily to factors associated with water development. The rapid increase in American shad abundance and distribution shortly after their introduction indicates that habitat and environmental conditions historically were ideal for shad. Although the rivers and Delta were largely modified with the construction of levees and many of the wetlands had levees constructed and filled soon after the introduction of shad, the Delta environment and river flow patterns were relatively unmodified until after 1950.

Delta Smelt

Delta smelt (*Hypomesus transpacificus*) are small (usually less than 3.5 inches long), plankton-feeding fish that live for only one year and are found only in the Sacramento-San Joaquin estuary. Except for spawning adults and recently hatched larvae and juveniles, delta smelt primarily inhabit the region of the estuary with salinities between approximately 0.45 and 4.4 parts per thousand. The location of this region varies from year to year depending on the volume of freshwater outflows, but it is generally in the western Delta and Suisun Bay. The critical habitat for delta smelt as proposed by the Service includes all of Suisun Bay and the Delta. Apparent declines in delta smelt abundance led to listing the species as threatened in 1993 under the Federal Endangered Species Act (ESA) (*Federal Register, 58*:12854-12862, March 5, 1993).

Delta smelt have no direct commercial value but were once one of the most abundant fish species in the Delta. Delta smelt abundance appears to be affected by Delta flow patterns, habitat loss and modification, entrainment in diversions, and possible competition from introduced species.

Longfin Smelt

The largest population of longfin smelt (*Spirinchus thaleichthys*) in estuaries on the Pacific Coast inhabits the Sacramento-San Joaquin River/San Francisco Bay-Delta estuary. Apparent declines in longfin smelt abundance in the estuary led to a petition to list the longfin smelt under the federal ESA; however, the Service determined that listing is not warranted at this time (*Federal Register, 59,*:4, January 6, 1994).

Spawning adults are found seasonally as far upstream in the Delta as Rio Vista, Medford Island, and the CVP and SWP pumps. Except when spawning, longfin smelt are most abundant in Suisun and San Pablo bays, where salinity generally ranges between 2 and 20 parts per thousand (Natural Heritage Institute, 1992). Delta outflow appears to be the primary factor influencing the abundance of longfin smelt. In high outflow years, adult longfin smelt are most abundant in San Francisco, San Pablo, and Suisun bays, but in low outflow years they are concentrated in the Delta and Suisun Bay where they migrate to reach conditions suitable for spawning.

Sacramento Splittail

Sacramento splittail (*Pogonichthys macrolepidotus*) are large cyprinids (minnow family) endemic to the lakes and rivers of the Central Valley of California (Moyle et al., 1989). Historically, they were collected from the Sacramento River as far north as Redding, from the San Joaquin River as far south as Fresno, and from the Delta. Commercial harvests occurred from 1916 to 1947 (California Bureau of Marine Fisheries, 1949).

Habitat loss and modification, annual flow variation, and entrainment in diversions from the Delta are major factors potentially affecting abundance of splittail populations in the Delta.

Reservoir Fisheries Communities

Reservoir construction in California has greatly increased game fish production; however, large self-sustaining game fish populations are uncommon. Most reservoirs are relatively artificial ecosystems that rarely meet all the needs of the species present.

The exact species composition in each reservoir is related to the history of introductions, but some species are common: bluegill, largemouth bass, carp, golden shiner, black crappie, brown bullhead, mosquitofish, and rainbow trout (hatchery strains). Native species that are permanently established in a number of Central Valley reservoirs include prickly sculpin, Sacramento sucker, hitch, and tui chub. Water-level fluctuation is the most frequently cited factor adversely affecting reservoir fishery production. Habitat quantity and quality are primarily determined by water-level fluctuation in reservoirs.

FISH SPECIES IN THE TRINITY RIVER BASIN

The Trinity River supports a variety of fishery resources. Anadromous salmonids include the spring-run and fall-run chinook salmon, coho salmon, and steelhead trout. In addition to natural production, the Trinity River Hatchery, located at the base of Lewiston Dam and built to mitigate for lost habitat, propagates and supplements basin production of chinook salmon, coho salmon, and steelhead trout. Other native and nonnative species present in the Trinity River Basin include the green sturgeon, Pacific lamprey, Klamath smallscale sucker, speckled dace, American shad, and brown trout. Factors affecting the abundance of anadromous fish produced in the Trinity River system are similar to those factors affecting anadromous fish produced in Central Valley streams, as described previously.

The times at which the majority of chinook salmon and steelhead trout smolts emigrate overlaps, although some differences are apparent. Summer- and winter-run steelhead trout smolts emigrate from the Trinity River from April to early June. Coho salmon smolts emigrate from later April to mid-June. Chinook salmon smolts are the latest to leave the Trinity system. This species generally emigrates from mid-May to early July. Adult spring-run chinook salmon generally enter the Trinity River beginning in early April; peak migration in the lower river occurs in mid-June, and peak abundance in the upper river occurs in July or August.

AGRICULTURAL AND ECONOMICS LAND USE

The Central Valley is an important agricultural region for both California and the United States. It contains almost 80 percent of the irrigated land in California. In 1993, the 19 Central Valley counties contributed more than 60 percent, by value, of California's agricultural production and included 6 of the top 10 agricultural counties in California (Table III-2). Agriculture in the Central Valley is an important employer and affects the regional economy through farm expenditures, as well as production of many crops that require processing or transportation after harvest.

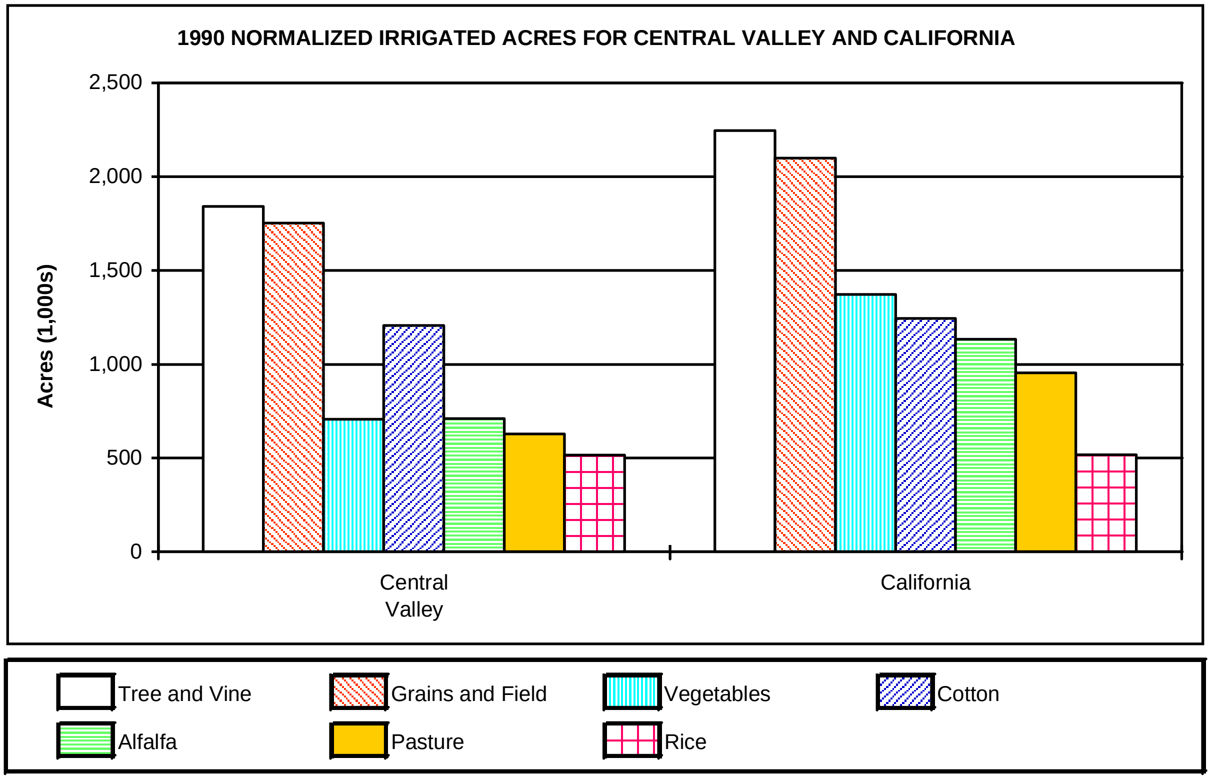
Central Valley agriculture receives irrigation water from the CVP, the SWP, local water districts, individual water rights holders, and groundwater. Most of this water is delivered to farmers through irrigation districts and other water agencies. Figure III-15 shows irrigation water deliveries by source for the years 1985-1992. Deliveries average about 22.5 million acre-feet per year, with the SWP providing about 10 percent, local surface water rights about 30 percent, and groundwater about 35 percent. The CVP normally supplies about 25 percent of Central Valley water to approximately 200 water districts, individuals, and companies through water service contracts and water rights and exchange contracts.

TABLE III-2

RANKING OF CENTRAL VALLEY COUNTIES BY TOTAL VALUE OF PRODUCTION IN 1993

1993 CA Rank	County	1993 Production ($1,000)	Percent of Total CA Value	Cumulative Percent	Leading Crops
1	Fresno	3,014,412	13.1	13.1	Grapes, cotton, tomatoes, milk, cattle & calves
2	Tulare	2,359,551	10.2	23.3	Milk, grapes, oranges, cattle & calves, cotton & seed
3	Kern	1,884,749	8.2	31.5	Grapes, cotton & seed, almonds, citrus, carrots
5	Merced	1,201,025	5.2	36.7	Milk, almonds, chickens, cotton, alfalfa
6	Stanislaus	1,147,126	5.0	41.7	Milk, almonds, chickens, walnuts, cattle & calves
7	San Joaquin	1,053,364	4.6	46.3	Milk, grapes, almonds, tomatoes, walnuts
12	Kings	836,860	3.6	49.9	Cotton lint, milk, cattle & calves, cottonseed, turkeys
13	Madera	615,047	2.7	52.6	Grapes, almonds, cotton lint, milk, pistachios
18	Sutter	292,108	1.3	53.9	Rice & seed, walnuts, peaches, prunes, tomatoes & seed
19	Butte	278,030	1.2	55.1	Almonds rice, walnuts, prunes, kiwifruit
20	Colusa	273,518	1.2	56.3	Rice, almonds, processing tomatoes, wheat, rice seed
21	Glenn	249,134	1.1	57.4	Rice, almonds, dairy products, prunes, cattle & calves
23	Yolo	235,805	1.0	58.4	Tomatoes, alfalfa hay, rice, safflower, wheat
24	Sacramento	228,651	1.0	59.4	Milk, pears, cattle & calves, wine grapes, ornamental nursery stock
28	Solano	177,705	0.8	60.2	Processing tomatoes, sugar beets, cattle & calves, nursery stock, alfalfa hay
32	Yuba	117,452	0.5	60.7	Rice, peaches, prunes, walnuts, cattle & calves
34	Tehama	100,365	0.4	61.1	Walnuts, prunes, almonds, cattle & calves, pasture & range
Total Central Valley		**$14,064,902**			
Total California		**$23,094,133**			

SOURCE:
California Department of Food and Agriculture (DFA), 1994.



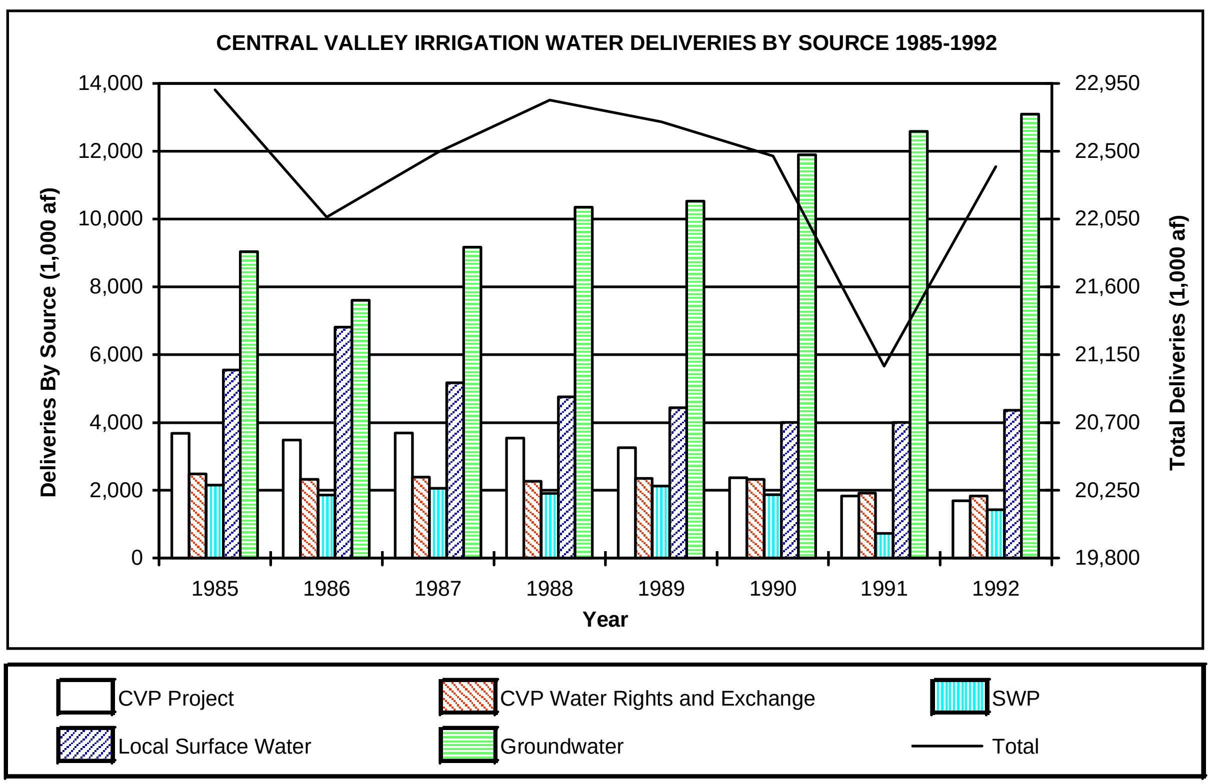


FIGURE III-15
1990 NORMALIZED IRRIGATED ACRES AND CENTRAL VALLEY IRRIGATION WATER DELIVERIES BY SOURCE FROM 1985-1992

Table III-3 shows 1989 project water supply and irrigated acreage by type of service and CVP division. Full irrigation service land is irrigable land that now receives, or is to receive, its sole and generally adequate water supply from CVP facilities. Supplemental irrigation service lands generally receive water from the CVP and other sources. Temporary irrigation service lands represent the acreage for which a water supply is available under temporary arrangements. The acreage may vary from year to year.

TABLE III-3

1989 CVP ACREAGE AND IRRIGATION WATER SUPPLY

CVP Division and Type of Service	Irrigable Acres for Service	Irrigated Acres	Percent Irrigated	Net CVP Supply Delivered to Farm (acre-feet)	CVP Delivery Per Acre Irrigated (acre-feet)
Full Service					
Delta Division	45,648	41,299	90	131,907	3.19
Sacramento River Division	32,253	23,834	74	72,052	3.02
Trinity Division	4,729	3,009	64	5,772	1.92
Total Full Service	82,630	68,142	82	209,731	3.08
Supplemental Service					
American River Division	51,826	7,580	15	19,642	2.59
Delta Division	167,518	138,533	83	280,657	2.02
Friant Division	999,808	813,885	81	856,481	1.05
Sacramento River Division	98,411	74,679	76	208,801	2.80
San Felipe Division	37,430	23,730	63	19,827	0.84
Shasta and Trinity Divisions	471,730	358,524	76	612,631	1.71
West San Joaquin Division	618,972	550,227	89	1,261,062	2.29
Total Supplemental Service	2,445,695	1,967,158	80	3,833,093	1.95
Temporary Service					
Delta Division	140,174	130,793	93	577,668	4.42
Friant Division	33,227	29,542	89	13,690	0.46
Sacramento River Division	4,262	1,506	35	2,862	1.90
Shasta Division	10,711	10,283	96	18,309	1.78
Total Temporary Service	188,374	172,124	91	38,537	3.56
Total/Average	**2,716,699**	**2,207,751**	**81**	**4,081,361**	**1.85**

SOURCE:
Reclamation, 1989. Does not include water rights contracts and some exchange contract water. Does not include COE projects.

Through contracts with 29 water agencies, the SWP provides water within the Central Valley to Butte, Solano, Kings, and Kern counties and outside the Central Valley to several Southern California counties, to Alameda and Santa Clara counties in the South Bay Area, and to Napa and Solano counties in the North Bay Area. Average SWP water supplies to the Central Valley from 1985 until 1992 were about 1.7 million acre-feet per year. In addition, the SWP provides water rights deliveries to water rights holders along the Feather River. Local surface water supplies (those not delivered by either project) averaged about 6.3 million acre-feet per year between 1985 and 1992, about 30 percent of all water supplies in the Central Valley.

Groundwater provides a significant supply in normal years and is often used to reduce or eliminate shortages of surface water supplies during drought. Declining groundwater tables, land subsidence, and loss of aquifer storage continue to be costly problems, particularly in the western and southern parts of the San Joaquin River Region where less surface water is available. Declining groundwater tables increase pumping costs. The costs of subsidence include damage to structures, failure of well casings, and frequent surveying. Water from the CVP and SWP had replaced some of the groundwater pumping, and withdrawals were about equal to estimated recharge (Bertoldi et al., 1991). However, the recent drought reduced surface water supplies and renewed the past trend of groundwater depletion in many parts of the valley.

REGIONAL DESCRIPTIONS

Sacramento River Region climate and soils cause a wide variation in crop mix. The uplands are suitable for a variety of crops, but the fine-textured soils adjacent to the Sacramento River are most suited to rice production. Grains and field crops; rice; and hay, pasture, and alfalfa are the major crops in the Sacramento River Region (72 percent of irrigated acres).

Irrigated acreage within the San Joaquin River Region is also very diversified. Almost half of the 1992 acreage was planted with grains, hay, and pasture. Orchards were planted on about 30 percent of the irrigated acres, and cotton and vegetables were each planted on about 10 percent. The region is the leading California area for production of grapes, almonds, walnuts, tomatoes, melons, and many other crops. Vegetables and cotton are grown on the west side, and grapes, fruits, nuts, and cotton are grown on the east side. Most of the west side depends on CVP water delivery.

The warm climate of the Tulare Lake Region provides ideal conditions for many crops. Cotton leads irrigated acres (32 percent), followed by fruits and nuts (28 percent), grains and field crops (17 percent), hay and pasture (12 percent), and vegetables (10 percent). The region has benefitted from supplemental water supply provided by the SWP for areas within Kern and Kings counties and from deliveries by the Friant-Kern Canal. Tulare County is the leading milk-producing county in the United States.

WATER PRICING

Water costs vary substantially throughout the valley depending on location and source of water. Average surface water prices are lowest in the Sacramento River Region at $11.35 per acre-foot and highest in the Tulare Lake Region at $42.50, reflecting higher SWP costs. Groundwater cost largely depends on the depth to water. Estimated groundwater pumping costs range from about $20 per acre-foot in parts of the San Joaquin River Region to more than $75 in parts of the Tulare Lake Region.

CROPPING PATTERNS AND IRRIGATED ACRES

Normalized 1990 irrigated acres for the Central Valley in DWR's three Central Valley hydrologic basins are shown in Figure III-15. Virtually all of California's rice and cotton acreage, almost half of its vegetable acreage, and 80 percent of its orchard land are in the Central Valley. The Central Valley also contains almost 60 percent of California's irrigated hay acreage.

From 1984 to 1993 vegetables and truck crops as a group increased by about 160,000 acres in the Central Valley. Orchard acreage increased by over 200,000. Acreage of grains, pasture, sugar beets, and cotton declined during this period. Acreage of program crops including cotton, rice, and grains have been strongly influenced by farm commodity programs.

AGRICULTURAL PRODUCTION COSTS AND REVENUES

Central Valley farms accounted for more than $8.5 billion in agricultural sales in 1987 and $10 billion in 1992, according to Census Bureau estimates. About two-thirds of these sales were receipts for crops. The remainder of the sales were mostly livestock products. Revenues in 1992 were probably less than normal because of the influence of drought. Farmers received an additional $329 million in government payments and $171 million from direct sales, custom work, and other farm services for a total income of $10.5 billion in 1992. Production expenses were about $8.2 billion, leaving a net cash return of $2.4 billion. Net cash return includes the payment for family labor, management, returns to land and water, risk, and some other uncounted costs of farming.

The market value of Sacramento River Region crops sold reached $1.7 billion in 1992; rice, tomatoes, almonds, and walnuts were the most valuable crops. In the San Joaquin River Region, fruits and nuts accounted for approximately half of the total value of crop production ($4.7 billion). Vegetables and cotton accounted for approximately 20 and 10 percent of the San Joaquin River Region's value of crop production. In the Tulare Lake Region, grapes were the highest value crop, followed by cotton and oranges. All fruits and nuts accounted for almost 60 percent of the total value of crop production (about $3.8 billion) in the Tulare Lake Region

Crop revenues, estimated by County Agricultural Commissioners as crop yield (in units of production per acre) multiplied by acres and by price, are shown in Table III-4.

AGRICULTURAL WATER CONSERVATION

On-farm application efficiency can be defined as the share of applied irrigation water that is consumed by the crop. On-farm application efficiency depends on many factors including crop type, soil, terrain, climate, irrigation system, and management of the system. Application efficiencies in the Central Valley range from below 50 to above 80 percent. Lowest efficiencies tend to occur in the Sacramento Valley where water is more abundant and less expensive. Rice cultivation here generates much more irrigation drainwater than other crops, but this drainwater returns to the hydrologic system. Higher efficiencies are found in much of the San Joaquin River and Tulare Lake regions. Some of the highest irrigation efficiencies in California are achieved on the west side of the San Joaquin Valley, due to scarce surface water, expensive groundwater, and costs of managing tailwater.

TABLE III-4

1985 THROUGH 1992 AVERAGE CROP ACREAGE, YIELDS, PRODUCTION, AND VALUE

Crop	Harvested Irrigated (1,000 Acres)	Average Yield (Tons/Acre) (1)	Product (1,000 Tons)	Average Price Per Unit	Average Revenue Per Acre	Value of Production ($ millions)
Wheat	371.8	3.03	1,127	107	325	121
Misc. Grain	151.9	2.30	350	106	244	37
Rice	415.9	3.85	1,600	151	581	242
Cotton (Bales)	1167.3	2.47	2,885	409	1,010	1,179
Sugar Beets	147.3	25.12	3,699	36	909	134
Corn	364.9	4.45	1,625	105	468	171
Misc. Hay	211.1	3.33	704	63	211	45
Dry Beans	167.9	1.11	186	555	616	103
Oil Seed	66.1	1.57	103	265	415	27
Alfalfa Seed	192.2	0.27	52	2,351	642	123
Alfalfa	579.7	7.60	4,480	88	671	389
Pasture (AUMs)	481.9	13.60	6,555	12	163	79
Process Tomatoes	232.1	31.41	7,291	51	1,609	374
Fresh Tomatoes	24.1	13.73	330	416	5,719	138
Melons	74.0	9.04	669	208	1,884	139
Onions	41.9	19.09	799	117	2,227	93
Potatoes	23.9	18.59	445	179	3,319	79
Misc. Vegetables	199.0	26.60	5,295	170	4,519	899
Almonds	459.0	0.68	310	2,357	1,592	731
Walnuts	160.0	1.37	219	1,022	1,401	224
Prunes	128.6	2.63	338	787	2,071	266
Peaches	134.0	12.69	1,701	368	4,676	627
Citrus	150.6	11.33	1,707	329	3,724	561
Olives	60.3	3.47	209	545	1,893	114
Raisin Grapes	347.9	7.97	2,773	345	2,753	958
Wine Grapes	189.8	8.50	1,614	193	1,644	312
Total	**6543.2**					**8,165**

NOTE:
(1) Tons per acre unless otherwise noted next to crop name. Cotton price includes value of cottonseed.

SOURCES:
CAC, 1985, 1992.

AGRICULTURAL WATER MEASUREMENT

Practically all agricultural districts in the Central Valley currently have some type of measurement capability at the district level, and most can measure water delivered to individual users. In some cases, control structures that are already in place could facilitate water measurement. These control structures are usually gates or weirs that, when lowered or opened, allow water to flow to the users. In some other cases, water is physically pumped out of a canal or ditch by the user.

LAND VALUES

Average values of irrigated land used for the same purpose are typically highest in the Central Coast Region, lower in the San Joaquin River Region, and lowest in the Sacramento River Region. Land values in the Sacramento River Region generally declined during the five-year period from 1985 to 1990, but prices generally increased in the San Joaquin River and Central Coast regions.

Irrigated land value for field crops, rice, cotton, and pasture ranged from $1,800 to $5,000 per acre in the Central Valley and Central Coast regions. Land values have held generally steady since 1990 with some notable movements in both directions. Throughout the region, reliable water supplies and suitability for permanent crops are two factors that enhance land value.

There is normally a large range in land values, reflecting local variations in climate, soils, and water supply and cost. Values tend to be lower in areas with high soil salinity, drainage problems, and unreliable water supply.

CENTRAL VALLEY AGRICULTURE IN NATIONAL AND INTERNATIONAL MARKETS

California leads all other states in value of agricultural production, and the Central Valley provides most of this production. The Central Valley accounts for almost 10 percent of the total U.S. market value of agricultural crops sold. More than half of this value comes from fruits and nuts. The Central Valley accounts for almost 40 percent of U.S. fruit and nut production.

California's 20 percent share of the U.S. cotton market value is produced on less than 10 percent of total U.S.-harvested cotton acres (including non-irrigated acres) because of the Central Valley's higher yields and the higher quality of its cotton. Central Valley hay and vegetables also account for disproportionately large value shares of the national market. In general, the Central Valley's climate and larger proportion of irrigated acreage allow yields and the share of vegetables, fruits, and nuts to exceed national averages.

In addition to its importance in national markets, Central Valley agriculture plays an important role in international markets. California produces about 10 percent of total U.S. agricultural exports. These exports represent almost 25 percent of the gross farm income of the state (Carter and Goldman, 1992). Leading California export commodities and the percent of each grown in the Central Valley include cotton (99 percent), almonds (100 percent), grapes (73 percent), oranges (77 percent), walnuts (96 percent), tomatoes (83 percent), and rice (100 percent).

FARM PROGRAMS

Commodity programs were designed to increase and stabilize incomes of growers of certain commodities. Rice, cotton, wheat, and corn are important program commodities in California. Almost 4 million acres of California cropland were eligible to participate in commodity programs in 1991 and 1992, and an average of 2.6 million acres were in compliance with the programs of the U.S. Department of Agriculture ([USDA], 1990-1992). The income provided by government payments is not an important share of all Central Valley agricultural income (roughly 3 percent), but farm programs have had important effects on commodity crop economics, especially rice and cotton. A large share of eligible rice and cotton acreage participates and, until 1996, a substantial share of net income was attributable to farm programs. As a condition for participating in the program, growers were required to set aside a percentage of eligible land each year, called the Acreage Reduction Percentage (ARP).

The Federal Agriculture Improvement and Reform Act of 1996 made several substantial changes to past farm programs. Participating commodity base acreage will receive fixed payments per acre regardless of what crop is grown on the base acreage. Any crop except for fruits or vegetables may be grown while payments are received, and acreage reduction requirements are no longer authorized. Non-recourse loan provisions are retained.

WATER TRANSFER

Water transfers are voluntary trades or sales of water between water users. Agricultural water users participate in water transfers as buyers and sellers. Water transfers between individual water users within a water district are common in dry conditions and are becoming more common even in average conditions. Water transfers between users within a district do not normally require approval from the SWRCB because such users are covered by the same water right permit.

Voluntary water transfers out of a district or region were not common in California until the 1987-1992 drought perioid. Early in the drought, agricultural water users transferred some water to municipal and other uses privately. The State Drought Water Bank was established in 1991 to acquire and transfer water to meet critical needs. DWR paid $125 per acre-foot and sold water for $175 an acre-foot. About 820,000 acre-feet were made available by fallowing land, by groundwater substitution, and from storage. Less was delivered to buyers due to losses, especially in the Delta. The Bank offered only $50 in 1992, and even though land fallowing to provide water was not allowed, 193,000 acre-feet were obtained.

Water transfers have raised a number of concerns involving third-party impacts. Land fallowing affects regional economies and local governments, and transfers may affect hydrology and cause unintentional harm to other water users. State and federal law provide some protections from these effects, but water transfers out-of-region in California are often controversial.

MUNICIPAL AND INDUSTRIAL LAND USE AND DEMOGRAPHICS

M&I land uses include residential, industrial, commercial, construction, institutional, and public administration purposes, as well as railroad yards, cemeteries, airports, golf courses, sanitary landfills, sewage treatment plants, water control structures, and other developments. Highways, railroads, and other transportation facilities are also included as M&I land use if they are located in an M&I region.

Until recently, most of the M&I land use in California was concentrated in or near the coastal areas. During the last decade, this trend has begun to shift, as the rate of new development in coastal areas has declined in response to the decreasing availability of developable land and the increasing prices of remaining available land. This trend is evident in the relationship between the San Francisco Bay Region and the areas of Sacramento and San Joaquin counties. During the 1980s, communities in the Sacramento, Tracy, and Stockton areas have grown, and now include residents who commute to Livermore, Walnut Creek, and other areas of the San Francisco Bay Region.

California had an estimated population of 29,760,000 in 1990. Approximately 36 percent, or 10,604,000, of these people are located within the four regions evaluated in detail for changes in land use in the PEIS. These four regions are discussed below. Trinity River Region would experience the same impacts in all alternatives as compared to the No-Action Alternative. These impacts are being evaluated in a separate environmental document, and therefore are not described in this PEIS. Land use and demographics also are not evaluated in detail in the PEIS and will be evaluated in future environmental documents concerning water transfers.

SACRAMENTO RIVER REGION

M&I land use in the Sacramento River Region increased after 1950, in part as a result of the post-World War II baby boom and strong economic conditions. Between 1950 and 1980, corridors of M&I development became established along Interstate 80 from Fairfield to Auburn and along Highway 50.

During the 1980s, the Auburn and Sacramento areas were among the fastest growing areas in California. Rapid growth in Sacramento County and surrounding areas has occurred as previously undeveloped or agricultural lands have been developed for the construction of single and multi-family housing. Irrigated agricultural acreage in the region peaked during the 1980s and has since declined with their conversion to M&I land uses.

The population in the Sacramento River Region increased by approximately 2.2 million between 1920 and 1990. This increase represents the largest percent change of the four regions and was similar to the rate of population growth for the state as a whole.

SAN JOAQUIN RIVER REGION

Between 1980 and 1990, M&I land acreage within the San Joaquin River Region increased from approximately 71,000 acres to 110,000 acres. This change in M&I land area represents the smallest change of the four regions during this period. Major M&I centers include the cities of Fresno, Stockton, Tracy, Modesto, and Merced, which are industrial hubs for food and grain processing. The cities of Tracy and Stockton have grown recently, fed by the San Francisco Bay Region growth trends. The City of Fresno is the major M&I center for the San Joaquin Valley.

The population of the San Joaquin River Region increased by approximately 1.6 million people between 1920 and 1990. This increase exceeded the state's population growth rate for that period and was the largest increase of the four regions.

TULARE LAKE REGION

Between 1950 and 1990, M&I acreage in the Tulare Lake Region approximately tripled from 96,000 acres to 294,000 acres. During the period between 1920 and 1990, M&I land use in the region increased from approximately 45,000 acres to 294,000 acres. Much of this growth was associated with the expansion of the City of Bakersfield, the largest M&I center within the region. Other municipal areas include the cities of Tulare, Hanford, and Visalia. The population in the Tulare Lake Region increased by approximately 821,000 people between 1920 and 1990.

SAN FRANCISCO BAY REGION

Between 1955 and 1970, M&I land use in the San Francisco Bay Region increased from approximately 225,000 acres to 485,000 acres, the largest increase of M&I land area in the four PEIS regions. During this period, the Santa Clara Valley developed rapidly, and by the 1980s, few areas in the immediate San Francisco Bay Area remained available for M&I land development. During the 1980s, extensive development occurred along the Highway 680 corridor. M&I land use for 1990 was 655,000 acres, a substantial increase in development for the 20-year period between 1970 and 1990. Although land development between 1950 and 1970 more than doubled, adding approximately 260,000 acres, the change from 1970 to 1990 was associated with “in-fill” developments and has resulted in greater regional population density than in previous periods. This region is extensively urbanized and includes the San Francisco, Oakland, and San Jose metropolitan areas.

Between 1920 and 1990, the population in the San Francisco Bay Region increased by approximately 4 million.

VEGETATION AND WILDLIFE RESOURCES

A wide diversity of vegetation and wildlife resources exist in the Central Valley, the Trinity River Basin, and in the San Felipe Division. Habitat types in these regions include natural terrestrial, agricultural, urban, riparian, and wetland habitats. This section describes the vegetation and wildlife resources in the CVPIA study area, with emphasis on biological communities in the Central Valley, where implementation of the CVPIA will have the greatest effect.

CENTRAL VALLEY RESOURCES

For the purposes of this assessment, the Central Valley was divided into four regions: Sacramento River Region, Sacramento-San Joaquin Delta Region, San Joaquin River Region, and Tulare Lake Region. Acreages of habitat types in these regions are listed in Table III-5.

Natural Terrestrial and Agricultural Habitats

Natural terrestrial habitats constitute large portions of the Sacramento River, San Joaquin River, and Tulare Lake regions (Table III-5), although extensive portions of these habitats also exist on the east slope of the Coast Mountains and the west slope of the Sierra Nevada. Grassland and valley foothill hardwood are the dominant natural terrestrial habitat types in the Central Valley, constituting approximately 36 percent, 58 percent, and 46 percent of these habitats in the Sacramento River, San Joaquin River, and Tulare Lake regions, respectively.

TABLE III-5

SUMMARY OF CENTRAL VALLEY HABITAT TYPES CONSIDERED IN THE ANALYSIS

	Habitat Type (1,000 acres)				
Region	Natural Terrestrial	Agricultural	Urban/Other	Riparian	Wetland
Sacramento River	8,443	1,984	1,309	14	157
Delta	0	505	107	7	25
San Joaquin River	4,347	3,140	615	15	138
Tulare Lake	3,319	2,200	707	14	32

NOTE:
Acreages are based on 1992 data.

Agricultural habitats are generally of lower quality than natural habitats. Rice and irrigated pasture provide the highest quality agricultural habitat for wildlife, followed by grain crops. The habitat value of row crops, orchards, and vineyards is less than that of the previously mentioned crops, but all these agricultural habitats provide better habitat value than cotton. The major agricultural habitats are grain, irrigated pasture, and rice in the Sacramento River Region; row crops in the Delta Region; irrigated pasture, orchards and vineyards, and cotton in the San Joaquin River Region; and cotton and irrigated pasture in the Tulare Lake Region.

Natural terrestrial and agricultural habitats support special-status species (federally and state-listed threatened or endangered species, species proposed for federal listing as threatened or endangered, and federal candidate species) (Tables III-6 and III-7). Grassland and valley foothill hardwood, the dominant habitats in the Central Valley, support 40 special-status plant and 22 special-status wildlife species. Examples of species that occur in grasslands are palmate-bracted bird’s beak, Chinese Camp brodiaea, San Joaquin kit fox, giant kangaroo rat, San Joaquin antelope squirrel, and blunt-nosed leopard lizard. Many of the special-status plant species are associated with rare habitats in grasslands, such as vernal pools. Examples of species that occur in valley foothill hardwoods are San Joaquin adobe starburst, Hartweg’s golden sunburst, striped adobe lily, loggerhead shrike, and California mastiff bat. A more detailed list of special status species is presented in the Vegetation and Wildlife Technical Appendix.

The extent of natural terrestrial and agricultural habitat is affected by urban development. Urban and other habitats generally provide low-quality habitat for native plants and wildlife because they are small and isolated, so that only a limited number of species can use them. Additionally, these areas generally receive high levels of human use, which disturbs native species and restricts their use of the area.

TABLE III-6

NUMBERS OF SPECIAL-STATUS PLANTS BY STATUS LEVEL AND HABITAT IN EACH CENTRAL VALLEY REGION

Region/Status	Mixed Conifer Forest	Montane Hardwood	Pinyon-Juniper	Valley-Foothill Hardwood	Valley-Foothill Riparian	Inland Dunes	Montane Riparian	Chaparral	Alkali Desert Scrub	Desert Scrub	Sagebrush & Bitterbush Scrub	Grassland	Freshwater Emergent Marsh	Saline Emergent Marsh
Sacramento River														
Federally listed or proposed	1	8		7				6	1			18	1	1
State listed	2	2		2	1			2	1			3	3	1
Federal candidate		1		1				3						
Sacramento River Totals	**3**	**11**		**10**	**1**			**11**	**2**			**21**	**4**	**2**
Delta														
Federally listed or proposed						2						9		2
State listed					1							2	2	1
Federal candidate														
Delta Totals					**1**	**2**						**11**		**3**
San Joaquin River														
Federally listed or proposed		6	1	9				2	4			15		
State listed	4	4		4	2			4				2	2	1
Federal candidate	1	2		3				2				1		
San Joaquin River Totals	**5**	**12**	**1**	**16**	**2**			**8**	**4**			**18**	**2**	**1**
Tulare Lake														
Federally listed or proposed		2	3	4				1	5			12		
State listed	1	1		1						1		1		
Federal candidate		1		1								1		
Tulare Lake Totals	**1**	**4**	**3**	**6**				**1**	**5**	**1**		**14**		

NOTE:
Coastal and desert habitats that do not occur in the Central Valley are not included in this table.

TABLE III-7

NUMBERS OF SPECIAL-STATUS WILDLIFE SPECIES BY STATUS LEVEL AND HABITAT IN EACH CENTRAL VALLEY REGION

Region/Status	Mixed Conifer Forest	Montane Hardwood	Pinyon-Juniper	Valley-Foothill Hardwood	Valley-Foothill Riparian	Inland Dunes	Montane Riparian	Chaparral	Alkali Desert Scrub	Desert Scrub	Sagebrush & Bitterbush Scrub	Grassland	Freshwater Emergent Marsh	Saline Emergent Marsh	Lacustrine	Riverine	Irrigated Pasture	Row Crops	Grain Crops	Rice
Sacramento River																				
Federally listed or proposed	1				1							3	8		4	4	1		1	
State listed					1		1					1	2	1	2	1		1	1	
Federal candidate												2	1				1		1	
Sacramento River Totals	**1**				**2**		**1**					**6**	**11**	**1**	**6**	**5**	**2**	**1**	**3**	
Delta																				
Federally listed or proposed						1							8	2	3	3	1		1	
State listed					2		1						1	1		1	2	1	3	
Federal candidate					1								1		1		1		1	
Delta Totals					**3**	**1**	**1**						**10**	**3**	**4**	**4**	**4**	**1**	**5**	
San Joaquin River																				
Federally Listed or proposed	1				2				6	1		5	6		3	3	1		1	
State Listed				1	3		1					1	1		1			2	1	
Federal Candidate												2	1		1		1		1	
San Joaquin River Totals	**1**			**1**	**5**		**1**		**6**	**1**		**8**	**8**		**5**	**3**	**2**	**2**	**3**	
Tulare Lake																				
Federally listed or proposed	1				2				5			5	4		2	1				
State listed	1				3		1	1				1	1		1			2	1	
Federal candidate						1					1	2	2		1		1		1	
Tulare Lake Totals	**2**				**5**	**1**	**1**	**1**	**5**		**1**	**8**	**7**		**4**	**1**	**1**	**2**	**2**	

NOTE:
Coastal and desert habitats that do not occur in the Central Valley are not included in this table.

Riparian and Wetland Habitats

Riparian habitats are associated with the rivers and streams in each region (Table III-5). Flood-control structures and land use changes have restricted the abundance and distribution of riparian habitat in each region. Freshwater emergent wetlands in the Sacramento River and San Joaquin River regions are generally associated with rivers and seasonal wetlands, such as vernal pools and swales. Freshwater and saline emergent wetlands are found in the Delta Region. Wetland habitat is restricted in the Tulare Lake Region because of the drier climate and land use practices.

Riparian and wetland habitats in the Central Valley support numerous special-status plant and wildlife species (Tables III-6 and III-7). Examples of those special-status species that occur in riparian habitat are delta button-celery and Mason's lilaeopsis, valley elderberry longhorn beetle, yellow-billed cuckoo, and riparian brush rabbit. Examples of special-status species found in wetland habitat are Colusa grass, orcutt grasses, Suisun thistle, salt marsh harvest mouse, black rail, giant garter snake, vernal pool fairy shrimp, and vernal pool tadpole shrimp.

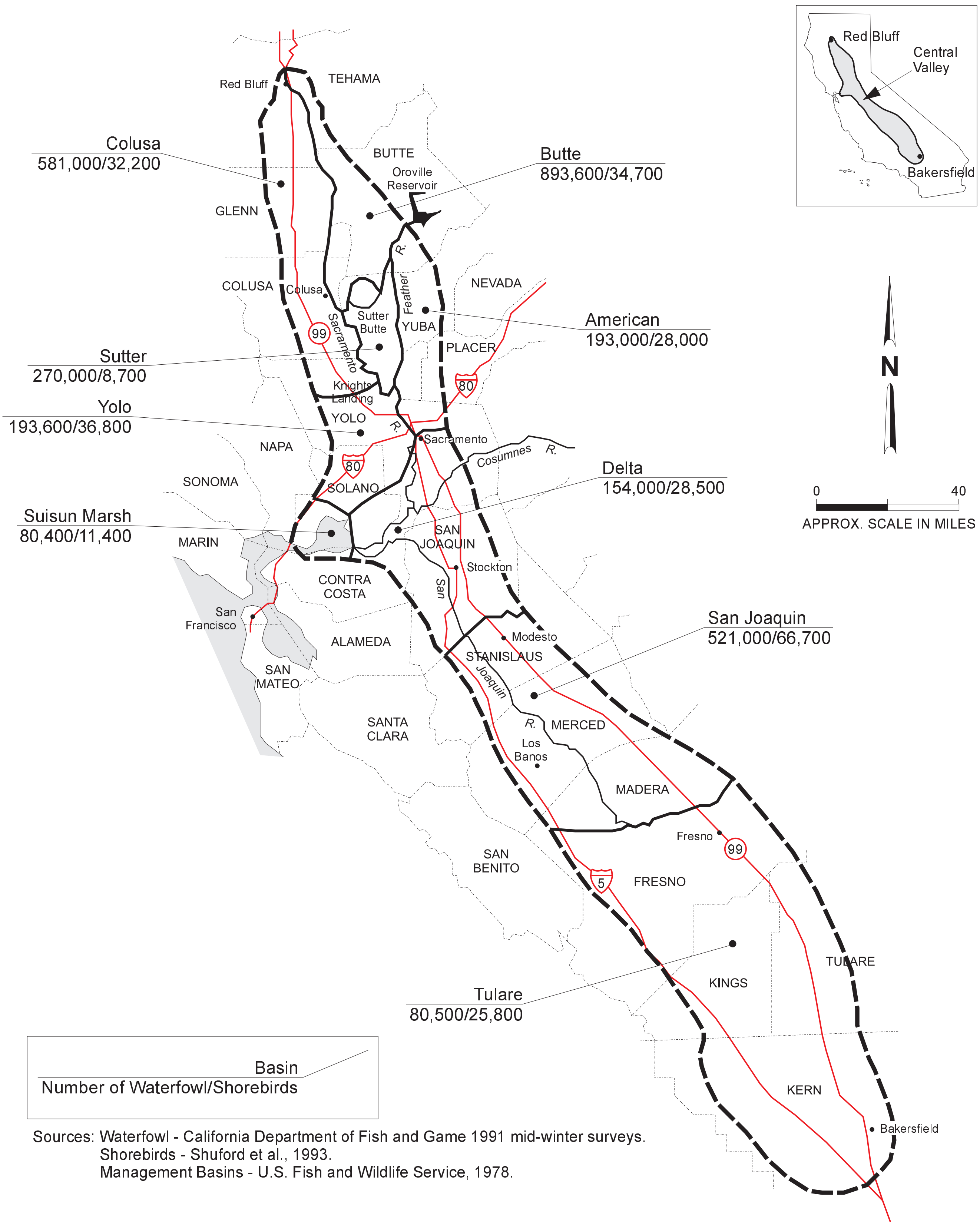
River and Reservoir Aquatic Habitats

River and reservoir aquatic habitats are those in the rivers and associated reservoirs operated by the CVP and the SWP. In the Sacramento River Region, aquatic habitats were evaluated in the Sacramento, Feather, and American rivers and Whiskeytown Lake, Shasta Lake, Lake Oroville, and Folsom Lake. Aquatic habitats evaluated in the San Joaquin River Region were the San Joaquin, Stanislaus, Tuolumne, and Merced rivers, San Luis and New Melones reservoirs, and Millerton Lake. Aquatic habitats provided by rivers and reservoirs in the Tulare Lake Region were not evaluated because they are not affected by operation of the CVP.

Special-status wildlife species associated with riverine habitat in the Central Valley include the bald eagle, bank swallow, and California red-legged frog. Reservoirs are used primarily by migratory birds that are present in the Central Valley between October and March. Shallow water habitat (less than 1 foot deep) is used by dabbling ducks, such as mallards and cinnamon teal; deep water habitat (more than 1 foot and less than 15 feet deep) is used by diving ducks, such as lesser scaup and ring-necked ducks; and open water habitat (more than 15 feet deep) is used by gulls and western grebes.

Waterfowl and Shorebirds

Natural and managed wetlands in the Central Valley provide the most important wintering area for waterfowl on the Pacific Flyway, supporting approximately 60 percent of that population and 18 percent of the entire continental wintering waterfowl population. Between 1970 and 1980, 5.5 to 7 million waterfowl wintered each year in the Central Valley; however, the population declined in recent years to approximately 3 to 4 million as a result of extended droughts in wintering and breeding ranges. The Central Valley also supports the largest concentrations of wintering shorebirds in western North America; more than 270,000 birds were counted during winter 1992-1993. Spring counts of shorebirds may be higher because many birds stop in the Central Valley before migrating to northern breeding grounds. The recent distribution of waterfowl and shorebirds in the Central Valley is shown in Figure III-16.



Sources: Waterfowl - California Department of Fish and Game 1991 mid-winter surveys.
Shorebirds - Shuford et al., 1993.
Management Basins - U.S. Fish and Wildlife Service, 1978.

FIGURE III-16

MANAGEMENT BASINS AND WINTERING WATERFOWL AND SHOREBIRD POPULATIONS IN THE CENTRAL VALLEY

Federal and state refuges and private duck clubs provide important wetland habitat for migratory waterfowl and shorebirds. Public refuges in the Sacramento River Region include Gray Lodge Wildlife Management Area (WMA), Oroville WMA, Sacramento National Wildlife Refuge (NWR), Delevan NWR, Colusa NWR, and Sutter NWR. The San Joaquin River Region supports the largest block of public refuges and private duck clubs in the Central Valley. These include Kesterson NWR, San Luis NWR, Merced NWR, North Grasslands WMA, Los Banos WMA, Volta WMA, the San Joaquin Basin Action Plan lands, and Grasslands Resource Conservation District. The Tulare Lake Region has three refuges: Mendota WMA, Kern NWR, and Pixley NWR.

TRINITY RIVER BASIN RESOURCES

The riparian zone along the Trinity River is primarily composed of blackberry, willow, and alder species. No federally listed species are present. Since the completion of Trinity Dam and the beginning of water diversion to the Sacramento River Basin in the 1960s, flows in the Trinity River have been reduced, resulting in the exposure of gravel bars within the river channel and the establishment of vegetation on the gravel bars.

A variety of species of mammals, birds, amphibians, and reptiles inhabit the riparian and neighboring areas throughout the spring months. Although present in the Trinity River Basin, the bald eagle is primarily limited to the reservoir areas. Reclamation has previously consulted on the effects of the operation of the CVP on bald eagles and is operating under the resultant biological opinion that addresses effects of CVP operations, including reservoirs.

The willow flycatcher, which is listed as an endangered species by the State of California, has been occasionally observed in the Trinity Basin (Wilson, 1993). Wildlife species designated by the State of California and/or federal agencies as species of special concern include the foothill yellow-legged frog and the northwestern pond turtle.

SAN FELIPE DIVISION RESOURCES

Although most of the non-urban land in the San Felipe Division is used for agricultural purposes, native trees and shrubs fringe some of the natural drainage courses. Willows, alders, cottonwood, black walnut, and sycamores, with an understory of California blackberry, sage, wild radish, and other annual plants are common among intermittent stream courses. Rare or endangered plant species in, or in the vicinity of, the San Felipe service area include the ferris ceanothus, the California balsam root, Hamilton thistle, and the glabrous popcorn flower.

Because of the varied natural and cultivated vegetation, birdlife is abundant and includes numerous non-game species in addition to upland game birds. The intense development of the valley floor, however, has eliminated many acres of marsh habitat previously used by waterfowl.

Rare, threatened, or endangered species in the San Felipe Service Area include the San Joaquin kit fox, the southern bald eagle, the red-shouldered hawk, the California least tern, the San Francisco garter snake, and the salt-marsh harvest mouse.

CENTRAL VALLEY PROJECT POWER RESOURCES

CVP facilities were constructed and are operated under Reclamation Law and the authorizing legislation for each facility. Initially, Reclamation projects were authorized solely for irrigation and reclamation purposes under the Reclamation Act of 1902. In 1906, Reclamation Law was amended to include power as a purpose of the projects if power was necessary for operation of the irrigation water supply facilities, or if power could be developed economically in conjunction with the water supply projects. The Act of 1906 also allowed for lease of surplus power. Surplus power is described as power that exceeds the capacity and energy required to operate the Reclamation facilities (Project Use Load). The Act of 1906 stipulated that surplus power would be leased with preference for municipal purposes.

The Reclamation Act of 1939 provided for surplus power to be sold with preference given to municipalities and other public corporations or agencies, and also to cooperatives and other non-profit organizations financed pursuant to the Rural Electrification Act. By Reclamation Law, the Preference Power Customers include irrigation and reclamation districts, cooperatives, public utility districts, municipalities, California educational and penal institutions, and federal defense and other institutions. In 1967, Reclamation and PG&E signed an agreement (Contract No. 14-06-200-2948A, or “Contract 2948A”) allowing for the sale, interchange, and transmission of electrical power between the federal government and PG&E. Under this agreement, power produced in excess of Project Use Load and preference customer deliveries is delivered to PG&E.

Until 1977, Reclamation operated the CVP power generation and transmission facilities and marketed the power generated by the CVP facilities. In 1977, Western Area Power Administration (Western) was established as part of the Department of Energy. Western operates, maintains, and upgrades the transmission grid that was constructed by the CVP. As part of their marketing function, Western ensures that CVP Project Use loads are met at all times by using a mix of generation resources including CVP generation and other purchased resources. Western also dispatches and markets power surplus to the CVP project needs to Preference Power Customers and other utilities.

CENTRAL VALLEY PROJECT HYDROELECTRIC GENERATION FACILITIES

The CVP power facilities, include 11 hydroelectric powerplants with 38 generators, and have a total maximum generating capacity of 2,045,000 kilowatts (kW) as schematically presented in Figure III-17. Major factors that influence powerplant operations include required downstream water releases, electric system needs, and Project Use demand. CVP powerplants have produced an average of 4,800,000 kWh per year over the last 15 years.

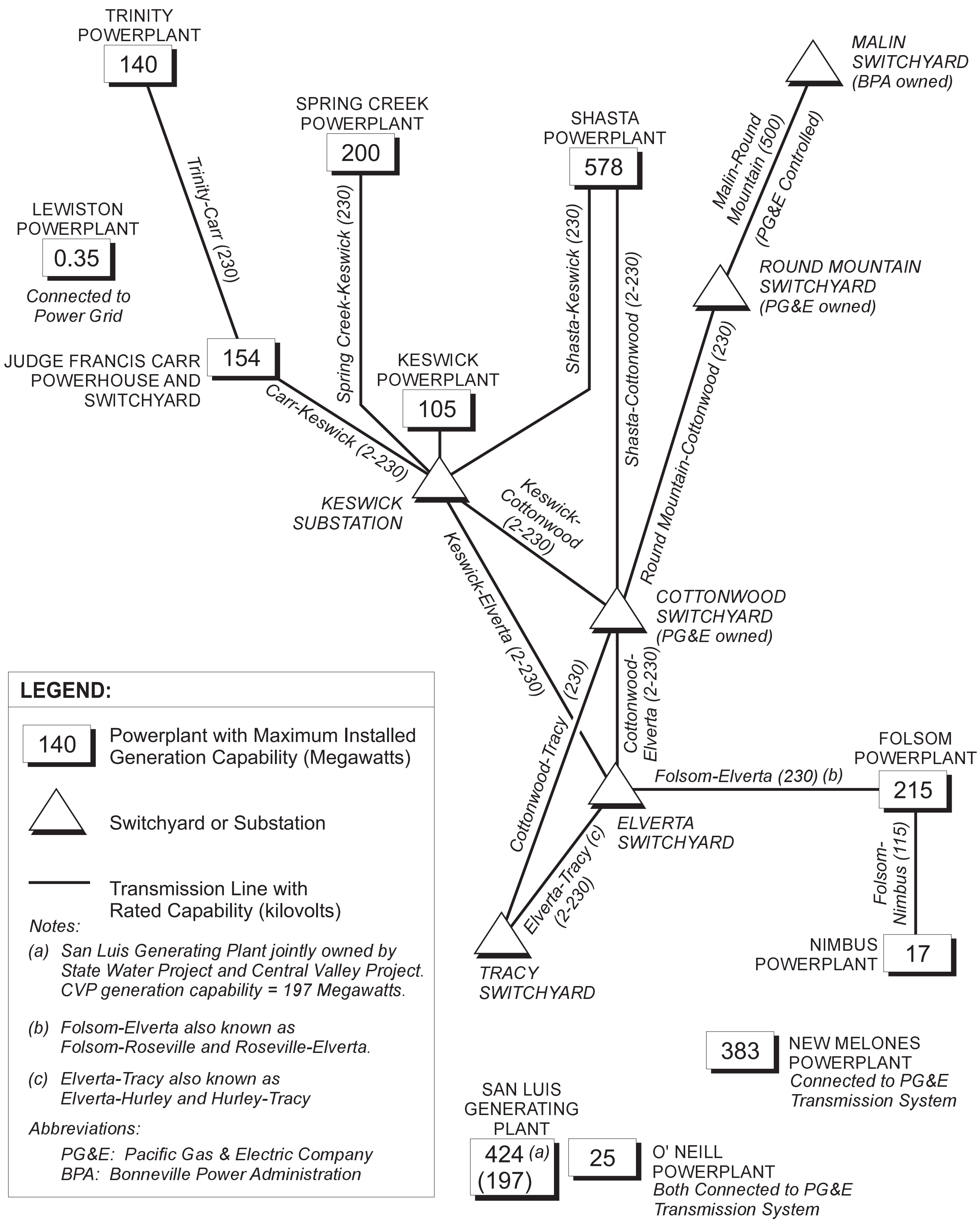


FIGURE III-17

CENTRAL VALLEY PROJECT POWER GENERATION FACILITIES AND ASSOCIATED WESTERN AREA POWER ADMINISTRATION MAJOR TRANSMISSION FACILITIES

Revenue from CVP generation is vital to project repayment and operation and maintenance expenses. Through appropriations, revenues from the sales of surplus CVP power are applied to several types of annual expenses, including:

- Power operation and maintenance
- Administration and general expenses allocated to power
- Power equipment replacement
- Interest on power investment
- Federal power investment
- Depreciation

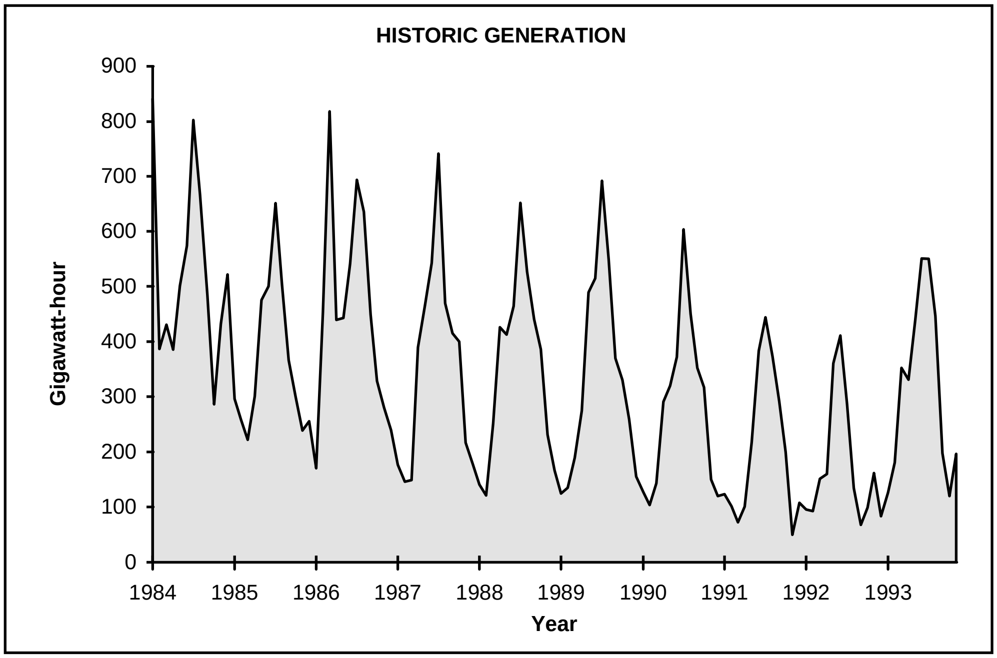
With the ability to support the Central and Northern California power system and the power system reliability, the CVP powerplants have a major long-term role with important implications in California and thus the Nation's security, energy self-sufficiency, quality of life, environment and economy. In addition to providing peaking generation to the Central and Northern California power system, it supplies many secondary benefits to the power system including VAR (magnetic or inductive power) support, spinning reserves, and black start capabilities. The continued stream of benefits derived from the CVP power facilities is of vital importance to the CVP water and power users. Loss of CVP hydropower generation results in a reduction of electric system reliability as well as potentially increasing electrical system costs.

POWER GENERATION

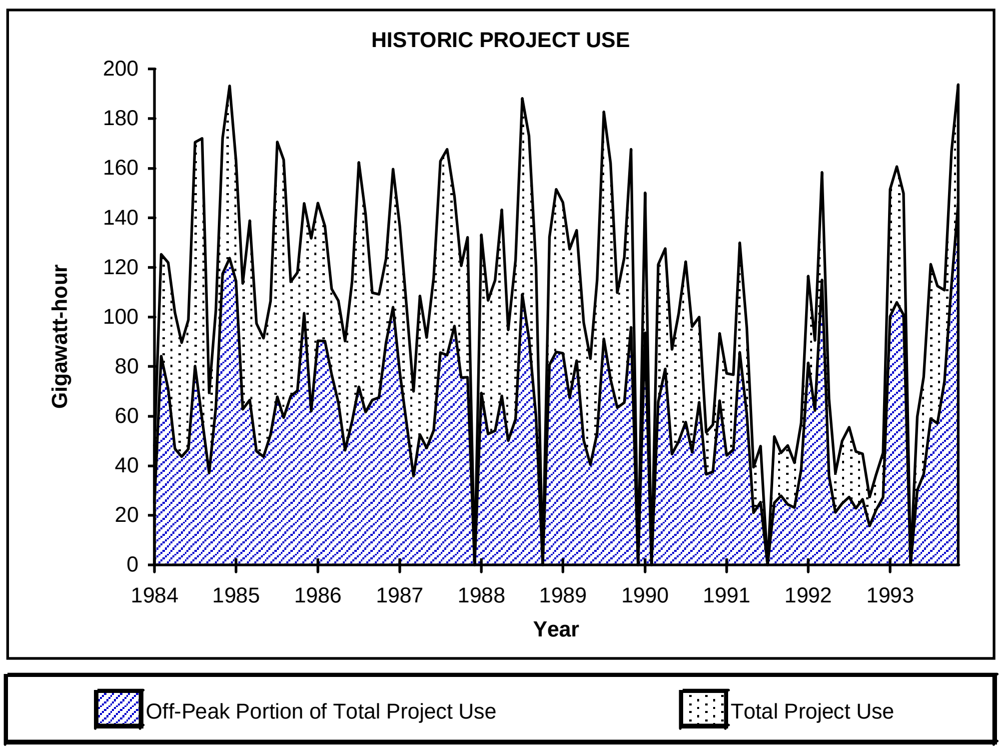
Historically, power generation from CVP hydropower facilities has fluctuated significantly with reservoir releases. Reservoir releases are significantly affected by droughts, minimum streamflow requirements, flow fluctuation restrictions, and water quality requirements. Figure III-18 shows monthly total CVP power generation for the period 1984 through 1993.

Recently, power generation has been affected by changes in CVP operations to meet minimum streamflow and water quality requirements. For example, Shasta Powerplant operations were affected by the SWRCB Water Rights Order 91-01 and the biological opinion issued by the NMFS in 1992 to protect winter-run chinook salmon in the Sacramento River. The SWRCB order and the biological opinion included maximum temperature requirements during specified months of the year. To meet the temperature requirements, cold water from the lower levels of Shasta Lake was released during the critical periods. Outlets in the dam that allowed the release of colder water are not connected to the Shasta Powerplant. Therefore, to meet temperature requirements, the powerplant was bypassed and annual power generation was significantly reduced. The construction of the Shasta Temperature Control Device now allows the colder water to pass through the powerplant.

Changes in CVP operations to meet water quality requirements have also impacted the monthly release patterns and resulting power generation at all CVP hydroelectric generation facilities. Historically, maximum releases from CVP facilities occurred during the summer months in periods of high irrigation water demand, which correspond to the peak power load periods in the area served by CVP generation. Recent water quality requirements have increased the need for water releases in the winter and spring months, reducing the amount of water available for release during



NOTE: Includes Trinity, Shasta, American, Eastside, and West San Joaquin Divisions.



NOTE: Based on Monthly Energy Balance Sheets including San Luis Unit, Delta Division, and CVP Portion of Banks Pumping Plant.

FIGURE III-18

HISTORIC MONTHLY CVP GENERATION AND PROJECT USE

the peak summer months. Consequently, peak generation during the summer period has been reduced and power generation in other months has been increased. Peak generation may not occur at the same time as peak power loads. Changes in power generation patterns affect coordinated operations of both PG&E and CVP facilities.

CENTRAL VALLEY PROJECT POWER CUSTOMERS

The CVP power generation facilities were initially developed based on the premise that power could be generated to meet Project Use loads. Currently, Project Use demand uses on average approximately 25 to 30 percent of the power generated by the CVP. Historic on- and off-peak Project Use summed for the major CVP pumping plants, which account for about 90 percent of total Project Use demand, is shown in Figure III-18.

The current Preference Power Customers include 11 municipalities, 1 rural electric cooperative, 23 federal installations, 8 state-owned installations, 10 public utility districts, 22 local water and irrigation districts, and the Bay Area Rapid Transit District.

POWER MARKETING

Hydropower generation does not always occur during times of peak loads of the CVP. Initial CVP plans included construction of fossil-fuel thermal powerplants to be located near Tracy to provide power generation in support of CVP project load. The hydropower generation plants were to be operated to meet CVP Project Use peak power loads. The initial concept also included an extensive transmission grid to provide project use power to all CVP facilities, to provide commercial firm power to Preference Power Customers, and to transmit power from all CVP hydropower plants. This project was reevaluated in the late 1940s as the CVP facilities were constructed. In 1951, it was determined that it would be more cost-effective to co-utilize generation and transmission facilities constructed by PG&E wherever possible to avoid duplication of facilities.

Under the terms of Contract 2948A, the generation of CVP hydroelectric powerplants is delivered to PG&E, along with Western power purchases. In return, PG&E supports firm power deliveries to CVP Project Use needs and Preference Customers. Contract 2948A also includes limits on contracts for Preference Power Customer loads to a stated maximum simultaneous peak load of 1,152,000 kW. The actual maximum contractual obligation of the power customers was calculated based upon different types of loads, timing of loads, and agreements for withdrawing power when CVP generation and Western power purchases cannot meet loads. The power accounting procedures under 2948A are based upon the assumption that all power is transmitted from the CVP generation units to the Tracy Switchyard. The power is then dispatched to the CVP Preference Power Customers and CVP Project Use loads. Therefore, all loads and available capacity are adjusted for line losses to the “load center” at the Tracy Switchyard.

In 1992, Western and PG&E resolved outstanding disputes concerning Contract 2948A. The Settlement Agreement addressed capacity purchases, purchase rates, project dependable power calculations, capacity credits from generation facilities in the Pacific Northwest, exchange accounts, sale and transmission of excess capacity, and several other provisions (Western, 1992b).

RECREATION

Recreation sites that could be affected by implementation of the CVPIA, include reservoirs, rivers, and wildlife refuges located in the study area. A detailed discussion of recreation sites is provided in the Recreation Technical Appendix.

RESERVOIRS

Recreation opportunities are provided by CVP, SWP, non-CVP, and SWP reservoirs in the Trinity, Sacramento River, and San Joaquin River regions. These reservoirs, including Clair Engle Lake, Shasta Lake, Whiskeytown Lake, Lake Oroville, Folsom Lake, Millerton Lake, San Luis Reservoir, and New Melones Reservoir, provide both water-dependent and water-enhanced recreation opportunities. Water-dependent recreation at these reservoirs includes power boating, water skiing, sailing, and fishing. Water-enhanced recreation includes camping, picnicking, hiking, and sightseeing. Most of these activities occur primarily during the summer months, typically May through September. Boating and fishing are typically the most popular year-round recreation activities at the reservoirs.

Shasta Lake is the most heavily used reservoir in the Sacramento River Region with approximately 2.4 million visitor days (also known as recreational visitor days [RVDs]) in 1992, followed by Lake Oroville with 418,000 visitor days, Folsom Lake with 362,000 visitor days and Lake Natoma with 186,000 visitor days. In the San Joaquin River Region, New Melones is the most heavily used CVP reservoir, with approximately 498,000 visitor days in 1992, followed by Millerton Lake with 316,000 visitor days, and San Luis Reservoir with 210,000. However, 1992 was a dry year and is not indicative of a long-term average.

Secondary CVP and SWP reservoirs, such as Keswick, Lake Red Bluff, Thermalito Forebay and Afterbay, Lake Natoma, O’Neill Forebay, and Bethany, also provide recreation opportunities. Because of their relative small size and proximity to larger reservoirs, these reservoirs are not as heavily visited as the major CVP and SWP reservoirs.

RIVERS

Rivers below major reservoirs provide important water-dependent and water-enhanced recreation opportunities. Major rivers below CVP and SWP reservoirs are the Trinity, Sacramento, American, Feather, San Joaquin, and Stanislaus. Rivers below reservoirs operated by other agencies are the Yuba, Tuolumne, Merced, Calaveras, and Mokelumne. These rivers provide important water-dependent recreation opportunities, including fishing, power boating, rafting, kayaking, and canoeing. Most of these activities occur during summer months. Fishing is typically the most popular year-round activity.

The Sacramento River is the most heavily used river in the Sacramento River Region with use in 1992 estimated at approximately 161,000 visitor days, followed by the American River with 27,000 visitor days. In the San Joaquin River Region, the San Joaquin, Merced, Tuolumne, and Stanislaus are the most frequently visited rivers, with a combined use in 1992 of approximately 538,000 visitor days.

WILDLIFE REFUGES

Federal and state wildlife refuges located in the Sacramento River, San Joaquin River, and Tulare Lake regions provide both consumptive and non-consumptive recreation opportunities. These opportunities are typically associated with the presence of waterfowl and include hunting and observing wildlife. Other activities are fishing and picnicking. Most visitation at the refuges coincides with the presence of waterfowl.

For all activities, combined annual visitation to wildlife refuges in the Sacramento River Region in 1992 totaled approximately 103,000 visitor days. Annual visitation to wildlife refuges in the San Joaquin River Region and Tulare Lake Region in 1992 each totaled 56,000.

FISH, WILDLIFE, AND RECREATION ECONOMICS

This section describes the economic benefits and expenditures associated with recreation and fishing resources that may be affected by CVPIA. Recreational uses at reservoirs, rivers, and wildlife refuges were described in the previous section. Additional use and benefits are associated with ocean commercial and sport fishing.

SACRAMENTO RIVER REGION

In 1992, recreation use at affected reservoirs, rivers (sport fishing only), and wildlife refuges in the Sacramento River Region totaled approximately 3.6 million visitor days. Recreation and trip-related spending at these sites was an estimated $70 million, which generated $34 million in personal income and 2,250 person-years of employment within the region. Recreation benefits, as measured by the amount over actual expenditures that recreationists are willing to pay for recreation opportunities, are estimated at $38 million for 1992. The majority of the economic activity comes from recreation associated with reservoirs, such as Shasta Lake, Lake Oroville, and Folsom Lake.

SAN JOAQUIN RIVER REGION

Recreation use in 1992 at reservoirs, rivers, and wildlife refuges in the San Joaquin River Region totaled approximately 2.9 million visitor days. The resulting trip-related expenditures are estimated at $52 million, which generated $26 million in personal income and 1,720 person-years of employment within the region. Recreation benefits associated with use at important recreation areas in the San Joaquin River Region in 1992 are estimated at $33 million.

TULARE LAKE REGION

Waterfowl hunting and wildlife observation at Kern NWR in the Tulare Lake Region totaled approximately 2,700 visitor days in 1992, resulting in an estimated $76,000 in trip-related spending and $84,000 in recreation benefits.

SAN FRANCISCO BAY/SACRAMENTO-SAN JOAQUIN DELTA REGION

Based on information from 1985 (Wade et al., 1987), recreation use of the Bay-Delta Region is estimated to have been approximately 7 million visitor days in 1992. Sport fishing accounted for an estimated 205,000 visitor days, which resulted in approximately $8.9 million in annual trip-related spending. Recreation benefits associated with this sport fishing activity are estimated at $3.7 million, based on an average benefit of $18 per day.

PACIFIC COAST REGION

The salmon sport fishery affected by stocks from the Sacramento and San Joaquin rivers includes coastal areas from Monterey, California, to the Oregon-Washington border. Saltwater sport fishing for salmon in the Pacific Coast Region accounted for an estimated 293,000 visitor days of recreation in 1992. Private fishing vessels accounted for approximately 216,000 visitor days of recreation, and charter vessels accounted for the remaining 77,000 visitor days. Total use resulted in an estimated $20 million in trip-related expenditures, which generated an estimated $9.9 million in personal income and 663 person-years of employment within the region. Annual recreation benefits associated with this activity are estimated at $18.5 million, based on an average benefit of $63 per day of salmon sport fishing.

The commercial salmon fishery is managed by the PFMC, which regulates when and how fish can be harvested. The California Department of Fish and Game sold 2,970 salmon fishing vessel permits in 1992; of these, about 1,100 landed salmon. The low percentage of permitted vessels landing salmon is largely due to closure of large areas to commercial fishing during 1992 and to the general deteriorating conditions in the salmon fishery. Table III-8 summarizes commercial salmon fishing activity in 1992. Over 1.6 million pounds of salmon were landed, with an ex-vessel value of about $4.4 million. The salmon industry in the Pacific Coast Region supported an estimated 550 person-years of employment in 1992, or about 24 percent of total commercial fishing employment in the region.

NON-USE VALUES

In addition to the use-related benefits described above, many people derive benefit from knowing that the natural environment is being preserved in good health. These benefits, which can be quantified in monetary terms, are often referred to as non-use (or existence) values. Some studies show that non-use values can exceed the use-related benefits associated with an ecosystem. Because of the difficulty and effort needed to develop supportable estimates of non-use values for resources affected by CVPIA implementation, no quantitative analysis is presented in this report. However, it is recognized that the non-use values associated with enhancing the natural environments affected by CVPIA implementation are important and potentially large.

TABLE III-8

COMMERCIAL SALMON FISHING ACTIVITY IN THE PACIFIC COAST REGION IN 1992

Subregion	Fishing Effort (days fished)	Pounds of Salmon Landed (thousands)	Total Pounds Landed (millions) (1)	Ex-Vessel Value of Salmon (millions of 1992 dollars)	Total Ex-Vessel Value of All Seafood Landed (millions of 1992 dollars) (1)
North Coast	NA (2)	21.5	77.2	0.05	38.6
San Francisco	6,300	989.0	56.1	2.71	35.
Central Coast	13,500	603.0	72.1	1.64	38.7
Total	**19,800**	**1,613.5**	**205.4**	**4.40**	**113.2**

NOTES:
(1) Total pounds landed and total ex-vessel values include information on all species landed in the subregions.
(2) Data for fishing effort in the subregions were unavailable but were very small in 1992 because of closure of the Klamath Management Zone to commercial fishing.

SOURCES:
California Department of Finance, 1993; PFMC, 1993a; U.S. Bureau of the Census, 1994.

LEGEND:
NA = No information on the subregion is currently available.

REGIONAL ECONOMICS

Between 1940 and 1992, the population of California grew at a 2.9 percent compound annual rate, while that of the U.S. grew at a 1.3 percent rate (California Department of Finance, 1995). Growth in California was stimulated by such factors as the baby boom following World War II, expanded job opportunities in electronics and defense-related sectors, and climate and other quality of life considerations in California.

REGIONAL ECONOMIC BASELINE CONDITION

Base year data for the IMPLAN regional economic models were constructed for the Sacramento River, San Joaquin River, Tulare Lake, North Coast, Central Coast, San Francisco Bay, and Central and South Coast regions. The North Coast and Central Coast regions are included because of potential effects on fisheries and related economies. The San Francisco Bay and Central and South Coast regions were used only to estimate the impacts of changes in M&I water costs caused by the alternatives.

All base year data for the regional analysis are in 1991 dollars or units because these data were the most current available at the time the models were estimated for this study. Changes to overall price levels between 1991 and 1992 were modest, about 2.8 percent economy-wide. The estimates from the regional models are, therefore, considered to be representative of 1992 level impacts.

Table III-9 shows 1991 levels of economic activity by sector for the seven regions. Final demand is the value of sales exclusive of sales between industries in each region, but total industry output includes these intra-regional sales. Output is often used as an indicator of size of the regional economy. Total place of work income is the sum of employee compensation and property income. IMPLAN also estimates employment by industry.

EMPLOYMENT

Patterns of employment in the Sacramento River Region reflect the changing rural and urban complexion of the region. The share of total employment provided by production agriculture has declined substantially since 1940. Similar patterns occurred in the San Joaquin River Region and the Tulare Lake Region. While production agriculture currently provides less than 4 percent of wage and salary employment, the percentage varies widely among the counties. For example, production agriculture accounted for 33 percent of employment in Colusa County, 19 percent in Glenn County, and 16 percent in Yuba County in 1992. However, agriculture accounted for less than one percent of employment in Sacramento, Placer, and Nevada counties.

In the North Coast Region, the forestry, fishing, and agriculture sector was the largest employer in 1940. At that time, production in this sector provided 26.4 percent of total household employment in the region. By 1992, the forestry, fishing, and agriculture sector accounted for only 4.2 percent of wage and salary employment, or about 7,200 jobs. Currently, the largest proportions of wage and salary jobs in the region are in the services, wholesale and retail trade, government, and manufacturing sectors.

Employment patterns in the San Francisco Bay and South Coast regions reflect the urban economies of these regions agriculture, forestry, and fisheries account for a small fraction of employment. Services, trade, manufacturing, and government are the primary employers.

MUNICIPAL AND INDUSTRIAL WATER USE AND COSTS

The affected environment for M&I water use includes any M&I providers who may be affected by CVPIA alternatives. Providers are considered to be potentially affected if they receive CVP contract water, if their water is delivered or stored by CVP facilities, or if, as a buyer of water, they might be affected by CVPIA water transfer provisions.

California's population is now about 30 million persons. A rapid increase in population over time has profoundly affected the use of the Central Valley land and water resource base. More people have meant greater urban water demand. Until recently, most urbanization in California occurred near the coastal cities. In the last decade, there has been a relative shift in new development from the coast to the Central Valley and inland deserts.

The affected environment for urban water use in the Sacramento River Basin is concentrated within the Sacramento Metropolitan Statistical Area (MSA, 1990 population 1,481,000), and near the City of Redding. Both of these areas include some CVP M&I contractors. Major urban

TABLE III-9

BASELINE 1991 DATA FOR REGIONAL ECONOMICS ANALYSIS

Industry	Final Demand (MM$)	Total Industry Output (MM$)	Total Place of Work Income (MM$)	Employment (Number of Jobs)
Sacramento River Region				
Agriculture, Forestry, Fishing	1,848	2,704	936	57,630
Mining	746	834	578	1,770
Construction	8,794	9,763	3,346	104,600
Manufacturing	9,547	12,130	4,745	82,200
Transportation, Comm.,	3,047	5,714	3,018	45,010
Wholesale, Retail Trade	8,269	9,822	6,438	264,940
Finance, Insurance, Real	9,276	12,260	7,920	107,620
Services	11,585	15,148	9,548	327,240
Govt. Enterprise & Special	11,677	12,822	10,752	306,250
Total	64,787	81,196	47,281	1,297,2600
Population	2,671,300			
San Joaquin River Region				
Agriculture, Forestry, Fishing	5,288	7,718	2,321	150,010
Mining	1,818	2,023	1,599	1,490
Construction	4,749	5,306	1,808	58,180
Manufacturing	12,888	15,511	4,909	91,090
Transportation, Comm.,	2,204	3,936	1,887	32,600
Wholesale, Retail Trade	4,885	6,292	4,186	169,740
Finance, Insurance, Real	4,892	6,970	4,577	59,590
Services	7,082	8,784	5,432	191,010
Govt. Enterprise & Special	4,172	4,462	4,065	136,520
Total	47,979	61,003	30,784	890,220
Population	1,944,100			
Tulare Lake Region				
Agriculture, Forestry, Fishing	4,181	5,316	1,649	108,270
Mining	2,332	2,513	1,060	3,830
Construction	2,676	3,382	1,043	34,980
Manufacturing	3,800	4,767	1,544	26,600
Transportation, Comm.,	1,432	2,281	1,224	22,770
Wholesale, Retail Trade	2,287	2,910	1,941	80,700
Finance, Insurance, Real	1,948	2,713	1,788	21,590
Services	2,864	3,917	2,379	85,400
Govt. Enterprise & Special	2,819	2,962	2,649	84,570
Total	24,340	30,761	15,277	468,710
Population	994,000			
North Coast Region				
Agriculture, Forestry, Fishing	474	785	268	15,070
Mining	296	318	125	710
Construction	2,221	2,453	843	26,150
Manufacturing	3,676	4,463	1,731	34,090
Transportation, Comm.,	1,051	1,573	710	10,900
Wholesale, Retail Trade	1,975	2,396	1,567	66,990
Finance, Insurance, Real	2,379	3,118	2,020	27,980
Services	2,841	3,713	2,330	87,030
Govt. Enterprise & Special	1,395	1,489	1,358	45,610
Total	16,309	20,308	10,952	314,520
Population	636,300			

TABLE III-9. CONTINUED

Industry	Final Demand (MM$)	Total Industry Output (MM$)	Total Place of Work Income (MM$)	Employment (Number of Jobs)
Central Coast Region				
Agriculture, Forestry, Fishing	2,440	3,038	950	57,790
Mining	601	650	477	720
Construction	2,272	2,563	871	28,010
Manufacturing	4,118	4,814	1,944	32,750
Transportation, Comm., Utilities	1,682	2,275	973	15,880
Wholesale, Retail Trade	2,630	3,178	2,058	89,730
Finance, Insurance, Real Estate	2,261	3,147	2,072	27,950
Services	3,838	4,998	3,240	110,080
Govt. Enterprise & Special Ind.	2,840	3,042	2,429	82,960
Total	22,680	27,706	15,014	445,860
Population	848,600			
San Francisco Bay Region				
Agriculture, Forestry, Fishing	1,191	1,572	737	29,990
Mining	3,718	3,810	1,819	4,780
Construction	15,205	17,313	6,957	169,010
Manufacturing	67,753	81,877	35,683	449,000
Transportation, Comm., Utilities	14,297	21,422	11,137	153,780
Wholesale, Retail Trade	23,904	29,844	19,357	642,710
Finance, Insurance, Real Estate	25,561	35,289	24,187	269,060
Services	36,225	52,661	34,087	994,810
Govt. Enterprise & Special Ind.	15,537	17,045	14,323	416,410
Total	203,390	260,833	148,288	3,129,540
Population	5,007,200			
Central and South Coast Region				
Agriculture, Forestry, Fishing	4,998	6,980	2,975	143,950
Mining	6,644	7,007	2,854	12,520
Construction	46,384	53,027	19,615	550,140
Manufacturing	149,168	184,117	81,661	1,350,450
Transportation, Comm., Utilities	23,383	44,719	23,403	349,600
Wholesale, Retail Trade	66,710	82,545	51,581	1,955,030
Finance, Insurance, Real Estate	73,836	101,390	69,404	774,660
Services	102,574	148,797	93,595	2,774,150
Govt. Enterprise & Special Ind.	43,693	48,778	40,690	1,246,640
Total	517,391	677,360	385,779	9,157,150
Population	17,585,500			

centers in the San Joaquin Valley include the cities of Fresno (MSA population 515,000) Stockton (347,000), and Merced. The City of Fresno is the largest urban center in the San Joaquin Valley. CVP water users in the San Joaquin Valley include Fresno, Stockton, Coalinga, Huron, and many other relatively small users.The City of Bakersfield (MSA population 403,000) is the main urban center within the Tulare Basin, in the South San Joaquin Valley, and is also the only major M&I user of SWP water in the Central Valley.

The San Francisco/Oakland area (1990 population about 5.5 million) and Los Angeles/San Diego area (about 17 million) include two of the four largest urban areas in the United States. Both areas are largely built out, but continued population growth occurs by densification, on fringe areas and by inland expansion. The San Francisco area is potentially affected through the North Bay and South Bay Aqueducts of the SWP and through CVP contract water deliveries through the Contra Costa Canal and the San Felipe Division of the CVP. The Central and South Coast includes areas served by the California Aqueduct of the SWP from San Luis Obispo County south through Los Angeles and San Diego County.

RETAIL WATER USE PATTERNS AND COSTS

Annual per capita use and average water bills vary greatly among providers within the affected environment. Summer and winter residential water use are similar in the northern coastal cities, reflecting climate and landscaping practices. In the Central Valley and southern coast, summer use per unit time is typically double winter use. Average annual use per residential account recently ranged from 0.17 acre-feet per year in San Francisco to 0.72 acre-feet in Sacramento. Lower use does not necessarily mean lower costs; Santa Barbara residents use almost the same amount of water per residence as San Franciscans, but they pay about three times as much for it. Commercial and industrial use are an important share of M&I use. Use patterns vary widely by region and industry.

Table III-10 shows 1990 normalized data for the M&I provider groups. Retail average cost data for a representative provider were obtained from DWR and price data were obtained from a survey of providers. Retail average cost includes service charges, while price is the charge per unit of water only. Data on 1990 water use and water supplies were generally developed from DWR. Demand during dry periods is greater than average because there is less recharge of urban landscape soil moisture.

CVP WATER SUPPLIES

The CVP supplies M&I project water to more than 40 entities in the CVP service area. Contract deliveries ranged from 270,000 to 446,000 acre-feet and averaged 352,000 acre-feet between 1983 and 1991.Use of CVP contracts among M&I contractors varies considerably. Some municipal users have used their full contract amounts in recent years; but most are not expected to do so until sometime after the year 2000. In addition to these contract deliveries, the CVP must be operated to provide municipal water under state water rights and exchange contracts. Water rights if requested, must be given priority over any other CVP deliveries. Total demand for water under CVP M&I contracts, water rights contracts, and exchange contracts could exceed 800,000 acre-feet as early as 2010.

TABLE III-10

1990 DATA FOR M&I PROVIDER GROUPS

Region	Retail Avg Cost $/acre-feet (1)	Retail Price $/acre-feet	Demand Served (thousand acre-feet)		CVP Contract and Water Rights and SWP Entitlement (thousand acre-feet)	Other Water Supplies (thousand acre-feet)	
			Avg.	Dry		Avg.	Dry
Sacramento River	254 to 311	0 to 205	566	613	361.7	204.8	251.4
Bay Area (2)	500 to 731	348 to 523	1,094	1,153	511.7	769.0	670.0
San Joaquin Cities	263 to 311	126 to 150	337	339	199.5	148.1	150.5
Central (3) and South Coast	461	383	3,784	3,916	2,332.7	2,499.4	2,321.2

NOTES:
(1) Includes service charges. The range provided is for subregions within the region.
(2) Includes the CVP San Felipe Service Area.
(3) Data are for South Coast only. The Central Coast Region includes providers served by the SWP coastal aqueduct, which did not deliver water in 1990.

LEGEND:
taf = thousand acre-foot (feet).

WATER TRANSFERS

M&I water users normally participate in water markets as buyers. In general, M&I users located in the Central Valley have not participated in water markets because supplies are sufficient, or because other available supplies are less expensive than water transfers. The coastal regions have recently participated in water markets to obtain spot supplies during the drought. The Drought Water Bank provided 307,000 acre-feet and 39,000 acre-feet for M&I use in 1991 and 1992, respectively, most through Metropolitan Water District of Southern California. Water was also purchased from Placer and Yuba counties. More recently, some M&I users have proposed more permanent transfers to meet their future needs.

THE DELTA AS A SOURCE OF DRINKING WATER

The Delta provides drinking water for approximately 20 million people. Consequently, the quality of its water can affect water treatment requirements and costs. A number of factors affect Delta water quality. Saline water intrudes into the Delta because of the interaction of tidal action, freshwater outflow and diversions, and atmospheric conditions. M&I treated effluent and agricultural return flows and drainage also are discharged to the Delta. Agricultural drainage is of particular concern because the peat soils of the Delta contribute organic chemicals to the agricultural drainage water. Organic chemicals contribute to the formation of trihalomethanes (THMs) during the disinfection process. By-products of the disinfection process, such as THMs, have been found to pose a threat to human health. Disinfection by-products (DBPs) have only been consistently measured since the early 1980s, as the U.S. Environmental Protection Agency (USEPA) first adopted a maximum contaminant level (MCL) for THMs in 1981 pursuant to the Safe Drinking Water Act. Delta island agricultural drainage in 1987 contributed up to 45 percent of the organic THM precursors during April to August and more than 50 percent during the winter leaching period (DWR, 1991).

Water in the Delta generally meets public water supply water quality standards identified by the USEPA and the California Department of Health Services (DHS). However, stricter federal standards to be promulgated within three to five years will be significantly more difficult and costly to meet. The standards of concern relate to DBPs and the potential requirements for more rigorous disinfection. In addition, lowering of the standard for arsenic, which is found naturally in Delta waters, is under evaluation. Microbiological organisms of principal concern as agents of disease or indicators of potential contamination in drinking water include coliform bacteria, viruses, and parasites.

Under authority of the Safe Drinking Water Act (SDWA) (Public Law 99-339), originally enacted in 1974, USEPA established drinking water regulations for 23 constituents. Amendments passed by Congress in 1986 require USEPA to set standards for 83 compounds within three years, establish 25 additional standards every three years, establish criteria for filtration of surface water supplies, and enforce requirements that all public water systems provide disinfection.

In 1996, Congress re-authorized the SDWA. The amendments changed the standard-setting procedure for drinking water and established a State Revolving Loan Fund to help public water systems improve their facilities and ensure compliance with drinking water regulations. The 1996 amendments eliminated the requirement for the USEPA to establish 25 standards every three years, replacing it with a requirement to develop a list of high priority contaminants with adverse health effects. From this list, the USEPA will select five contaminants every five years and determine whether to regulate them.

MOSQUITOS

In addition to being persistent pests, mosquitos carry diseases known as arboviruses. At least 18 arboviruses of particular concern to humans exist in California (Reeves, 1990). Western Equine Encephalomyelitis and St. Louis Encephalomyelitis (both commonly known as “encephalitis”) are arboviruses of particular concern. Neither virus is usually reported unless patients develop acute symptoms; therefore, the prevalence of both viruses is significantly under-reported. Mosquitos also transmit malaria (a parasitic blood disease) to humans and heartworm (a parasite) to dogs.

Encephalitis and malaria cases have been reported in all three major hydrologic regions in the Central Valley. The Tulare Lake Region has had more outbreaks of human encephalitis than either the Sacramento River or San Joaquin River regions, whereas the highest rate of malaria is reported in the Sacramento River Region.

Any environment in which water is allowed to stand in shallow, quiescent areas can serve as habitat for breeding mosquitos. These environments include wetlands, wildlife refuges, rice fields, pastures, drains, and slack water areas along streams, canals, and reservoirs.

Local mosquito control agencies have been developed to control vectors in an effort to control epidemics of human encephalitis and malaria. The mosquito abatement districts and control agencies adapt their practices in response to hydrologic conditions and the extent of areas that support appropriate breeding habitat. The three methods of mosquito control commonly used in California are water management, biological control, and chemicals.

SOCIAL CONDITIONS

SOCIAL GROUPS

Based on a review of numerous social indicators, and upon interviews with key community and economic leaders throughout the Central Valley, five social and economic groups were identified for inclusion in the Draft PEIS social analysis. The following potentially affected groups were identified: 1) farmers and ranchers who irrigate all or a portion of their lands with CVP water supplies, 2) farm workers and agribusiness workers who support agricultural production, 3) commercial fishermen and fishing businesses, 4) recreationists and recreation workers, and 5) Native American Tribes, specifically the Hoopa and Yurok tribes located in Trinity County. Each of these groups is described in more detail in this section.

Farmers

Farmers are those individuals who own land and/or manage farm operations for lands receiving CVP water supplies. They are decision-makers who must determine the crops to plant and related farm production expenditures and who could be affected by changes in agricultural water supply quantities or reliability.

Farmers rely on long-term and firm water supplies to manage farm production. Lack of stability in water supplies can affect their ability to obtain loans for farming operations, plan for future equipment needs and farm inputs (seed, fertilizer, etc.), and make decisions for long-term investments in irrigation systems and permanent crops. Many farmers have commented that supply reliability is key to making farm operating decisions and protecting farm investments, particularly investments in long-term cropping systems such as fruits, trees, and vineyards that require water in all years. Reduced irrigation supplies for long-term crops can affect crop productivity in future seasons, causing economic hardship in more than one water year or total loss of a crop.

In general, the economy of the rural communities relies on the success of farming for its livelihood. When farming conditions are good, farmers can support local community businesses. However, when farming conditions are poor, local communities also can suffer economic losses due to lack of expenditures from farmers. Farmers would like to see increased water supply reliability so that they can plan for long-term production goals, obtain funding, and maintain a trained work force.

Farm Workers and Agribusiness Workers

Farm workers and agribusiness workers are those individuals indirectly involved in farm production. Farm workers are hired by managers to assist with planting, irrigation, thinning, pruning, harvesting, and sorting and packing of crops. These workers may be hired on a seasonal basis or may be permanent farm employees. Generally, farm labor demands are greatest for fruit and vegetable crops that require more intensive farm management. Crops such as grains, cotton, sugar beets, pasture, and alfalfa have low farm labor demands.

Agribusiness workers are those individuals who own, operate, or are employed by businesses that provide production supplies such as seed, fertilizer, and pesticides; supply equipment and repair service; or serve as markets for farm products including packing and processing plants. Farm workers and agribusiness workers could be indirectly affected by changes in water supplies and farm production. In addition, these individuals are further removed from control of the production process and must rely on information gathered from farmers and ranchers to determine needs for services and products.

Lack of stability in CVP supplies can directly affect farm production, including acres planted and types of crops produced, and the need for farm labor. Similarly, changes in water supplies and cropping patterns will affect the need for farm supplies, equipment and repair needs, and packaging and processing needs. In recent years, the Central Valley has experienced losses of olive and melon packing plants, tomato processors, and cotton gins as plants have been consolidated, moved to other regions, or gone out of business. Many seasonal workers can face economic hardship due to lack of work when farming conditions are poor and farmers plant fewer acres or change to less labor-intensive crops. Farm workers and agribusiness workers would like to see farmers receive reliable water supplies so that they could have job assurance and a steady income as well as plan for farm production needs, including seed, fertilizer, equipment, and sale of other necessary inputs.

Commercial Fishermen and Fishing Businesses

Commercial fishermen and fishing businesses rely on fishing for their income. Businesses that support commercial fishing include boat sales and repair, fuel and service, fishing equipment sales, and fish packing and processing plants. Commercial fishermen and fishing businesses are located along the California coast extending from San Luis Obispo to the Oregon border, but are concentrated along the northern coastal towns. Changes in water supplies in inland streams and rivers can affect water quality, temperature, or quantities in streams where fish migrate and spawn. The resulting changes in fish abundance directly affect the quantity of fish available for ocean commercial and sport harvest, and thus directly affect the livelihood of fishermen and supporting businesses.

The fishing industry expanded in the 1980s, but has since declined with numerous businesses and processing plants closing because of declines in fish harvest numbers, particularly salmon.

Income for commercial fishermen has decreased while costs have continued to rise with increased regulation of the fishing industry, including increased safety requirements for fishing boats and crew members. Reduced harvest numbers and shortened season limitations have further impacted both the commercial and sport fishing industry.

With declining incomes and increasingly costly safety regulations, fishermen are less able to hire help for their boats and must fish longer periods and at distances farther from shore. Long-time fishermen were concerned with recent changes in the industry affecting their ability to maintain and sell their boats. The fishermen have put a substantial investment in the boats and often cannot sell the boats for their full value because of reduced interest in fishing. Many fishermen indicated that they no longer wished for their children to learn the fishing trade, because it is becoming increasingly more difficult and dangerous to make a living fishing for salmon.

Commercial fishermen would like to see more water dedicated to fishery resource needs to maintain the fishery resource. They would like to see reduced Delta exports that they feel jeopardize fish migration and would like to reverse some of the losses in spawning and rearing areas that have contributed to an overall decrease in anadromous fish populations. The fishermen are not opposed to all water exports or to farming, but would like to see greater equity in the allocation of limited water resources. For example, fishermen believe that during drought conditions, water diversions are maintained to the maximum extent possible, resulting in an unfair balance in favor of farming rather than fishing.

Recreationists and Recreation Workers

Recreationists are boaters, sport fishermen, hunters, and bird watchers who use reservoirs, rivers and streams, and wildlife refuges that store, convey, or use CVP water supplies. Sport fishing also occurs along the coastal area, and individuals engaged in sport fishing on the coast are included in the recreationists group. Recreation workers are those persons employed by service industries such as river guides, marina operators, boat repair businesses, and recreation supply businesses that provide gear and equipment for hunters, boaters, and fishermen. Members of this group generally are located in Central Valley towns near CVP facilities, wildlife refuges, and rivers, and in coastal fishing communities.

Recreation in CVP reservoirs can be affected by seasonal variations in reservoir levels. During recent drought conditions when reservoir levels dropped significantly, marinas often had to relocate facilities or were unable to use facilities. Operators of reservoir recreation businesses also commented that business can drop substantially when reservoir levels are low because of increased boating hazards created by reduced lake area and exposed hazards, as well as loss of scenic values. Sport fishing also has declined as fish numbers have dropped, resulting in decreased needs for river guides and fishing supplies in inland and coastal areas. These businesses have had to reduce staff in recent water-short years. Staff reductions can have a substantial effect on the local community, particularly reservoir and coastal communities whose economies are centered around activities related to fishing and boating.

Recreationists would like to see more water dedicated to recreation uses. Marina owners at CVP reservoirs would like to have reservoir levels maintained at higher levels during critical vacation times. Recreationists and recreation workers recognize that these interests often conflict with water needs of downstream urban and irrigation users.

Native American Tribes

Two Native American tribes were selected for the social analysis: the Hoopa Valley Tribe and Yurok Tribe, both located in Trinity County. These tribes rely on Trinity River water supplies and fishery for subsistence living and ceremonial uses, and have therefore been directly affected by management of the CVP. Declines in fishery numbers, primarily salmon, combined with effects of declines in the timber industry, have had an impact on the tribal economies, resulting in changes in tribal community interaction.

Changes or diversion of Trinity River flows could affect the lifestyle of these individuals. Poverty and unemployment rates for tribal members living on the Hoopa and Yurok reservations are high. Declines in fishery resources can affect the ability of tribal members to provide for their families at a subsistence level, affect the ability of a tribe to perform important tribal ceremonies, and generally affect the communities' ability to provide for trade between tribal members and with other tribes for services and other supplies.

The Hoopa and Yurok tribes would like to see greater flows maintained in the Trinity River. If less water were diverted to the Sacramento Valley, instream flows would be greater and would contribute to an increase in the salmon fishery and other fisheries necessary for subsistence living and ceremonial uses, such as the Boat Dance in the fall.

SOCIAL INDICATORS

Social indicators selected for analysis include unemployment, housing costs, and the need for and ability of communities to provide social service support programs. Unemployment in Central Valley rural areas, particularly the San Joaquin Valley, is higher than in urban areas such as San Francisco, Sacramento, Fresno, and Los Angeles. This is attributable to the large seasonal labor markets in these areas and the limited availability of other employment opportunities. Urban areas generally have more opportunity to absorb displaced workers, whereas employment in rural areas is centered around farming. If a farming economy declines, available employment opportunities also decline.

Literature available for rural areas generally is limited to the San Joaquin Valley and therefore the environmental analysis drew heavily from these resources. Seasonal unemployment in some communities, such as Mendota, is very high, approaching 40 percent at times. The average unemployment rate for Fresno County ranged from 10 to 14.5 percent between 1988 and 1992. The high level of seasonal unemployment in Mendota may be attributable to the limits of agricultural production. A study by the Giannini Foundation indicated that in 1982-1983, the average farm worker was able to work only 23 weeks (less than half of the year). The lack of available work results in low income and the need for supplemental incomes during periods of unemployment. The study also indicated that the workers would like to work more but work was not available. The study further states that jobs such as harvesting have a span of 10 to 15 years and are not a career. This could lead to workers leaving the work force or continuing to work at jobs that are less demanding, but also pay less.

Studies of the western San Joaquin Valley support a finding that increases in population have led to greater total revenues for the region. However, these revenues are supported by a larger population and actually reflect a lower per capita income. Per capita income in the San Joaquin Valley decreased in Fresno, Madera, Kings, and Merced counties between 1980 and 1990. During the same time frame, income in Stanislaus and San Joaquin counties increased slightly, possibly because of their proximity to the San Francisco Bay Area. Per capita income in Fresno County for 1990 was $15,346 while per capita income for the City of Mendota was substantially less at $4,920. Although revenues for the region have increased, expenditures to provide social support services to a poorer population also have increased.

The need for social services in areas of high unemployment is greater than in other areas. Higher levels of unemployment in the western San Joaquin Valley can be attributed to several factors, including a work force with limited skills, lack of formal education, and in need of training in English as a second language. Although the work force is very skilled in farm labor operations such as pruning, sorting, packing, and irrigation technology, these skills do not readily transfer to other labor markets. Therefore the demand for workers with these skills is limited and training programs will be necessary to bring new employment opportunities to these individuals (Applied Development Economics, Inc. 1994). It is assumed that similar conditions exist in the Sacramento Valley, but to a lesser extent because fewer acres are dedicated to crops with intensive labor requirements. Data to support this assumption are lacking.

Housing costs and rental costs were compared for several counties in the Central Valley (Butte, Colusa, Fresno, Merced, Sacramento, San Joaquin, Shasta, and Stanislaus counties) and for Mendocino County along the coast. Median housing costs for all areas increased substantially from 1980 to 1990, ranging from 26 percent in Fresno County to 55 percent in San Joaquin County. Fresno County has a large rural housing base that may have held down median housing costs, while San Joaquin County may have had larger increases in housing costs because of its proximity to the San Francisco Bay Area. Housing costs for rural counties increased less than for urbanized counties. Housing costs increased 43 percent from 1980 levels in Mendocino County. While housing costs were reflective of regional influences, increases in median rental costs increased at a relatively similar rate for all counties from 1980 to 1990. Increases in rental costs ranged from a low of 45 percent in Shasta County to a high of 55 percent in San Joaquin County. On average, rental costs increased by 47 percent for the ten-year period, a substantially higher rate of increase than that in housing costs. This finding is significant, particularly in areas with large seasonal employment or where a larger percentage of the population is unable to purchase a home. The increases indicated that a larger percentage of income is required for housing, leaving less money available for savings or other expenses such as transportation, health care, food, clothing, or education.

Several studies have focused on San Joaquin Valley agriculture and the response of agriculture to reductions in water supply. These studies have used data collected during drought conditions from 1987 to 1992, excluding 1990. One study, *The Impact of Water Supply Reductions on San Joaquin Valley Agriculture*, generally referred to as the Rand Study December 1994, indicated that there was little change in agricultural employment and crop revenue in Fresno County during this period.

The Rand Study found that agricultural revenues decreased by approximately 7 percent during the drought. It was recognized that greater reductions were likely offset by changes to higher value vegetable crops and potentially due to improvements in irrigation efficiency. The study also indicated that farmers may have been able to conserve water without substantial hardship or the need to implement drastic cropping or land use changes. However, the study cautioned that long-term reductions in the water supply could also force farmers to adjust to temporary reductions and may lead to greater changes in response to drought periods. This could lead to reductions in farm labor needs, expenditures, and revenues, which could affect the ability of a community to provide essential services.

CULTURAL RESOURCES

PREHISTORIC RESOURCES

The PEIS study area has a long and complex cultural history with distinct regional patterns that extend back more than 11,000 years before present (B.P.) time. The first generally agreed on evidence for the presence of prehistoric peoples in the study area is represented by the distinctive fluted spear points called “Clovis” points, found on the margins of extinct lakes in the San Joaquin Valley. Based on information obtained from sites outside the CVPIA study area, the ancient hunters who used these spear points existed only between 11,200 B.P. and 10,900 B.P. This span of time is often called the Clovis Period. Most researchers believe the Clovis Period was followed by another widespread complex, although the indicative artifacts consist of stemmed spear points rather than the fluted points that typify the Clovis Period. This poorly defined early cultural tradition is best known from a small number of sites in the San Joaquin Valley and the Sierra Nevada foothills and is thought to date 8,000 to 10,000 B.P.

Approximately 8,000 years ago, many California cultures shifted the main focus of their subsistence strategies from hunting to seed gathering, as evidenced by the increase in food-grinding implements found in archeological sites dating to this period. Recent studies suggest that this cultural pattern is more widespread than originally described and is, in fact, found throughout the study area. Radiocarbon dates associated with this time period vary between 8,000 and 2,000 B.P., but cluster in the 6,000 to 4,000 B.P. range (Basgall and True, 1985).

Cultural patterns, as reflected in the archeological record and, particularly, specialized subsistence practices, became better defined within the last 3,000 years. The archeological record becomes more complex as specialized adaptations to locally available resources were developed and populations expanded. Many sites dated to this time period contain mortars and pestles or are associated with bedrock mortars, implying that the occupants exploited acorns intensively. The range of subsistence resources increased and exchange systems expanded significantly from the previous period. Along the coast and in the Central Valley, archeological evidence of social stratification and craft specialization is indicated by well-made artifacts, such as charmstones and beads, which were often found with burials.

Of the various types of prehistoric sites that may be affected by the CVPIA alternatives, habitation sites, especially those sites containing midden soils, are most susceptible to damage. Soils containing middens tend to be loose and easily eroded by wave action or the movement of water across a site. Midden soils often retain identifiable remnants of faunal material (e.g., bone or shell), possibly human burials, and occasionally perishable artifacts (e.g., basketry remains) that, if exposed, would deteriorate due to wet/dry cycling. Generally the scientific value of habitation sites lies in the information on prehistoric life ways that can be extracted. Any activity that moves, removes, or destroys aspects of a site will compromise that information. Habitation sites are highly susceptible to intentional vandalism by artifact collectors and unintentional damage by off-highway vehicle (OHV) users.

Lithic scatters, strictly defined as those sites that contain only material manufactured from stone, constitute another site type commonly found in the study area. The greatest danger to these sites is from artifact collection. Further, erosional forces could remove artifacts from a site, and the submersion of obsidian artifacts could prevent the proper dating of objects by hydration-dating techniques.

Rock art sites containing petroglyphs, pictographs, and intaglios (artistic alignments of rocks) can be extremely vulnerable to changes in water level. Sites that may have been previously submerged under reservoirs and are exposed during drawdowns may suffer from wet/dry cycling, erosion due to wave action, and vandalism.

Bedrock mortars (used for grinding vegetal materials) are the prehistoric resource type least susceptible to damage through hydrologic mechanisms. However, midden, often associated with bedrock mortars, would be vulnerable to hydrologic impacts.

HISTORIC RESOURCES

Historic resources (including archeological resources, structures, and buildings) within the study area include sites associated with early historic settlement, mining (hardrock and placer), agriculture (farming and ranching), transportation (railroads and roads), oil exploration, and logging.

Historic structures (including buildings, windmills, mining winches, and bridges) or their remains are highly susceptible to water level changes. The exposure of structures in reservoirs previously covered by inundation could subject them to erosion (especially if they are in a wave zone), wet/dry cycling, and vandalism.

Wooden portions of ditches and flumes (often associated with agriculture, mining, and logging) are highly susceptible to wet/dry cycling and erosion. Earthen ditches are affected principally by water level changes, especially wave action.

Debris scatters, which can be found within any type of historic site, are extremely vulnerable to water level changes. Erosion can completely remove a debris scatter, and wet/dry cycling can accelerate the decomposition of metal, wood, and leather artifacts. Debris scatter exposed by receding waters is very susceptible to vandalism.

Historic stone resources such as tailings piles (remnants from mining) and rock walls (often associated with ranching) are less prone to water damage unless these resources are left in a wave zone by changing water levels.

Table III-11 shows the number of historic-period resources in the PEIS study area that are listed in the National Register of Historic Places, California Historic Landmarks, California Inventory of Historic Resources, and California Points of Interest.

TABLE III-11

HISTORIC RESOURCES IN THE PEIS STUDY AREA

Region	Number of Properties in the National Register of Historic Places	Number of California Historic Landmarks	Number of Sites in California Inventory of Historic Resources	Number of California Points of Historical Interest
Sacramento River	294	224	452	196
San Joaquin River	156	111	255	50
Tulare Lake	44	36	49	6
North Coast	139	56	115	17
Central Coast	10	5	6	2
San Francisco Bay	407	176	724	156

ETHNOGRAPHY

The study area encompasses lands occupied by more than 40 distinct Native American cultural groups. Although most California tribes shared similar elements of social organization and material culture, linguistic affiliation and territorial boundaries primarily distinguish them from each other. Prior to European settlement of California, an estimated 310,000 native Californians spoke dialects of as many as 80 mutually unintelligible languages representing six major North American stocks (Cook, 1976, 1978; Shipley, 1978).

All native Californians followed a basic hunter-gatherer lifestyle, subsisting through a seasonal round of plant collecting, hunting, and fishing. Then, as now, the environment was bountiful and the products of the various regions, such as shore, mountain, and desert, were often widely traded. Reliance on particular resources varied with location and season. Archeological evidence indicates a general evolution over time from subsistence strategies that were based primarily on hunting large game to a broad-based economy that placed greater emphasis on diversity.

AIR QUALITY

The California Air Resources Board (ARB)-designated air basins are distinct regions within the state of California that consist of similar meteorological and topographical conditions (California ARB, 1975). The following air basins, shown in Figure III-19, generally correspond to the Draft PEIS study area regions in the Central Valley.

Sacramento River Region:
- Sacramento Valley Air Basin
- San Francisco Bay Area Air Basin
- Mountain Counties Air Basin

San Joaquin River Region:
- San Joaquin Valley Air Basin
- Mountain Counties Air Basin

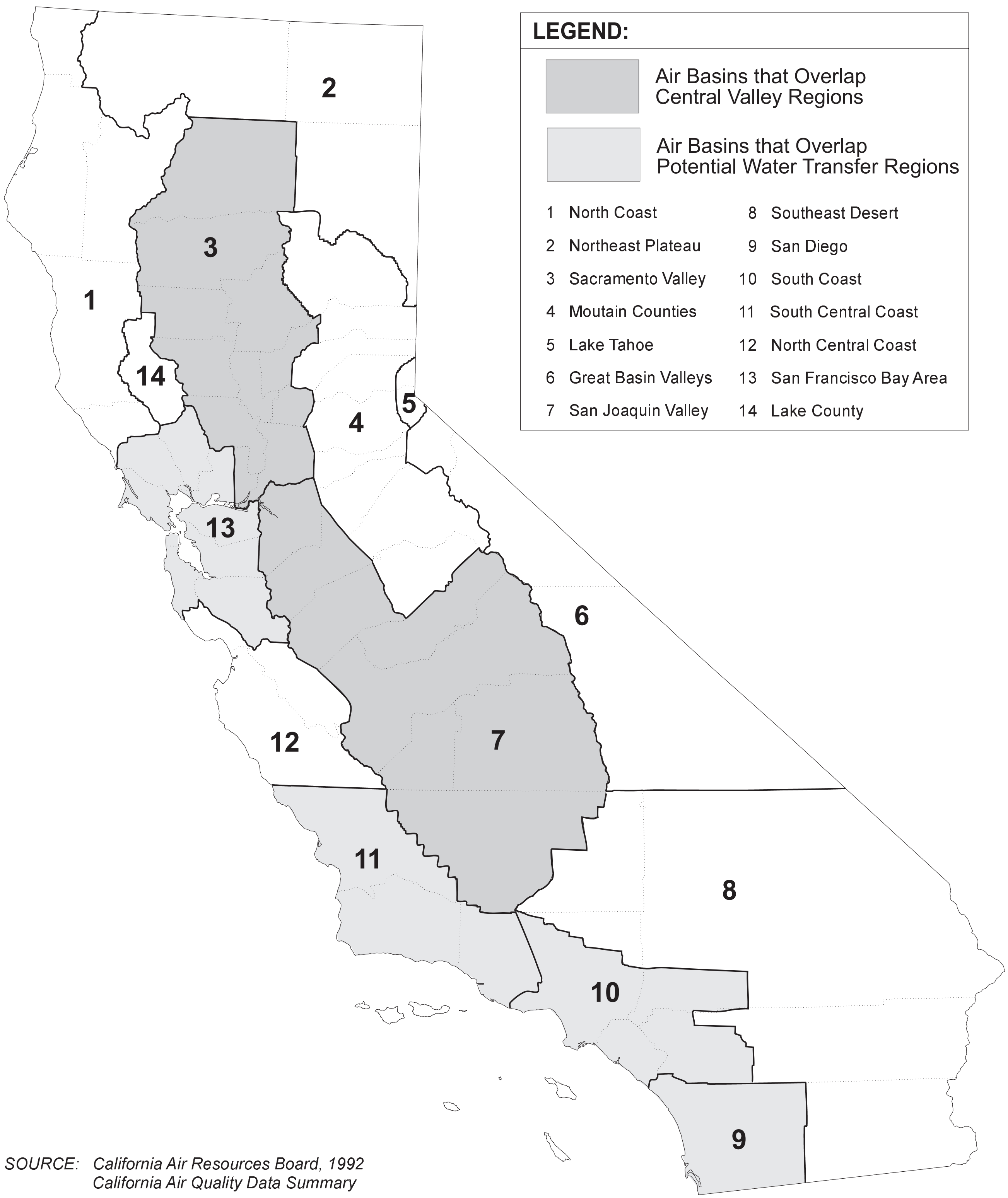
Tulare Lake Region:
- San Joaquin Valley Air Basin

Most of the air pollutants in the study area may be associated with either urban or agricultural land uses. Pollutants commonly associated with agricultural land uses include particulate matter (PM) less than 10 microns (PM_{10}), carbon monoxide (CO), nitrogen oxides (NO_X), and ozone (O_3) precursors. No clear relationship exists between agricultural acres and the occurrence or resulting concentrations of O_3 and PM_{10} in the atmosphere. Several variables other than land uses can affect air quality conditions, and these variables may change over time.

The air quality of the Northern Sacramento Valley Air Basin is currently designated as nonattainment with respect to national and state O_3 and PM_{10} standards. The Chico urban area is designated as nonattainment for national and state CO standards (California ARB, 1996). The air quality of the Southern Sacramento Valley Air Basin is designated as nonattainment with respect to national and state O_3 standards. Sacramento County is designated as nonattainment with respect to both national and state PM_{10} standards; whereas, Placer, Solano, and Yolo counties are nonattainment with respect to the state PM_{10} standards only (California ARB, 1996).

The San Joaquin Valley Air Basin is designated as nonattainment with respect to the national and state O_3 and PM_{10} standards, and the urban areas of Fresno, Modesto, and Stockton are designated as nonattainment for national and state CO standards.

The Mountain Counties Air Basin is directly affected by the upward currents (east-northeasterly and southerly) from the Sacramento Valley and Bay Area air basins (ARB, 1984). The transport contribution from these regions is significant, as upwind air basins have independently caused exceedences of the state O_3 standard in the Mountain Counties Air Basin.



SOURCE: California Air Resources Board, 1992
California Air Quality Data Summary

FIGURE III-19

CALIFORNIA AIR BASINS

SOILS

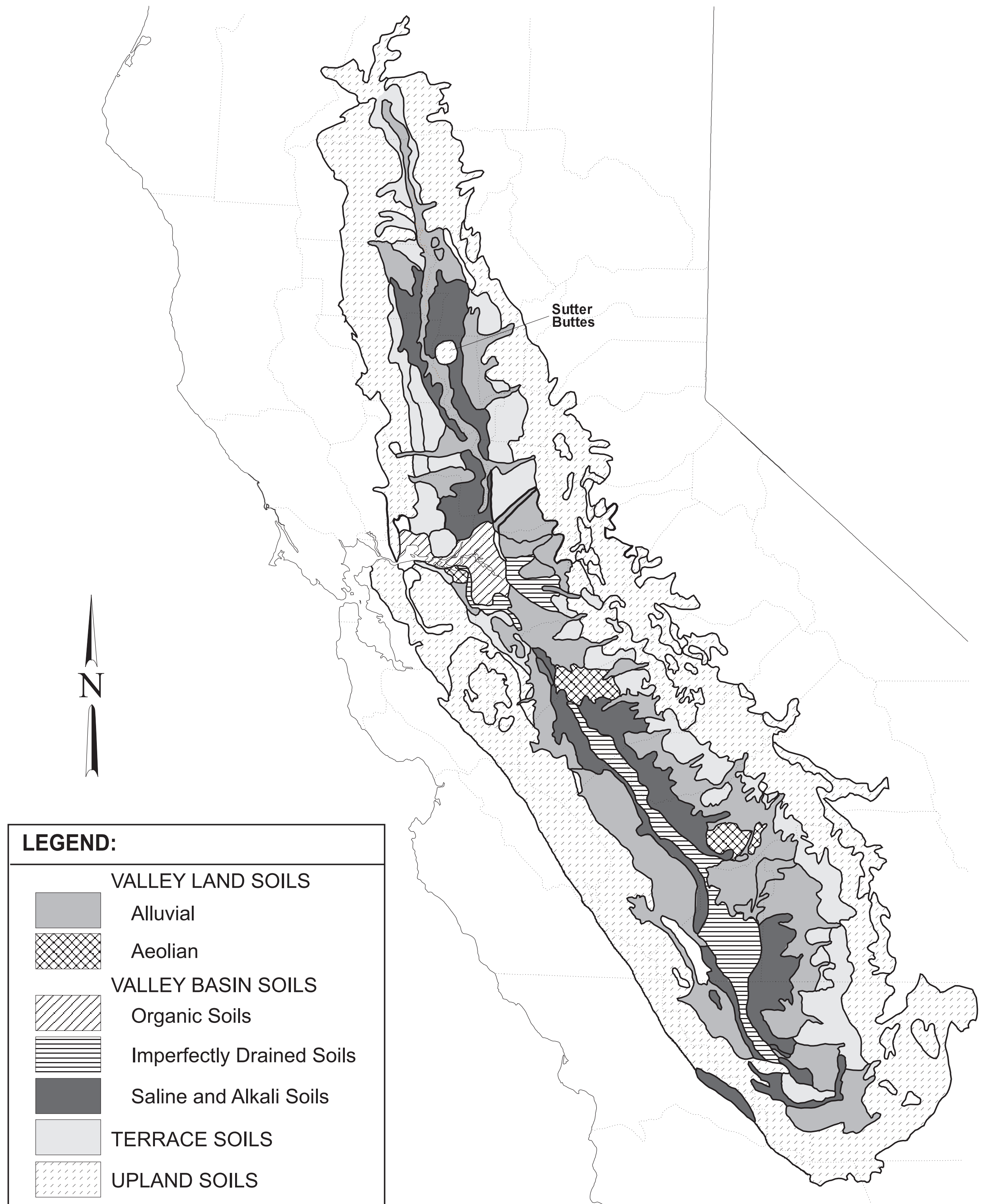
The soils of the Central Valley are divided into four physiographic groups: valley land soils, valley basin soils, terrace soils, and upland soils. As shown in Figure III-20, valley land and valley basin land soils occupy most of the floor of the Central Valley. Valley land soils consist of deep alluvial and aeolian soils that make up some of the best agricultural land in the state. Areas above the Central Valley floor consist of terrace and upland soils. Overall, these soils are not as productive as the valley land and valley basin land soils. Without irrigation, terrace and upland soils are primarily used for grazing and timberland; with irrigation, additional crops can be grown.

Drainage and soil salinity problems have persisted in the San Joaquin Valley. A 1984 study (Backlund and Hoppes) estimated that about 2.4 million of the 7.5 million acres of irrigated cropland in the Central Valley were salt-affected. These saline soils generally exist in the valley trough and along the edges on both sides of the San Joaquin Valley. By the year 2000, it is projected that up to 918,000 acres of farmland in the San Joaquin Valley will be affected by a high water table existing less than 5 feet from the ground surface (1990 San Joaquin Valley Drainage Program Management Plan). In addition to drainage, problems associated with upstream aggregate mining have been identified, and have historically occurred in the Central Valley with the accumulation of metals (particularly selenium) that have been leached from natural deposits through the application of irrigation water.

Soil selenium is primarily a concern on the west side of the San Joaquin Valley. When the soils in this area are irrigated, selenium, other salts, and trace elements dissolve and leach into the shallow groundwater. Soils derived from the Sierra Nevada on the east side of the valley are less salty and contain much less selenium. Over the past 30 to 40 years of irrigation, soluble selenium has been leached from the soils into shallow groundwater.

In areas with high selenium concentrations, selenium leached from the soils enters the return flows and subsurface drainage flows. Irrigation of these soils, mobilizes selenium, facilitating its movement into shallow groundwater that is retained in poorly drained soils or mechanically drained soils. In the absence of adequate drainage facilities, leaching cannot fully remove the salts from these soils because water cannot percolate beyond a clay lens under the shallow groundwater aquifer. To maintain agricultural production, drainage from these soils must be removed from the area. Reclamation has initiated the San Joaquin Basin Drainage Program to reduce the drainage problem.

Aggregate removal, or mining, occurs within many streams in the western foothills of the Sierra Nevada, along the coastal streams, and in the coastal dunes. In addition, unconsolidated gravels and slates are mined in the lower Sierra Nevada foothills. Problems commonly associated with instream gravel mining include increased sediments in the river and the removal of soils with nutrients and vegetation.



SOURCE: University of California, 1980

FIGURE III-20

SOIL TYPES IN THE CENTRAL VALLEY

VISUAL RESOURCES

The visual landscape of the Sacramento River and San Joaquin River regions has changed considerably since before World War II. In the 1940s, the valley was largely open grasslands with scattered expanses of oak woodland. Wetlands, vernal pools, and riparian corridors added visual variety to the landscape. Settlement was sparse, with small communities, located primarily along the rivers, and scattered rural ranches. A significantly smaller area of the landscape was irrigated and few of the rivers were regulated. Much of the view opportunity was limited to the road and railroad corridors.

After the population influx following World War II, rapid agricultural development and the growth of communities changed the visual landscape substantially and relatively quickly. Much of the grassland was replaced by irrigated cropland, rice fields, and orchards. Most of the wetlands, vernal pools, and riparian corridors were eliminated.

Construction of dams and reservoirs substantially altered the visual character of valleys in which reservoirs were constructed. The reservoirs added visual variety, because large water bodies are widely perceived as features of high visual interest, but changed the visual character provided by free-flowing streams. CVP canals also added visual variety to the landscape by their form and water feature qualities.

The Delta landscape once consisted of a vast system of wetlands and river channels. The construction of levees, beginning in the 1850s, dramatically changed the visual. The establishment of settlements in the Delta began in the mid-1800s. Continued urban growth has substantially altered the visual aspect of the Delta margins.

Wild and Scenic Rivers or designated river segments located within the PEIS study area include at least portions of the Klamath, the Trinity, the North Fork American, the Tuolumne, the Merced, and the Lower American rivers, as well as various tributaries.

Scenic highways are roads designated as scenic by the State of California or local agencies and are recognized as having exceptional scenic qualities or affording panoramic vistas. Officially designated state scenic highways (Caltrans, 1992), including state routes and interstates within the study area, include SR 151 immediately downstream of Lake Shasta; SR 160 in Sacramento County between the southern county line and I-5; I-5 between I-205 (San Joaquin County) and just south of SR 152 in Merced County (includes views of the Delta-Mendota Canal); and SR 152 from I-5 to the Madera County line (passes San Luis Reservoir).

CHAPTER IV

ENVIRONMENTAL CONSEQUENCES

Chapter IV

ENVIRONMENTAL CONSEQUENCES

This chapter summarizes environmental consequences associated with the alternatives considered in the PEIS for the issue areas described under Affected Environment. Impact assessments are presented for four Alternatives and 15 Supplemental Analyses. As described in Chapter II, the Alternatives are based on relatively specific assumptions for multiple implementation methods addressing CVP water system operations, CVP water pricing, and fish and wildlife habitat improvements as compared to the No-Action Alternative. The Supplemental Analyses evaluate the differences between more general assumptions for less defined implementation methods. The Supplemental Analyses are compared to Alternatives 1, 2, 3, or 4. Six of the Supplemental Analyses evaluate water transfer opportunities under CVPIA provisions. Tables at the beginning of the major issue area sections present a summary of the assumptions and results of the impact assessment.

The assessment of environmental consequences for many of the resources evaluated in the PEIS was supported with the use of computer-based analytical tools. Prior to the evaluation of alternatives, a set of analytical tools was selected through a screening process. Over 200 analytical tools were reviewed to identify a set of tools that would generally provide similar geographic coverage and level of analytical detail to support the programmatic analysis required for the PEIS. The analytical tool or tools used and associated analytical methodology is described for each issue area. Environmental consequences associated with each of the alternatives considered in the PEIS are described for the following resources and issues.

- ♦ Surface Water Supplies and Facilities Operations
- ♦ Groundwater
- ♦ Fishery Resources
- ♦ Agricultural Land Use and Economics
- ♦ Municipal and Industrial Land Use and Demographics
- ♦ Vegetation and Wildlife Resources
- ♦ Central Valley Project Power Resources
- ♦ Recreation
- ♦ Fish, Wildlife, and Recreation Economics
- ♦ Regional Economics
- ♦ Municipal and Industrial Water Use and Costs
- ♦ The Delta as a Source of Drinking Water
- ♦ Mosquitos
- ♦ Social Conditions
- ♦ Cultural Resources
- ♦ Indian Trust Assets
- ♦ Air Quality
- ♦ Soils
- ♦ Visual Resources

SURFACE WATER SUPPLIES AND FACILITIES OPERATIONS

This section summarizes potential changes to the operation of CVP facilities, river flow regimes, and CVP water supply deliveries that would result from the implementation of the alternatives considered in the PEIS. The PEIS alternatives include a range of component CVPIA actions that would affect facility and river operations, as well as the availability of water supplies to CVP water users. These component CVPIA actions include the dedication of CVP water supplies to improve anadromous fish habitat, the delivery of firm Level 2 refuge water supplies, and releases from Lewiston Dam to provide increased instream Trinity River flows, as discussed in Attachment G. Additional actions include the retirement of land pursuant to the San Joaquin Valley Drainage Plan, and the acquisition of water from willing sellers for delivery to wildlife refuges, increased instream flows, and increased Delta outflow. A summary of the assumptions associated with each of the Alternatives and Supplemental Analyses for the surface water analyses is presented in Table IV-1.

The analysis focuses primarily on the re-operation of surface water supply facilities, and describes changes in reservoir storage conditions, reservoir releases, resulting downstream river flows, deliveries of surface water pursuant to CVP and SWP contracts, and water acquisition quantities. A summary of the surface water impact assessment for the Alternatives and Supplemental Analyses is presented in Table IV-2.

IMPACT ASSESSMENT METHODOLOGY

The impact assessment methodology used to support the analysis presented in this chapter is based on the use of surface water, groundwater, and agricultural economics computer model analyses. Model simulations were conducted at a planning level, in accordance with the programmatic nature of the overall PEIS analysis. The Project Simulation Model (PROSIM) and the San Joaquin Area Simulation Model (SANJASM) were used to evaluate the potential to re-operate system reservoirs to attempt to meet CVPIA objectives, and assess the resulting impacts to CVP water supply deliveries.

The model simulations for the PEIS analyses were conducted using the historical hydrology for the period 1922 through 1990, adjusted to be representative of a projected 2022 level of development. The projected land-use conditions were based on information developed for DWR Draft Bulletin 160-93 (DWR, 1993) and are assumed to be fixed over the simulation period. The historical hydrology during the 1922 through 1990 period is considered to be representative of the range of hydrologic conditions that may be expected under future CVP operations.

The models are based on a monthly time step and use general operations criteria representative of CVP operations. The simulations do not take into account daily or weekly changes in operations or river travel time. A discussion of the specific approach, model modifications, and data development required to apply these analytical tools to the analysis of the alternatives in the PEIS is provided in the PROSIM and SANJASM Methodology/Modeling Technical Appendices.

Subsequent to the completion of the surface water modeling conducted for the PEIS, Reclamation and the Service have discovered an inconsistency in the PROSIM input hydrology that may cause the model to over estimate the potential flexibility of CVP operations. As a

TABLE IV-1

SUMMARY OF ASSUMPTIONS FOR SURFACE WATER SUPPLIES AND FACILITIES OPERATIONS

Alternative or Supplemental Analysis	Assumptions Specific to the Alternative or Supplemental Analysis
Assumptions Common to All Alternatives or Supplemental Analyses	
	Projected 2020 level water demands based on water rights, CVP contract amounts with limitations due to environmental documentation, and DWR Bulletin 160-93 projections, as described in Chapter II. Continued CVP operations under CVP-Operations Criteria and Plan, October 1992. Continued CVP and SWP operations under Bay-Delta Plan Accord, SWRCB D-1422, and Winter Run Chinook Salmon, and Delta Smelt Biological Opinions as amended in 1995. Shasta Temperature Control Device in operation. SWP operations per Monterey Agreement.
No-Action Alternative	Common assumptions only.
1	No-Action Alternative assumptions plus Implementation of Reoperation and (b)(2) water management for Bay-Delta Plan Accord component and additional operations on Sacramento River, American River, Stanislaus River, and Clear Creek. Water accounting for (b)(2) water use based on changes in deliveries to CVP Water Service Contractors. Firm Level 2 refuge supplies per 1989 Refuge Water Supply Study. Includes a 25 percent shortage per the Shasta Index. Improve flows for passage on Spring run streams and major Sacramento River Tributaries Increased Trinity River instream fishery flows.
1a	Same as Alternative 1 plus Implementation of preliminary (b)(2) Water Management actions in the Delta in addition to Bay-Delta Plan Accord.
1b	Same as Alternative 1 plus Operation of fish barrier at head of Old River and on Georgiana Slough.
1c	Same as Alternative 1 plus Several scenarios considered for use of CVP water not delivered.

TABLE IV-1. CONTINUED

Alternative or Supplemental Analysis	Assumptions Specific to the Alternative or Supplemental Analysis
1d	Same as Alternative 1 plus Delivery of full Level 2 refuge water supplies in all years without shortage.
1e	Same as Alternative 1 plus Transfer opportunities limited by available facilities capacity. Transfer of consumptive use or irrecoverable loss only.
1f	Same as Supplemental Analysis 1e.
1g	Same as Alternative 1.
1h	Same as Alternative 1.
1i	Same as Alternative 1 plus Operation of Red Bluff Diversion Dam gates has no impact on ability to divert water into Tehama Colusa Canal.
2	Same as Alternative 1 plus Acquire Level 4 refuge water supplies. Acquire up to 170,000 af/yr (total) on Stanislaus, Tuolumne, and Merced rivers, and Butte Creek for instream and Delta fishery needs.
2a	Same as Alternative 2 plus Operation of fish barriers at the head of the Old River and on Georgiana Slough.
2b	Same as Alternative 2 plus Transfer opportunities limited by available facilities capacity. Transfer of consumptive use or irrecoverable loss only.
2c	Same as Supplemental Analyses 2b.
2d	Same as Alternative 2.
3	Same as Alternative 1 plus Acquire Level 4 refuge water supplies. Acquire up to 800,000 af/yr (total) on Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba Rivers for instream fishery needs. Acquired water may be exported from Delta if other conditions allow.

TABLE IV-1. CONTINUED

Alternative or Supplemental Analysis	Assumptions Specific to the Alternative or Supplemental Analysis
3a	Same as Alternative 3 plus Transfer opportunities limited by available facilities capacity. Transfer of consumptive use or irrecoverable loss only.
4	Same as Alternative 1 plus Implement (b)(2) Water Management actions in the Delta in addition to Bay-Delta Plan Accord. Acquire Level 4 refuge water supplies. Acquire up to 800,000 af/yr (total) on Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba Rivers for instream and Delta fishery needs. Acquired water may not be exported by Delta pumping facilities.
4a	Same as Alternative 4 plus Transfer opportunities limited by available facilities capacity. Transfer of consumptive use or irrecoverable loss only.

TABLE IV-2

SUMMARY OF IMPACT ASSESSMENT FOR SURFACE WATER SUPPLIES AND FACILITIES OPERATIONS

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	Reservoir operations, river flows, and Delta outflow are generally as described under affected environment, including Bay-Delta Plan Accord with changes in operations due to increased water rights and M&I demands at a 2020 level of development. Average annual refuge deliveries of about 335,000 acre-feet from historical sources. Average annual CVP deliveries of about 5,770,000 acre-feet. Average annual SWP deliveries of about 3,330,000 acre-feet.
	Changes Compared to the No-Action Alternative
1	Increase and stabilize fall/winter Shasta Lake releases per AFRP flow targets (see Attachment G). Average annual Shasta September carry over storage reduced by 60,000 acre-feet. Increase and stabilize fall/winter Folsom Lake releases per AFRP flow targets, and meet spring pulse flows as possible. Increase average annual Folsom Lake September carry over storage by 80,000 acre-feet toward AFRP targets. Increase Clear Creek flows to meet AFRP flow targets in all but critically dry years. Provide Stanislaus spring pulse flows in April through June in all but critical dry years. Average annual New Melones Reservoir September carry over storage decreases by 100,000 acre-feet. Trinity River flows increase from 50,000 to 410,000 acre-feet per year depending on water year type. Average annual Claire Engle Lake September carry over storage decreases by 200,000 acre-feet. Average Annual Trinity River Basin diversions to the Sacramento River decrease by 180,000 acre-feet. Average annual Delta outflows reduced by 60,000 acre-feet due primarily to the reduction in diversions from the Trinity River Basin. CVP provides additional 233,000 acre-feet in average annual refuge deliveries to provide Level 2 refuge water supplies. Replaced several intermittent water supplies. Reduction of 470,000 acre-feet in average annual CVP deliveries due to instream (b)(2) Water Management component, increased Level 2 refuge deliveries, and increased Trinity River instream flows. Potential increase of 100,000 acre-feet in average annual SWP deliveries due to incidental benefit as a result of the actions in Alternative 1.

TABLE IV-2. CONTINUED

	Changes Compared to Alternative 1
1a	North of Delta reservoir and river operations are similar to Alternative 1, plus Average annual Delta outflows increased by 140,000 acre-feet, due to use of (b)(2) Water Management for Delta components. Reduced CVP operational flexibility to fill San Luis Reservoir in the fall and supplement San Luis Reservoir releases in April and May. Average annual refuge deliveries are the same as Alternative 1. Reduction of 100,000 acre-feet in average annual CVP deliveries due to use of (b)(2) Water Management actions in addition to Bay-Delta Plan Accord. Decrease of 40,000 acre-feet in average annual SWP deliveries.
1b	Average annual conditions similar to Alternative 1, plus Potential need for additional CVP and SWP reservoir releases during dry years to offset potentially higher salinity water entering the Delta due to increased reverse flows in the lower San Joaquin River west of Jersey Point.
1c	Reduction of 570,000 acre-feet in CVP average annual deliveries due to increased water pricing. Use of non-delivered CVP water not determined at this time. Options include re-allocation to other CVP contractors, transfer by CVP contractors with reduced demand, or use for fish and wildlife purposes.
1d	Average annual conditions are similar to Alternative 1, plus Increase of 30,000 acre-feet in dry period (1928-1934) average annual refuge deliveries. Reduction of 50,000 acre-feet in dry period (1928-1934) average annual CVP deliveries due to full water deliveries to refuges in critical dry years. Dry period (1928-1934) average annual SWP deliveries same as Alternative 1.
1e	Conditions are similar to Alternative 1, except in dry years when site specific transfer operations may affect surface water operations. Further site specific analyses will be required.
1f	Conditions are similar to Supplemental Analysis 1e.
1g	Conditions are similar to Alternative 1.
1h	Conditions are the same as Alternative 1.
1i	Conditions are the same as Alternative 1.

TABLE IV-2. CONTINUED

	Changes Compared to the No-Action Alternative
2	CVP reservoir operations and river flows as a result of (b)(2) Water Management are similar to Alternative 1, plus Increase April through June stream flows on the Stanislaus River due to acquisition of up to 60,000 acre-feet per year from willing sellers. Increase April through June stream flows on the Tuolumne River due to acquisition of up to 60,000 acre-feet per year from willing sellers. Increase April through June stream flows on the Merced River due to acquisition of up to 50,000 acre-feet per year from willing sellers. Acquired water was not exported from the Delta, resulting in an 80,000 acre-feet average annual increase in Delta outflow. Increase of 370,000 acre-feet in average annual refuge deliveries due to the CVP providing Level 2 deliveries and acquisition of additional Level 4 refuge water supplies. Reduction of 590,000 acre-feet in average annual CVP deliveries due to actions described under Alternative 1, plus assumed purchase of about 120,000 acre-feet per year for Level 4 refuge supplies from Sacramento River Water Rights and San Joaquin River Exchange Contractors. Potential increase of 80,000 acre-feet in average annual SWP deliveries due to the actions described under Alternative 1, plus assumed purchase of about 20,000 acre-feet per year for Level 4 refuge supplies from SWP willing sellers south of the Delta.
	Changes Compared to Alternative 2
2a	Average annual conditions are similar to Alternative 2, plus Potential need for additional CVP and SWP reservoir releases during dry years to offset potentially higher salinity water entering the Delta due to increased reverse flows in the lower San Joaquin River west of Jersey Point.
2b	Conditions are similar to Alternative 2, except in dry years when site specific transfer operations may affect surface water operations. Further site specific analyses will be required.
2c	Conditions are similar to Supplemental Analysis 2b.
2d	Reduction of CVP average annual deliveries due to increased water pricing are similar to Supplemental Analysis 1c. Use of non-delivered CVP water not determined at this time. Options include re-allocation to other CVP contractors, transfer by CVP contractors with reduced demand, or use for fish and wildlife purposes.

TABLE IV-2. CONTINUED

	Changes Compared to the No-Action Alternative
3	North of Delta CVP reservoir operations and river flows as a result of (b)(2) Water Management are similar to Alternative 1. Increase stream flows on the Stanislaus River in fall and winter months with pulse flows in April through June, due to acquisition of up to 200,000 acre-feet of water per year from willing sellers. Generally increase stream flows on the Tuolumne River in most months with pulse flows in April through June, due to acquisition of up to 200,000 acre-feet of water per year from willing sellers. Increase stream flows on the Merced River in all months with pulse flows in April through June, due to acquisition of up to 200,000 acre-feet of water per year from willing sellers. Increase winter and spring stream flows and decrease summer and fall flows on the Calaveras River, due to acquisition of up to 30,000 acre-feet of water per year from willing sellers. Increase fall through spring stream flows on the Mokelumne River due to acquisition of up to 70,000 acre-feet of water per year from willing sellers. Increase spring, summer, and fall stream flows on the Yuba River due to acquisition of up to 100,000 acre-feet of water per year from willing sellers. Increase flows on the San Joaquin River at Vernalis in nearly all months with pulse flows in April and May, due to upstream water acquisition from willing sellers. Average annual Delta outflows increase by about 200,000 acre-feet due to upstream water acquisition. Refuge deliveries are the same as Alternative 2. Reduction of 390,000 acre-feet in average annual CVP deliveries due to actions described under Alternative 2, plus ability to export acquired water. Assumed purchase of about 120,000 acre-feet per year for Level 4 refuge supplies from Sacramento River Water Rights and San Joaquin River Exchange Contractors. Potential increase of 270,000 acre-feet in average annual SWP deliveries due to ability to export acquired water. Assumed purchase of about 20,000 acre-feet per year for Level 4 refuge supplies from SWP willing sellers south of the Delta.
3a	Conditions are similar to Alternative 3, except in dry years when site specific transfer operations may affect surface water operations. Further site specific analyses will be required.

	Changes Compared to the No-Action Alternative
4	North of Delta CVP reservoir operations and river flows as a result of (b)(2) Water Management are similar to Alternative 1. Tracy Pumping Plant exports are reduced due to (b)(2) actions in the Delta. The increases in stream flows due to acquired water are the same as Alternative 3. Acquired water was not exported from the Delta, resulting in an 780,000 acre-feet average annual increase in Delta outflow. Refuge deliveries are the same as Alternative 2. Reduction of 620,000 acre-feet in average annual CVP deliveries due to actions in Alternative 3 plus use of (b)(2) Water Management for Delta components. Assumed purchase of about 120,000 acre-feet per year for Level 4 refuge supplies from Sacramento River Water Rights and San Joaquin River Exchange Contractors. Average annual SWP deliveries are similar to the No-Action Alternative. Assumed purchase of about 20,000 acre-feet per year for Level 4 refuge supplies from SWP willing sellers south of the Delta.
4a	Conditions are similar to Alternative 4, except in dry years when site specific transfer operations may affect surface water operations. Further site specific analyses will be required.

result, current PROSIM simulations may under estimate the use of CVP storage and conversely over estimate water deliveries in some critical dry years. This inconsistency affects all of the PEIS simulations and has a minimal impact on the relative differences between the simulations. Therefore, there is little affect on the PEIS surface water impact assessment, due to the general programmatic nature of the PEIS analyses and the comparative use of the PROSIM simulation results. However, this reduction in operational flexibility in the No-Action Alternative may make incremental reductions in water availability in the other alternatives more difficult to accommodate operationally.

NO-ACTION ALTERNATIVE

The No-Action Alternative provides a base condition for comparison of PEIS alternatives analyses, and represents assumed future conditions at a projected 2022 level of development without implementation of CVPIA. As described in Chapter II of the PEIS, the No-Action Alternative assumes that CVP facilities would be operated in accordance with operating rules and criteria that were in effect or being developed as of October 1992 when the CVPIA was adopted.

The No-Action Alternative assumes the continued implementation of the Bay-Delta Plan Accord and WR-95-01 because the process to develop the new Delta water quality standards was being implemented at the time CVPIA was enacted. Similarly, the No-Action Alternative includes the 1993 Winter-Run Chinook Salmon Biological Opinion as amended in 1995 by NMFS, because Reclamation had begun to operate to preliminary provisions of the 1993 biological opinion in October 1992. As described in the Affected Environment, requirements of the 1995 Delta Smelt

Biological Opinion are fulfilled through meeting the operations requirements of the Bay-Delta Plan Accord, WR-95-01, and 1995 amendments to the Winter-Run Chinook Salmon Biological Opinion. On the Stanislaus River, it is assumed that the interim drought management actions implemented during the drought period from 1987 through 1992 do not constitute a long-term operational approach, and therefore could not be anticipated to represent operational conditions in the year 2022. Descriptions of the Bay-Delta Water Quality Control Plan, the Winter Run Biological Opinion, and the operations of New Melones Reservoir are provided in the description of the No-Action Alternative in Attachment G of the PEIS.

For the purposes of the PEIS No-Action Alternative, it is assumed that the COA, as described in Chapter II, would remain in place in the year 2022. The COA is the mechanism by which the CVP and SWP coordinate operations to meet Delta standards as defined by SWRCB Water Quality Control Plans. The current COA was developed based on the SWRCB D-1485 standards. Additional assumptions were required to adapt the COA to criteria included in the May 1995 Draft Water Quality Control Plan.

ALTERNATIVE 1

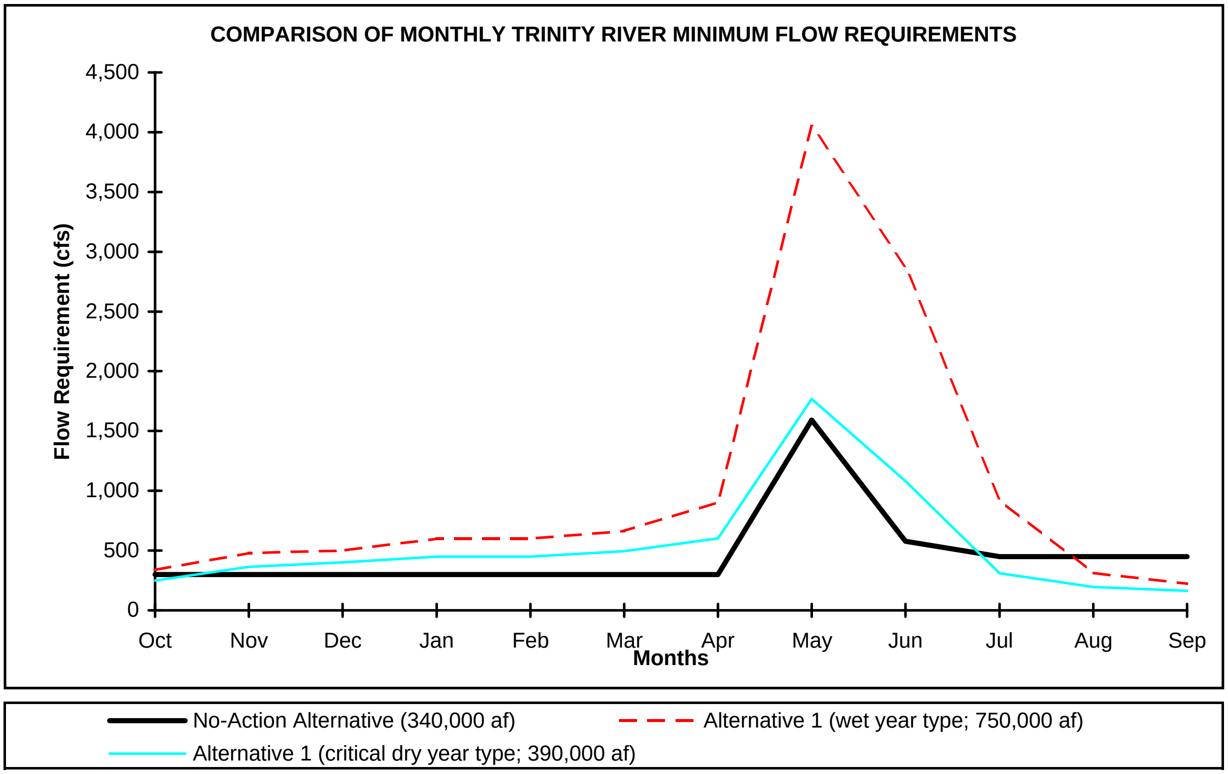
Water management provisions in Alternative 1 were developed to utilize two of the tools provided by CVPIA, Re-operation 3406(b)(1)(B) and 3406(b)(2) water management, toward meeting the target flows for chinook salmon and steelhead trout in the CVP-controlled streams. The term (b)(2) water management is used to indicate the integrated use of 3406(b)(1)(B) and 3406(b)(2) water use. As described in Chapter II, Alternative 1 also includes the use of CVP water to provide firm Level 2 water supplies to refuges, and the preliminary Trinity River instream fishery flow release pattern developed by the Service for the PEIS.

CVP Operations and Deliveries

This section provides a discussion of the potential changes to the operation of CVP facilities, river flow regimes, and CVP water deliveries that would result from implementation of the CVPIA actions integrated into Alternative 1. Friant Division operations under Alternative 1 would be similar to those under the No-Action Alternative.

CVP Operations

Trinity River Division. The major change specific to Trinity River Division operations in Alternative 1 is the increase in Trinity River instream fishery flows. Alternative 1 Trinity River flows range from 390,000 acre-feet in critical dry years to 750,000 acre-feet in wet years. Average flows down the Trinity River in Alternative 1 increase by 190,000 acre-feet per year as compared to the No-Action Alternative. Figure IV-1 shows a comparison of monthly Trinity River instream flow patterns as compared to the No-Action Alternative. CVP Trinity River diversions to Whiskeytown Lake are reduced by 180,000 acre-feet on an average annual basis to attempt to balance the net demands on Clair Engle Lake. Frequency distributions of the simulated annual diversions from the Trinity River Basin in the No-Action Alternative and Alternative 1 are presented in Figure IV-1. A schematic diagram of how to use a frequency distribution curve is presented in Attachment G. As shown in Figure IV-2, the increase in Trinity River minimum flow requirements in Alternative 1 reduces Clair Engle Lake average end-of-



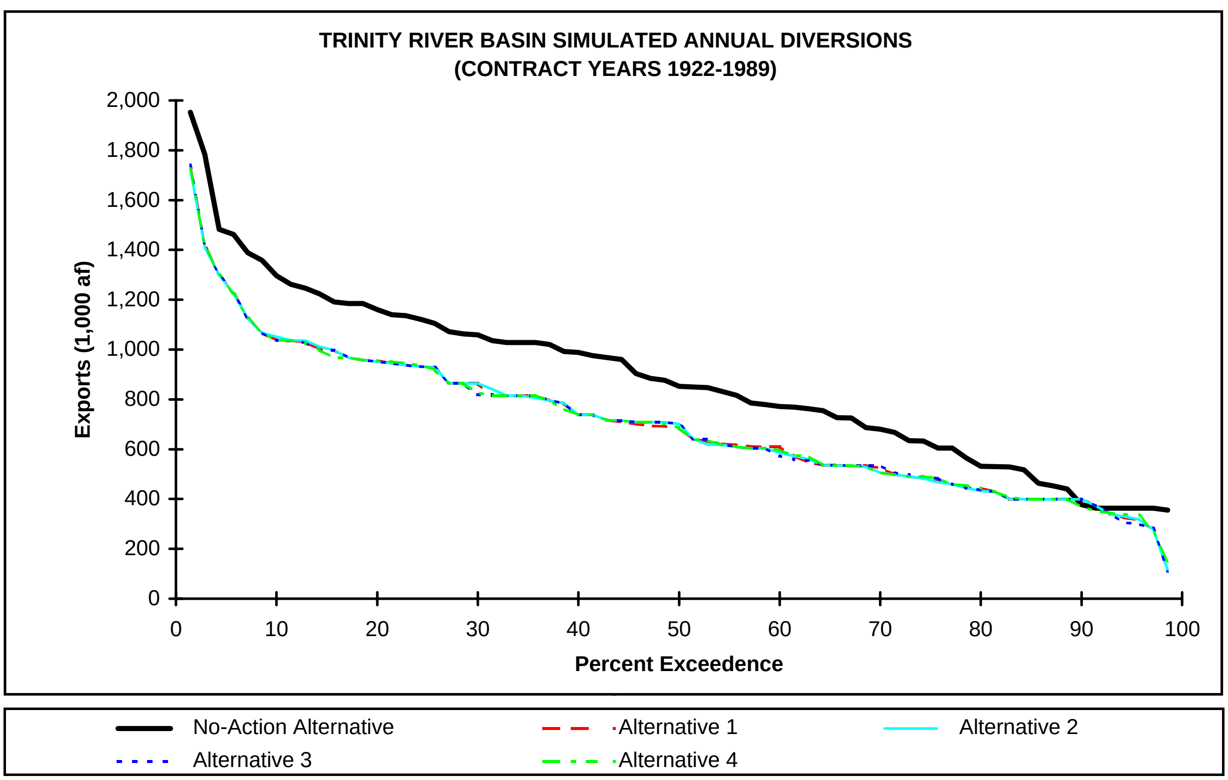


FIGURE IV-1
TRINITY RIVER MINIMUM FLOW REQUIREMENTS
AND SIMULATED ANNUAL EXPORTS

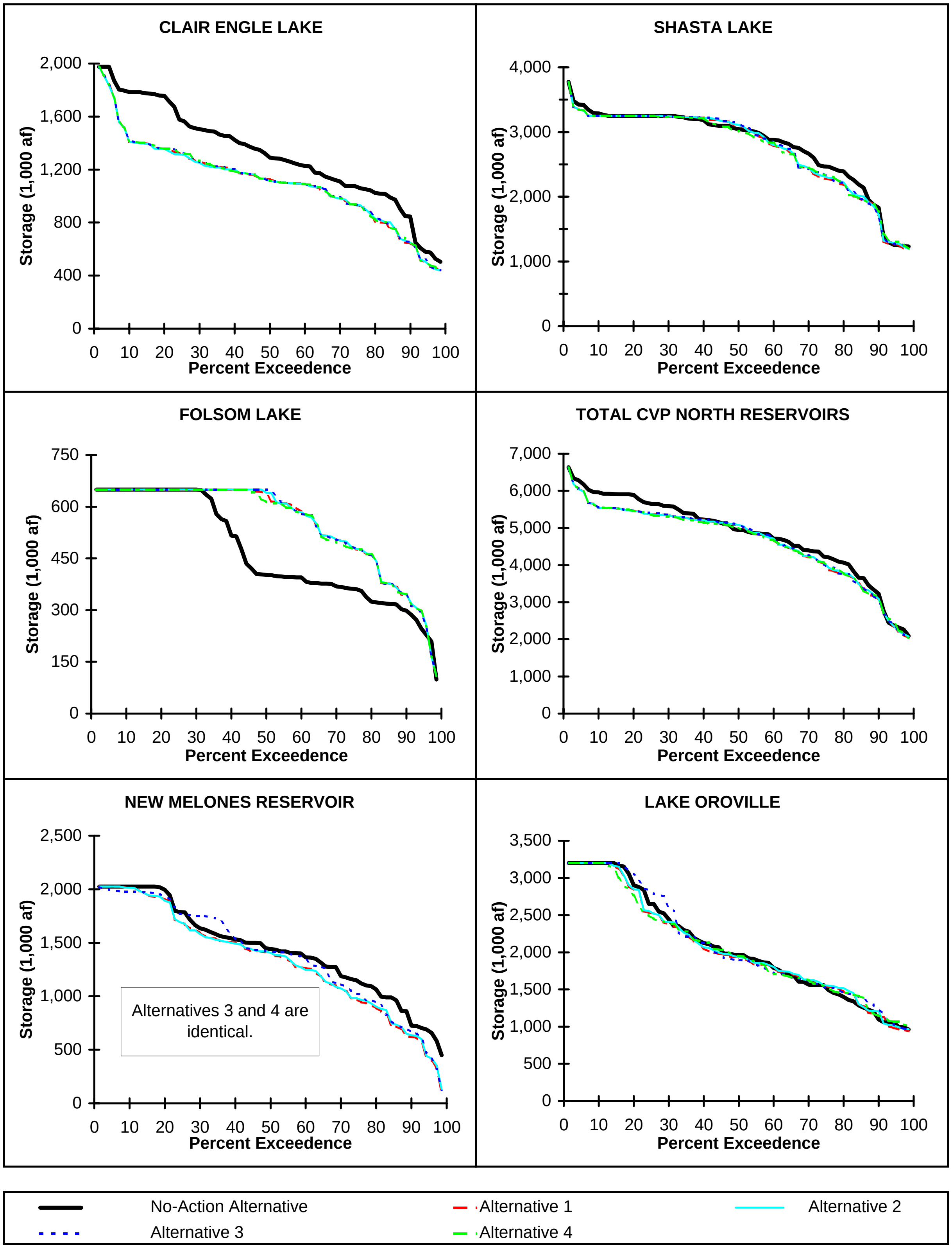


FIGURE IV-2

SIMULATED FREQUENCY OF END-OF-WATER YEAR STORAGE 1922-1990

water year storage by about 200,000 acre-feet as compared to the No-Action Alternative. The overall reduction in Clair Engle Lake storage is primarily due to a major increase in minimum flow requirements in wetter years, and the low refill potential of the lake.

Alternative 1 includes use of (b)(2) water on Clear Creek to attempt to meet the target flows. The target flows are achieved in all but critically dry years, when natural inflows to Whiskeytown Lake and diversions from the Trinity River Basin are not sufficient to maintain both the target flows and minimum storage levels in Clair Engle and Whiskeytown Lakes. Figure IV-3 shows the increase in simulated average monthly Clear Creek flows in Alternative 1 as compared to the No-Action Alternative. The increase in flow on Clear Creek would result in generally lower water temperatures as compared to the No-Action Alternative.

Shasta and Sacramento River Divisions. The Alternative 1 operations of the Shasta and Sacramento River Divisions are affected by the multiple changes to CVP operations associated with (b)(2) Water Management, the delivery of firm Level 2 refuge supplies, and the increase in Trinity River minimum flow requirements. This reduction in Trinity River Basin diversions to the Sacramento River requires increased releases from Shasta Lake during spring and summer months for Winter-Run Biological Opinion temperature requirements, downstream water rights, minimum navigational flow requirements, water service contractors, and Delta water quality requirements. During fall and winter months, Shasta releases are increased to meet (b)(2) flows, and supply water for export to San Luis Reservoir. The resulting decrease in Shasta Lake end-of-water year storage is shown in the comparison of frequency distributions for Alternative 1 and the No-Action Alternative in Figure IV- 2. In most dry and critical dry years, Shasta Lake releases are governed by water rights and fisheries objectives including the target flows, Winter Run Biological Opinion, and Delta water quality requirements.

Under the No-Action Alternative, simulated flows on the Sacramento River below Keswick Dam meet the flow targets in almost all months, except during some of the drier years. The reduced diversions from the Trinity River Basin under Alternative 1 require increased releases from Shasta Lake to meet the target flows, and reduces the operational flexibility to meet winter run temperature control requirements. This occurs because, although there are no target flows from May 1 through September 30, minimum Shasta Lake releases are still required during this period to maintain water temperatures in the Sacramento River for winter run. To the extent possible, releases from Shasta Dam are shifted from the spring and summer months to the fall and winter months to meet target flows, while maintaining summer temperature levels. The October through April Keswick target flows are based on October 1 storage in Shasta Lake and are therefore achieved in all months. A comparison of flows in the Sacramento River below Keswick Dam, Figure IV-4, shows that summer flows in Alternative 1 are lower than flows in the No-Action Alternative, and that fall and winter flows are generally similar. The variability of downstream temperatures for winter run salmon under Alternative 1 is similar to the No-Action Alternative.

Changes to Folsom Lake operations for (b)(2) water purposes affect the need for Shasta Lake releases, and resulting Sacramento River flows below Keswick Dam. In Alternative 1, fall and winter releases from Folsom Lake are increased to attempt to meet American River target flows, to meet a greater portion of the downstream Delta export and water quality requirements, and to

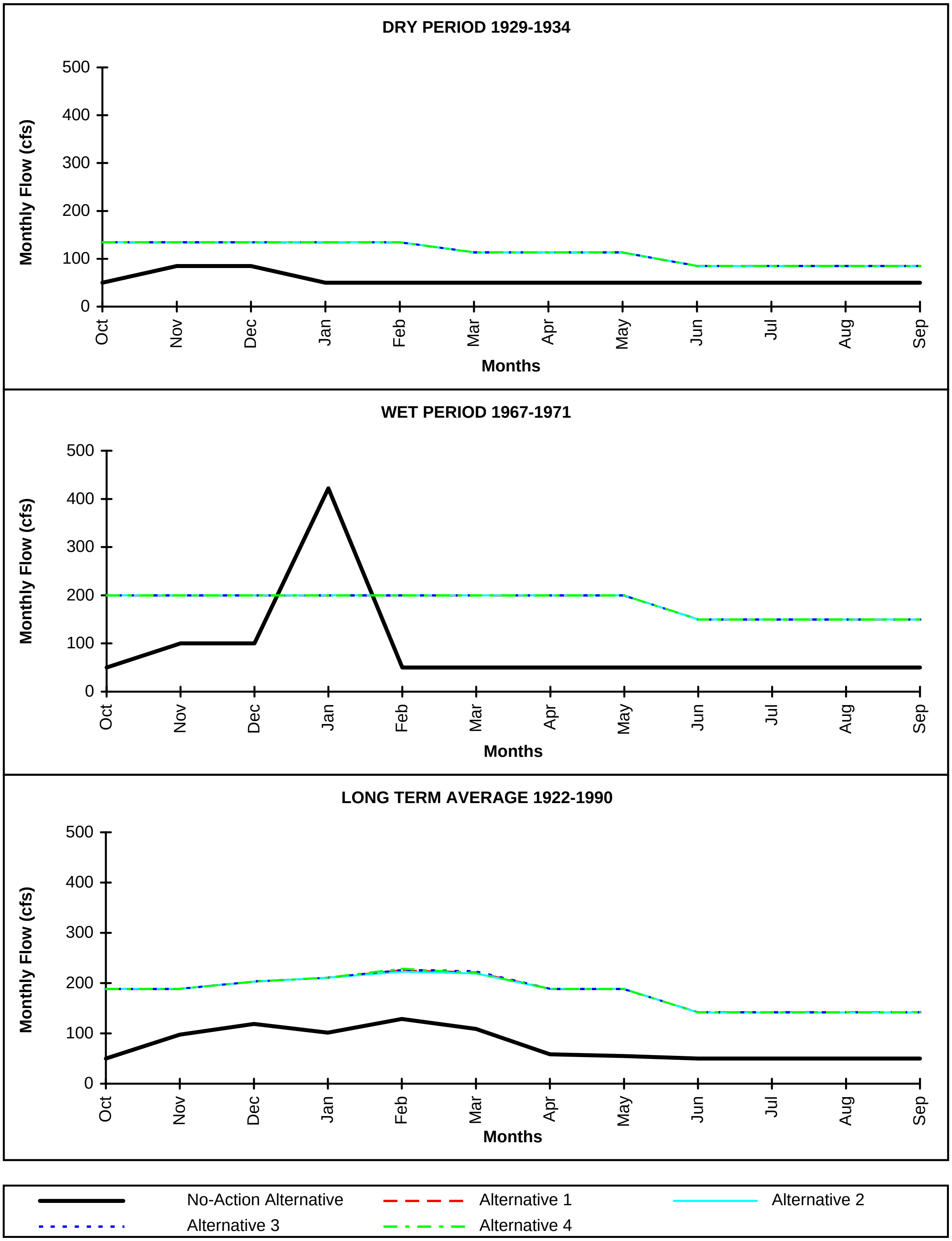


FIGURE IV-3
CLEAR CREEK BELOW WHISKEYTOWN
SIMULATED AVERAGE MONTHLY FLOWS

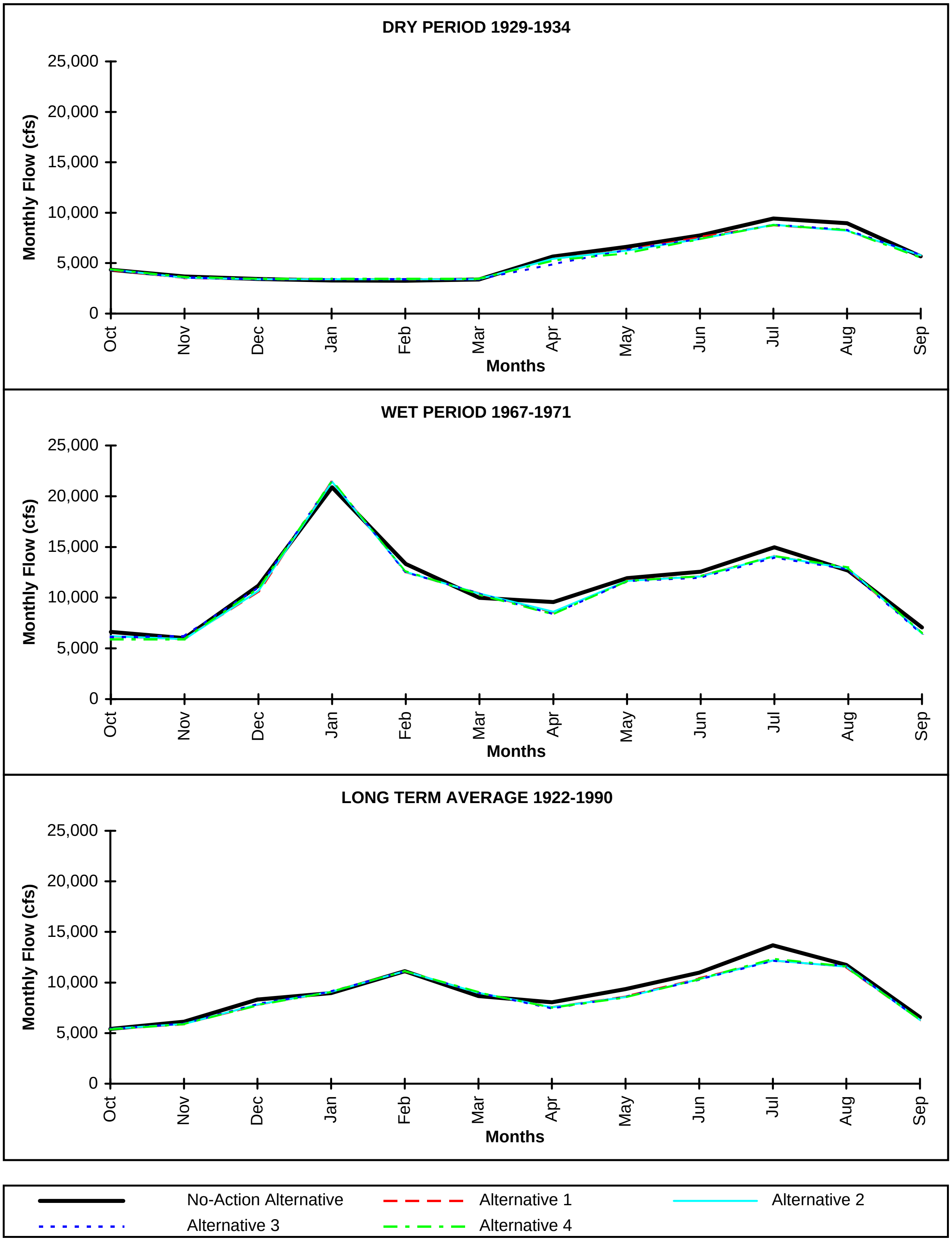


FIGURE IV-4
SACRAMENTO RIVER BELOW KESWICK
SIMULATED AVERAGE MONTHLY FLOWS

reduce the need for Shasta Lake releases in excess of the Keswick target flows. Reduced summer releases from Folsom Lake may require higher summer Shasta Lake releases to meet Delta water rights and water quality requirements. This additional burden on Shasta Lake during the summer may reduce the CVP's ability to respond to short-term increases in the need for water to meet irrigation demand.

American River Division. The primary goals on the American River are to increase Folsom Lake September end-of-water year storage, and provide higher, more stable fall and winter flows in the American River, as discussed in Attachment G. The frequency distribution in Figure IV- 2 shows that in Alternative 1, Folsom Lake end-of-water year storage increases by about 80,000 acre-feet as compared to the No-Action Alternative. The Draft AFRP September storage target of 610,000 acre-feet is met in about 50 percent of the 69 years in the PEIS simulation period. The re-operation of Folsom Lake average monthly storage in the dry, wet, and 69-year average simulation periods is shown in Figure IV-5.

The target flows in the October through February period below Nimbus Dam are achieved in 100 percent of the months in wet, above normal, and below normal water years. For the same period, target flows are met in 80 percent of the dry years and 40 percent of the critical dry years. A comparison of simulated average monthly flows in the American River below Nimbus Dam in the No-Action Alternative and Alternative 1 is presented in Figure IV-6.

Under Alternative 1, the integrated operations of Shasta and Folsom Lakes are balanced to attempt to meet as many of the (b)(2) water objectives as possible, while still fulfilling existing CVP obligations and operational criteria as defined under the No-Action Alternative. This is particularly difficult during summer periods, where the objective is to decrease releases on both the Sacramento and American Rivers to provide additional September storage to help meet fall and winter flow targets. The ability to decrease summer releases is constrained by CVP obligations to provide water for existing minimum flow requirements, CVP M&I and agricultural contract obligations, water rights holders, and Delta water quality requirements.

Eastside Division. Under Alternative 1, New Melones Reservoir would be operated to provide higher instream flows on the Stanislaus River during non-critical years, as compared to the No-Action Alternative. This operation would result in lower end-of-water-year storage levels than under the No-Action Alternative, as shown in Figure IV-2. Instream flows would not be increased during critically dry years, due to the limited water supply in the Stanislaus River watershed, therefore storage levels during periods of consecutive critical dry years would be approximately the same as under the No-Action Alternative.

Simulated average monthly flows in the Stanislaus River below Goodwin Dam in the No-Action Alternative and Alternative 1 simulations are shown in Figure IV-7. As described in Chapter II, the (b)(2) Water Management operations at New Melones attempt to completely meet target flows from July through March, and partially meet target flows during April through June in non-critical years. Because of the limited available water supply in the Stanislaus River watershed, no change in instream flow objectives is made during critically dry years, as compared to the No-Action Alternative. The resulting operation would meet July through March target flows in

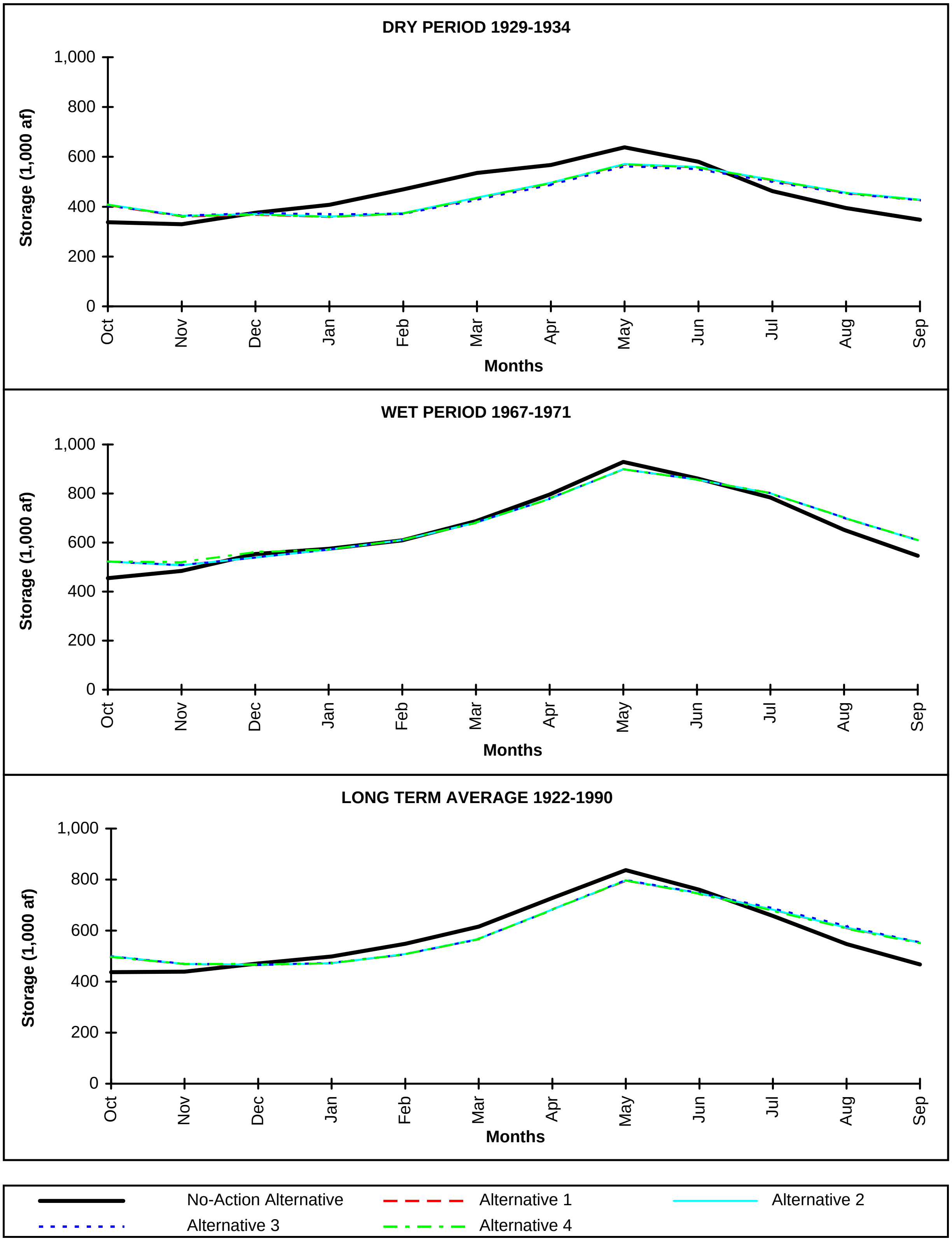


FIGURE IV-5

SIMULATED FOLSOM LAKE AVERAGE END-OF-MONTH STORAGE

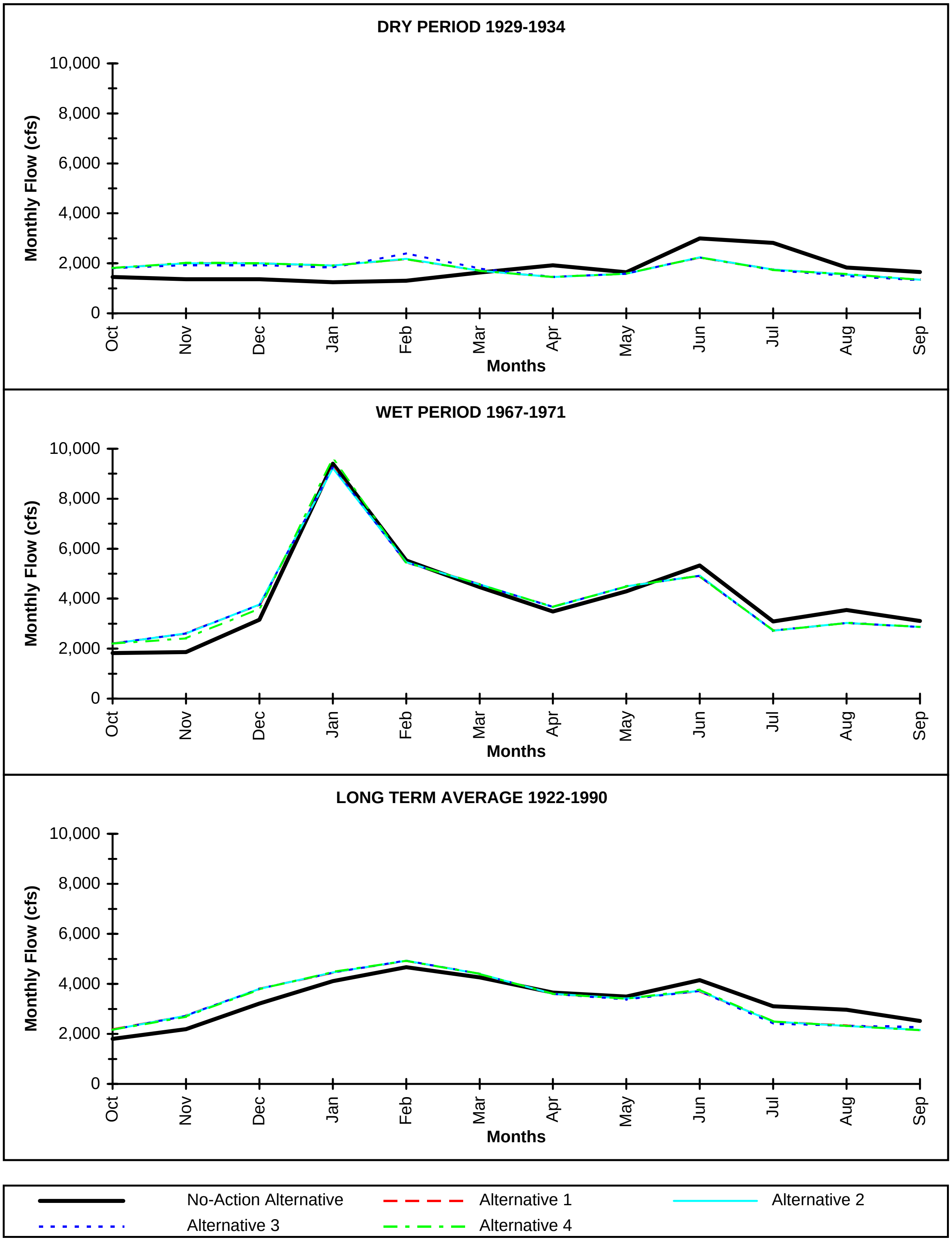
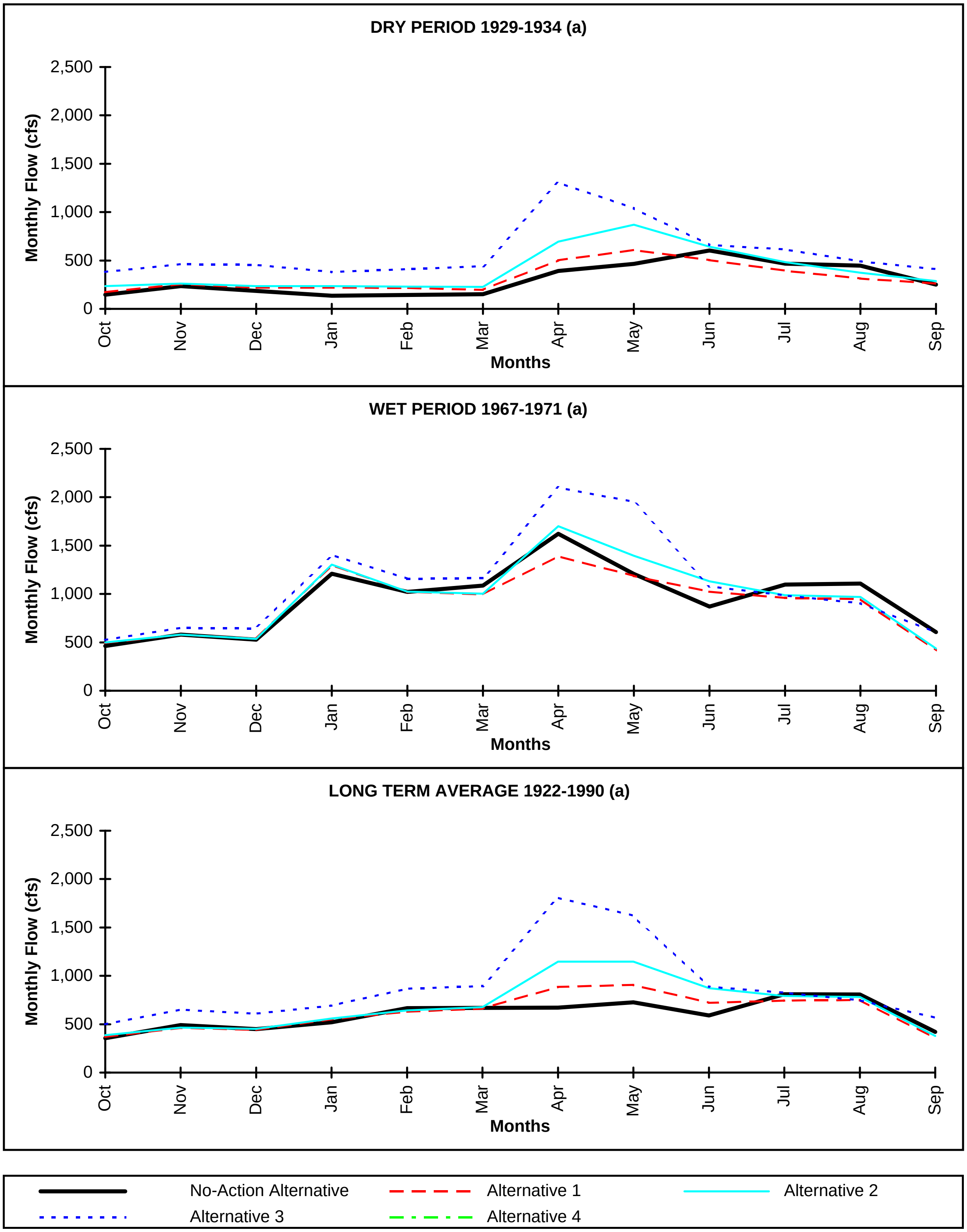


FIGURE IV-6

AMERICAN RIVER BELOW NIMBUS SIMULATED AVERAGE MONTHLY FLOWS



NOTE: (a) Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE IV-7
STANISLAUS RIVER BELOW GOODWIN
SIMULATED AVERAGE MONTHLY FLOWS

all years, and would meet or partially meet target flows during the April through June period in some, but not all years. As a result of the reduced storage conditions in New Melones Reservoir, however, the threshold for maximum water quality releases during water deficient years is invoked in one additional year during the dry simulation period of 1929-1934, and results in lower average monthly flows during June, July, and August in that period.

Simulated average monthly flows in the San Joaquin River at Vernalis in the No-Action Alternative and Alternative 1 are shown in Figure IV-8. Although the changes in flows resulting from modified Stanislaus River operations affect the flow at Vernalis, the changes are relatively small compared to the total flow at Vernalis. The simulated monthly water quality on the San Joaquin River at Vernalis during the irrigation (April - August) and non-irrigation (September - March) seasons for the No-Action Alternative and Alternative 1 is shown in the frequency distributions in Figure IV-9. The figures show that for both the irrigation and non-irrigation seasons, the frequency with which water quality exceeds the standard increases in Alternative 1 over the No-Action Alternative. The increase in the salinity concentration during the irrigation season occurs during the driest 10 percent of the simulated years, and corresponds to periods when releases from New Melones Reservoir for water quality are limited by available supplies. Salinity concentration increases during the non-irrigation season are primarily due to the increase in deliveries and subsequent return flows from the refuges in the San Joaquin Valley.

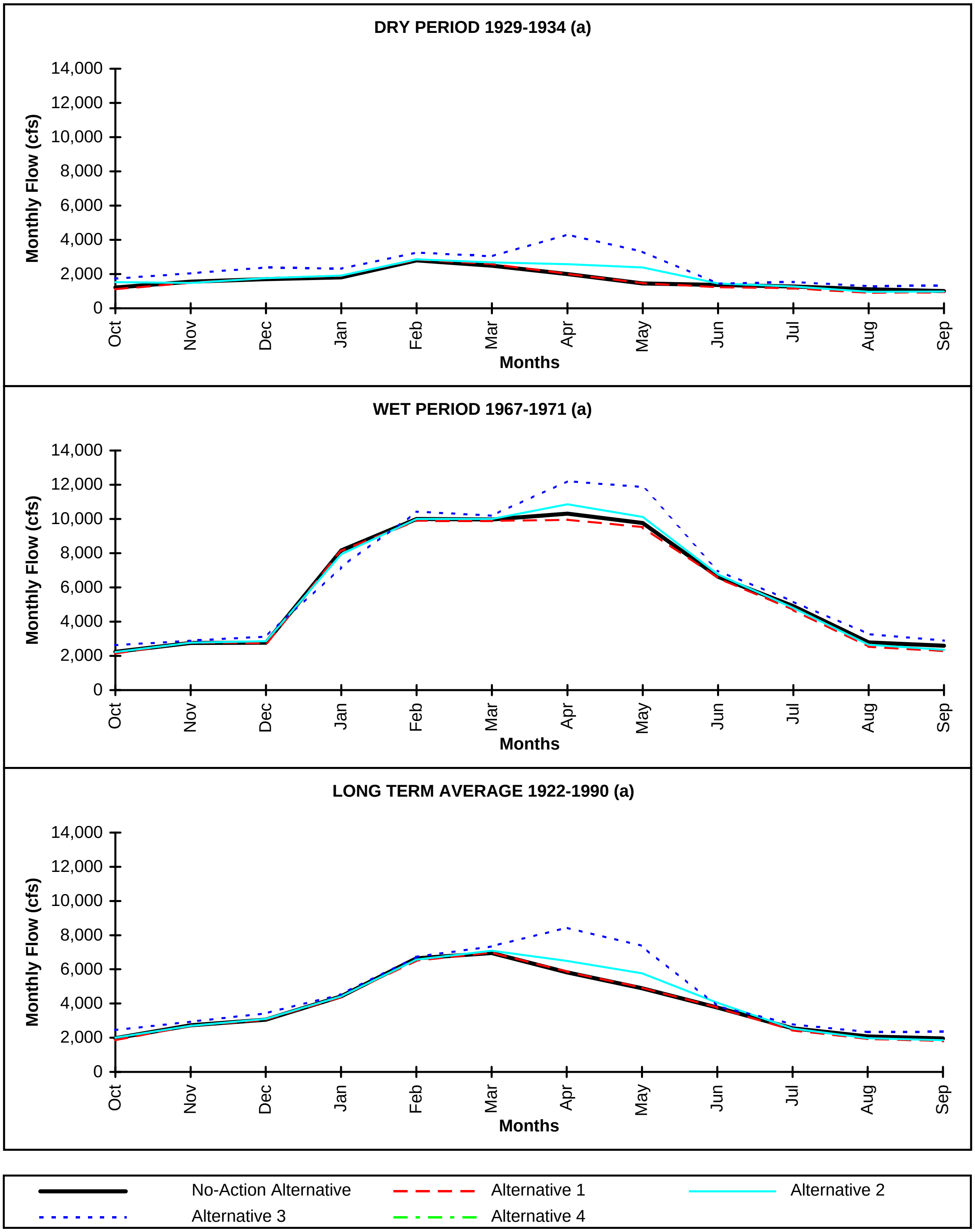
Delta Division. Figure IV-10 shows the change in simulated average monthly Tracy exports for the dry, wet and long-term average periods. The figure shows an increase in October through January average monthly Tracy exports, for the dry and long-term average conditions, due to the increased upstream CVP releases to meet target flows. In many years, these combined upstream reservoir releases exceed the maximum pumping capacity of Tracy Pumping Plant. In contrast, the Alternative 1 average monthly March through September Tracy exports are lower, due to decreased spring and summer Trinity River Basin diversions to the Sacramento River, and reduced summer upstream CVP reservoir releases. The net impact is about a 250,000 acre-feet reduction in average annual CVP exports through Tracy Pumping Plant. The frequency distribution in Figure IV-11 shows the Alternative 1 decrease in simulated annual Tracy Pumping Plant exports as compared to the No-Action Alternative.

In comparison to the No-Action Alternative simulation, average annual Delta outflows in Alternative 1 are reduced by approximately 60,000 acre-feet. However, the reduction in outflow is small in proportion to the total Delta outflow and cannot be easily discerned in the average monthly outflow plots shown in Figure IV-12.

West San Joaquin Division. The Alternative 1 impacts to CVP storage in San Luis Reservoir are a direct result of changes in Tracy Pumping Plant monthly exports. As shown in Figure IV-11, Alternative 1 average monthly CVP San Luis Reservoir storage levels are higher than in the No-Action Alternative, due to increased October through January Tracy Pumping Plant exports.

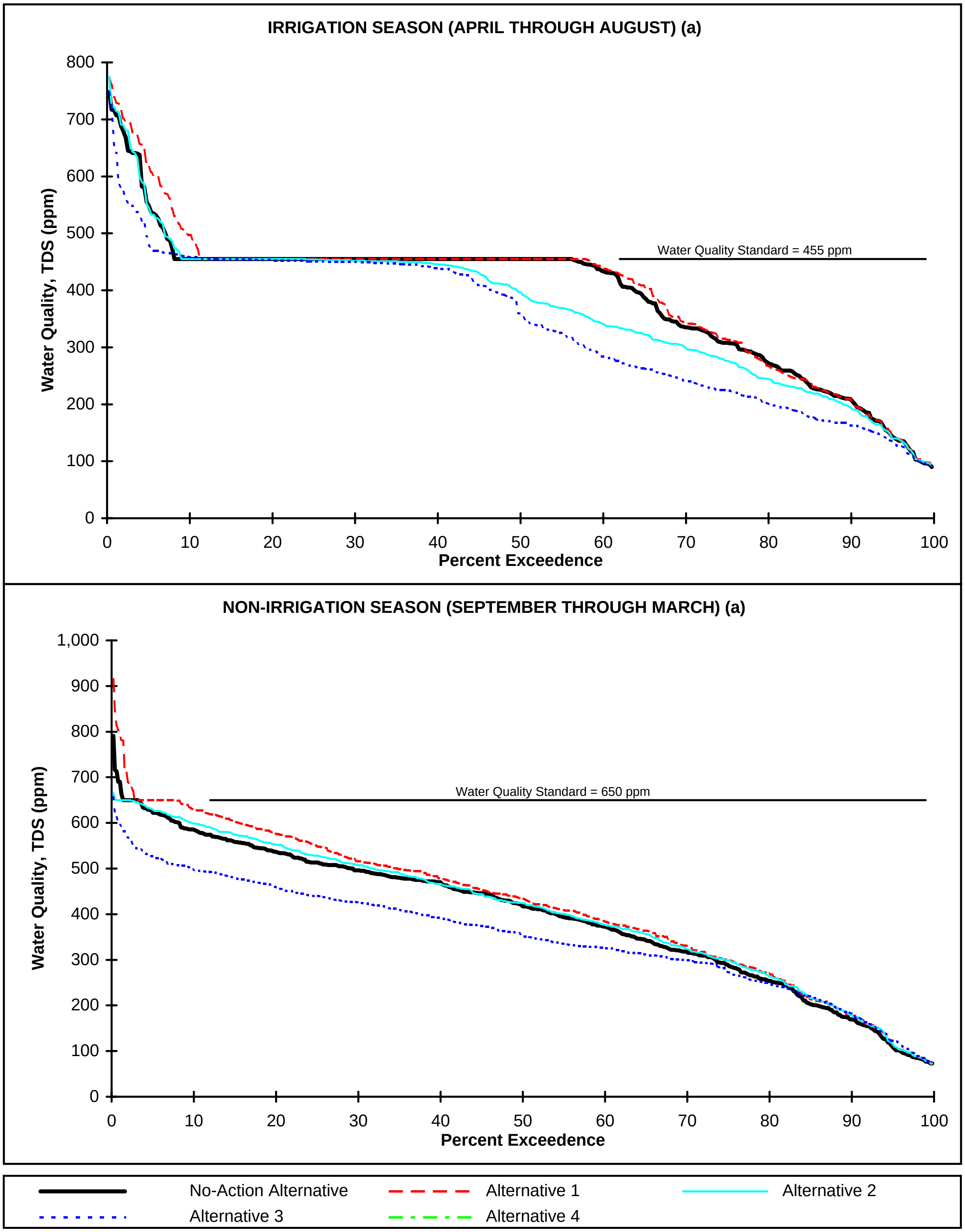
CVP Water Deliveries

This section describes potential changes to CVP water contract deliveries in Alternative 1, as compared to the No-Action Alternative, due to: 1) use of (b)(2) water towards meeting the target



NOTE: (a) Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE IV-8
SAN JOAQUIN RIVER AT VERNALIS
SIMULATED AVERAGE MONTHLY FLOWS



NOTE: (a) Water quality conditions under Alternatives 3 and 4 are identical.

FIGURE IV-9

SIMULATED MONTHLY WATER QUALITY AT VERNALIS

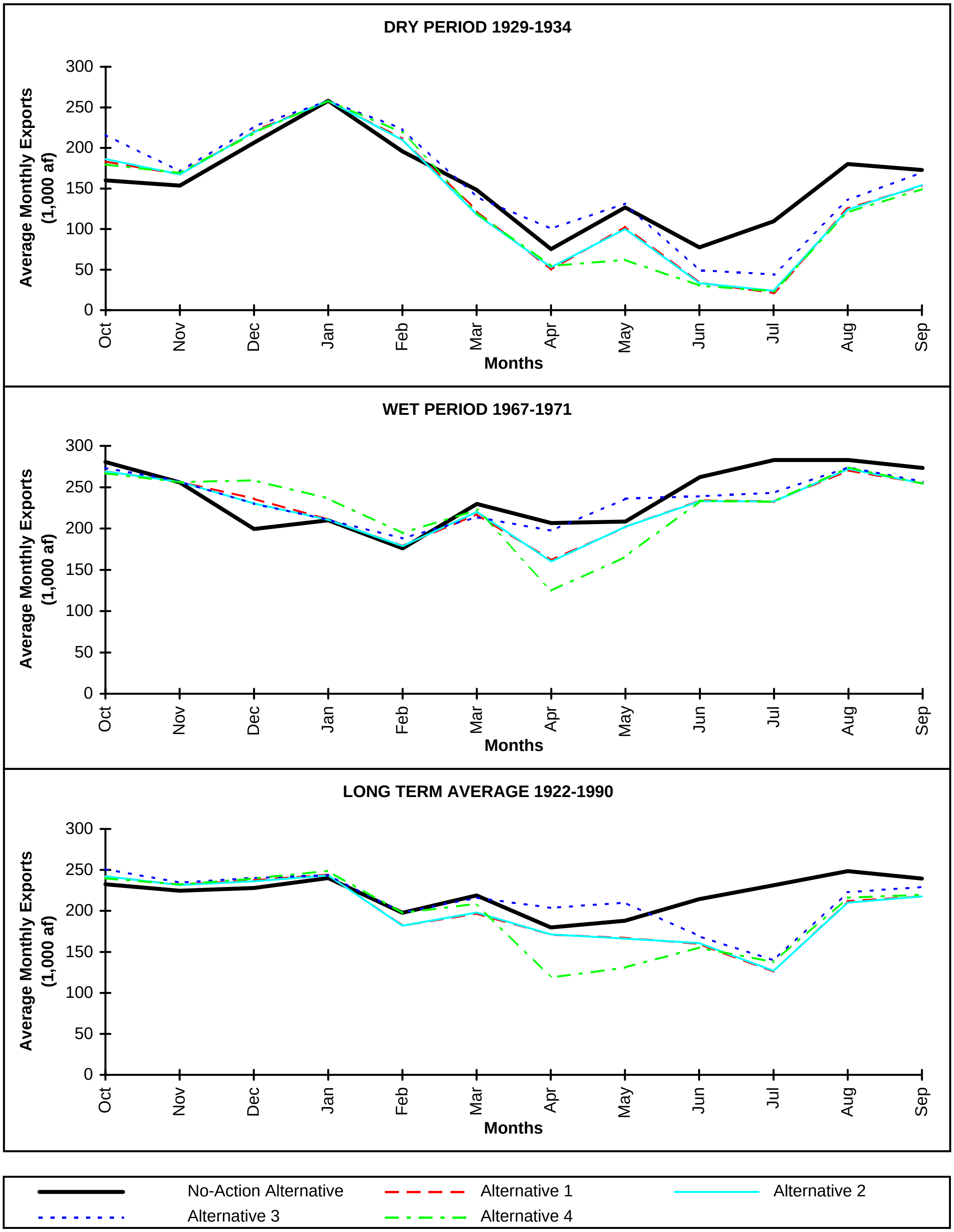


FIGURE IV-10

TRACY PUMPING PLANT SIMULATED AVERAGE MONTHLY EXPORTS

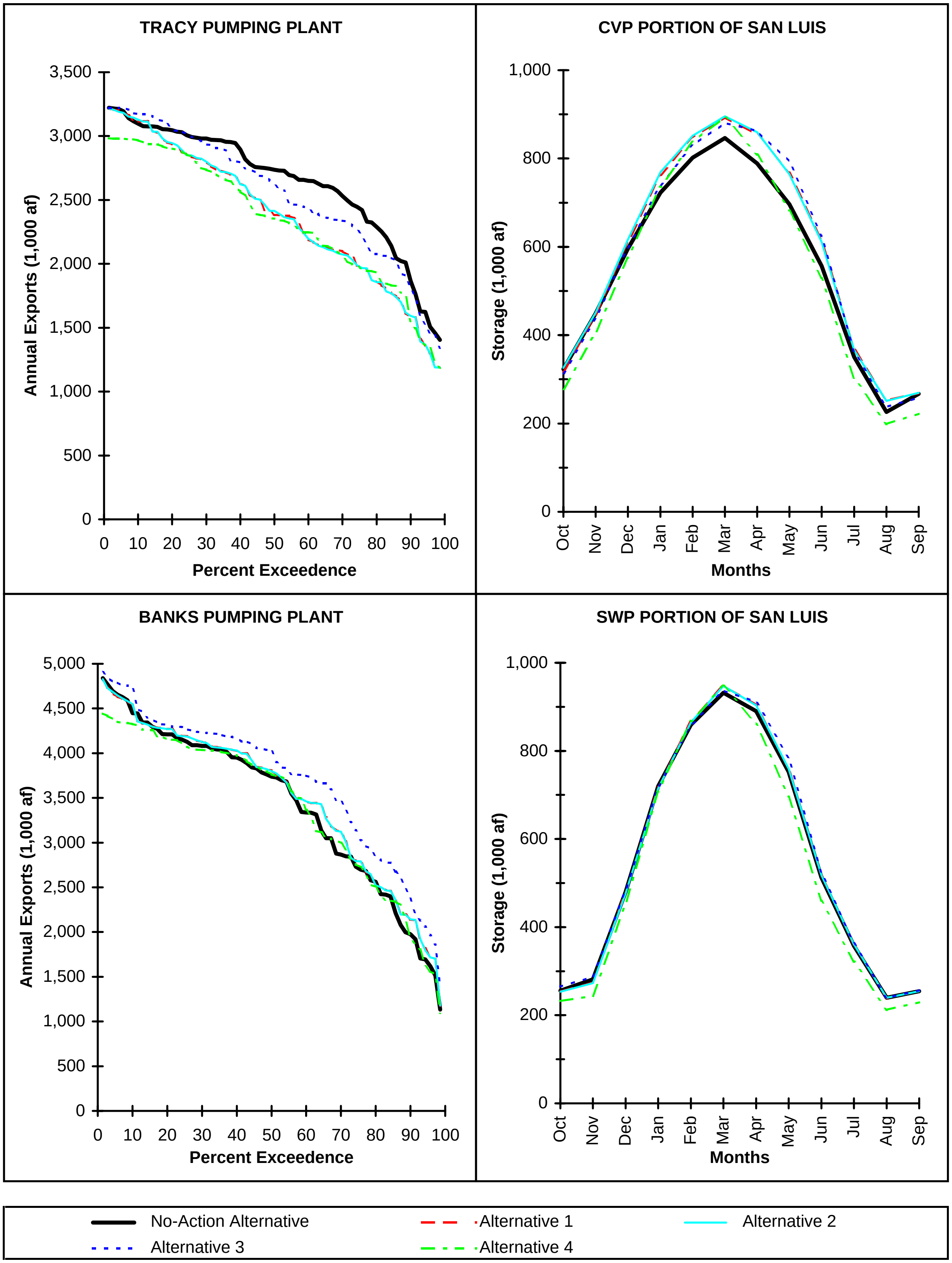


FIGURE IV-11
SIMULATED ANNUAL EXPORTS AND SAN LUIS
RESERVOIR AVERAGE END-OF-MONTH STORAGE 1922-1990

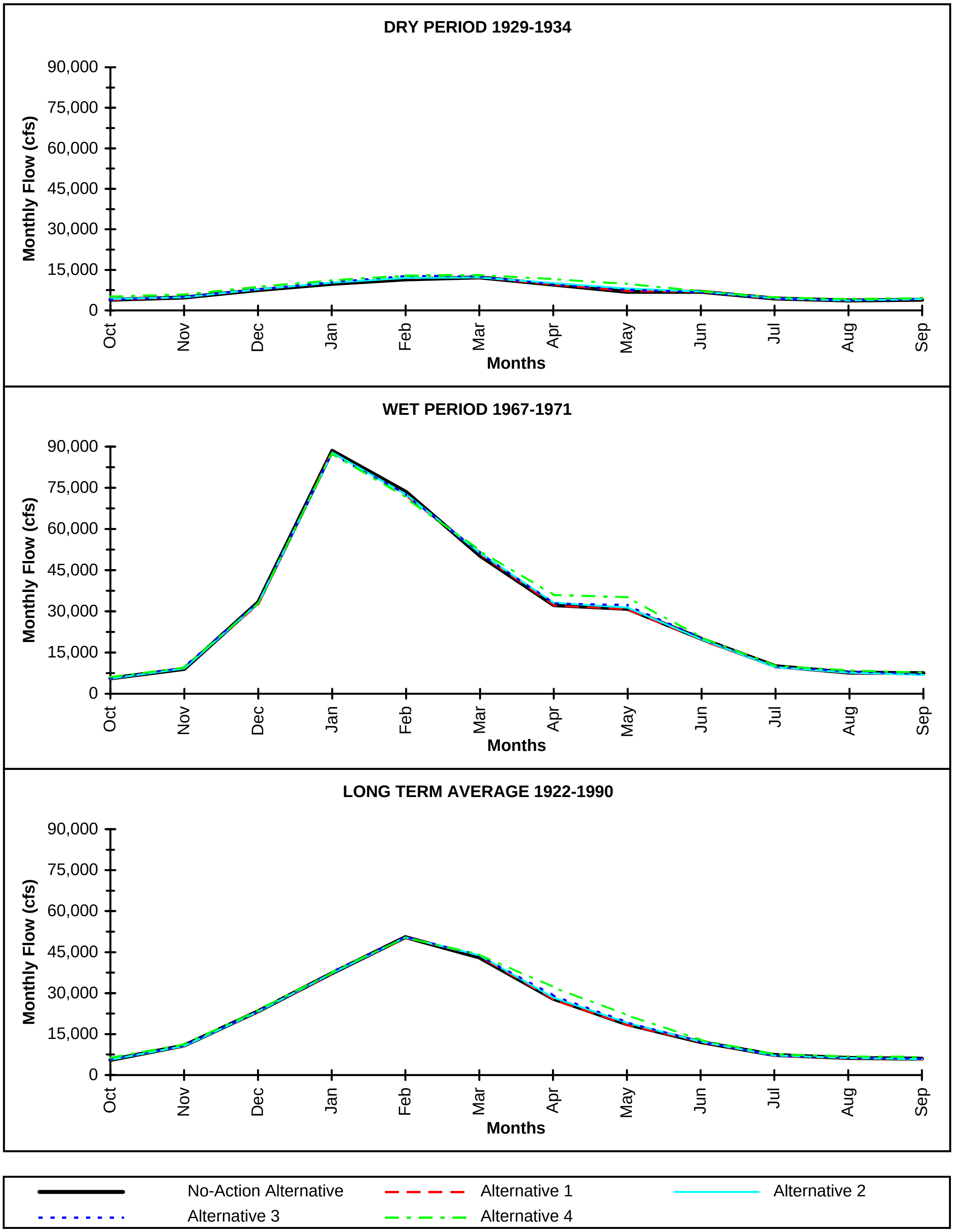


FIGURE IV-12

DELTA OUTFLOW SIMULATED AVERAGE MONTHLY FLOWS

flows, 2) firm Level 2 refuge deliveries, and 3) increased instream Trinity River flow requirements. The "target flows" were developed for the purposes of the Draft PEIS based upon preliminary information developed for the AFRP. The methodology used to develop the "target flows" is described in Alternatives G-2 and G-3. A summary comparison of deliveries to CVP contractors in the Alternative 1 simulation, as compared to the No-Action Alternative simulation is provided in Table IV-3.

TABLE IV-3

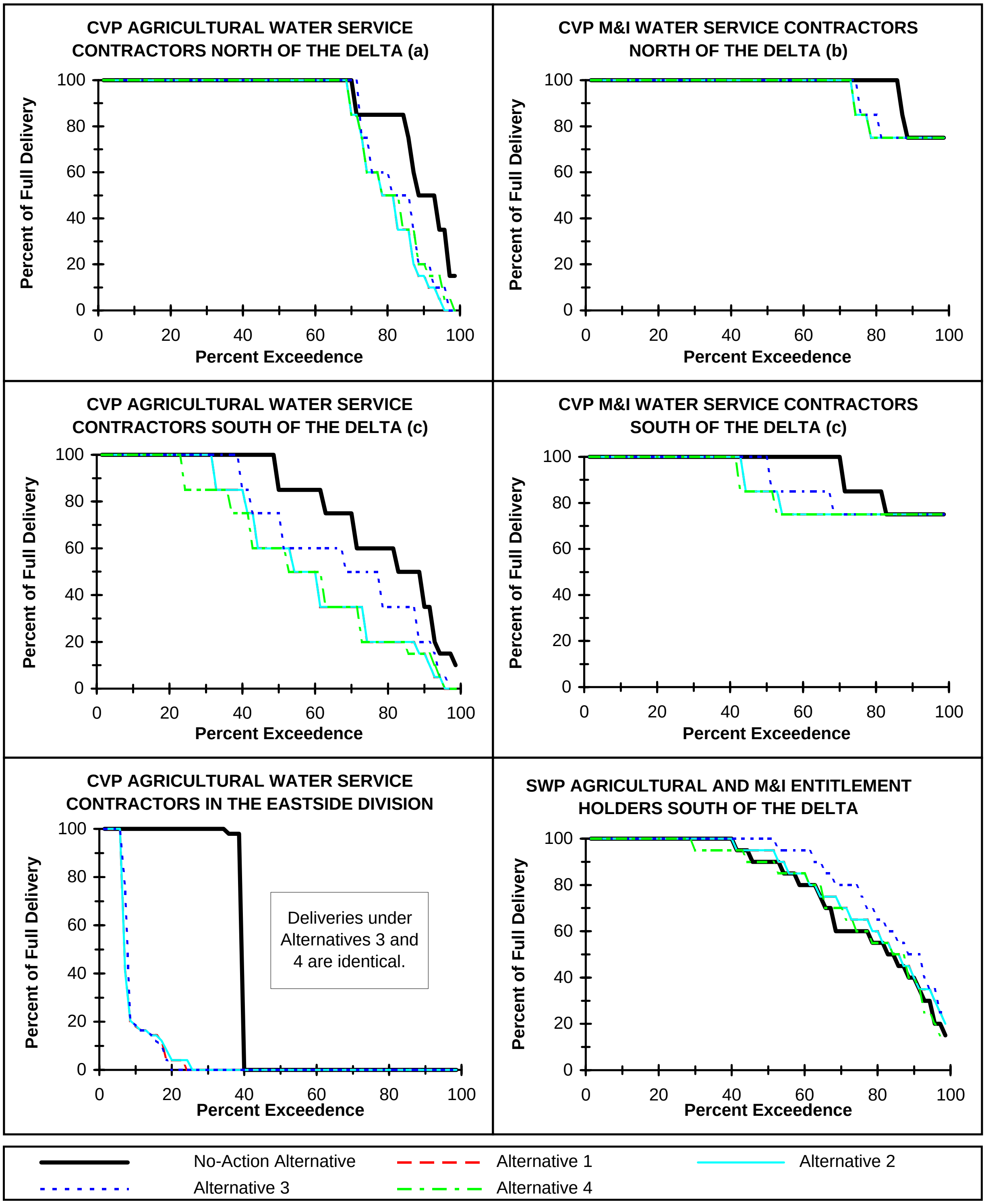
COMPARISON OF SIMULATED AVERAGE ANNUAL CVP DELIVERIES

		CVP Deliveries (in 1,000 af)	Differences in CVP Deliveries in Comparison to the No-Action Alternative (in 1,000 af)			
Contract Years	**Type of Period**	**No-Action Alternative**	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
1922 - 1990	Simulation Period	5,770	-470	-590	-390	-620
1928 - 1934	Dry Period	4,560	-510	-620	-340	-590
1967 - 1971	Wet Period	6,310	-290	-410	-300	-470

Notes:
(1) CVP deliveries include deliveries to agricultural and M&I water service contractors, Sacramento River water rights contractors, other water rights contractors, San Joaquin Exchange Contractors. CVP deliveries do not include refuge water supplies.
(2) Values in Alternatives 2, 3, and 4 include purchase of up to 130,000 acre-feet of water per year for level 4 refuges from the Sacramento River Water Rights and San Joaquin River Exchange Contractors.

CVP Water Deliveries North of the Delta. CVP deliveries north of the Delta include deliveries to Sacramento River Water Rights Contractors, and Agricultural and M&I Water Service Contractors. CVP deliveries to Sacramento River Water Rights Contractors do not change in Alternative 1, since their delivery deficiencies are based on the Shasta Criteria. CVP water service contract deliveries decrease as available water supply is reduced due to the use of (b)(2) water, increased firm Level 2 refuge water supplies, and decreased diversions from the Trinity River Basin.

Frequency distributions for the percent of full delivery to CVP Agricultural Water Service Contractors north of the Delta are presented for Alternative 1 and the No-Action Alternative in Figure IV-13. The figure generally shows a 5 to 10 percent reduction in the frequency of deliveries across all delivery levels, with the minimum delivery dropping from about 15 to 0 percent of full contract amount. The minimum delivery to M&I water service contractors is limited to 75 percent of the contract amount, as shown in the frequency distribution in Figure IV-13. The minimum delivery is made in 15 percent of the years in the No-Action Alternative and 45 percent of the years in Alternative 1. The only exception occurs on the American River in 1977, when all M&I contract and water rights deliveries from the river are reduced below 75



NOTE: (a) Includes Sacramento River and American River Divisions.
(b) Includes Sacramento River and American River Divisions plus Contra Costa exports.
(c) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE IV-13
SIMULATED FREQUENCY OF PERCENT OF FULL ANNUAL DELIVERIES 1922-1990

percent in the No-Action Alternative and Alternative 1. The figure shows that full M&I deliveries are reduced from 85 to 70 percent of the years in the 69-year simulation period.

CVP Deliveries Eastside Division. Frequency distributions of the simulated percent of full deliveries to CVP agricultural water service contractors on the Stanislaus River are shown for the No-Action Alternative and Alternative 1 in Figure IV-13. The reduction in deliveries results from the use of (b)(2) water to help meet target flows in the Stanislaus River. Partial or full deliveries would be made in approximately 10 to 20 percent of the years in Alternative 1, compared to approximately 40 percent of the years under the No-Action Alternative. A Reader's Guide to use frequency distribution curves is included in Attachment D.

CVP Water Deliveries South of the Delta. CVP deliveries south of the Delta include deliveries to San Joaquin River Exchange Contractors, and Agricultural and M&I Water Service Contractors. CVP deliveries to San Joaquin River Exchange Contractors would not change under Alternative 1, since their delivery deficiencies are based on the Shasta Criteria. Deliveries to Agricultural and M&I Water Service Contractors south of the Delta are a function of available CVP water supply and the amount of water that can be exported through Tracy Pumping Plant. The frequency distribution for the percent of full delivery to CVP Agricultural Water Service Contractors south of the Delta is presented in Figure IV-13. The figure generally shows a 20 to 30 percent reduction in the frequency of deliveries across all delivery levels, with the minimum delivery dropping from about 10 to 0 percent of full contract amount. The minimum delivery to M&I water service contractors is limited to 75 percent of the contract amount, as shown in the frequency distribution in Figure IV-13. The minimum delivery is made in 20 percent of the years in the No-Action Alternative and about 50 percent of the years in Alternative 1. The figure shows that full M&I deliveries are reduced from 70 percent of the years in the 69-year simulation period in the No-Action Alternative to 40 percent in Alternative 1.

CVP Water Deliveries To Refuges. Alternative 1 provides delivery of firm Level 2 water supplies to refuges. Table IV- 4 shows the average annual increase of about 230,000 acre-feet in Alternative 1 CVP refuge deliveries as compared to the No-Action Alternative. About 60,000 acre-feet of this increase was assumed to come from non-CVP sources in the No-Action Alternative. The 25 percent deficiency to refuge deliveries in critical dry years is based on the Shasta Criteria, as it is in the No-Action Alternative.

SWP Operations and Deliveries

This section provides a comparison of Alternative 1 and No-Action Alternative SWP reservoir operations, resulting river flows, and water deliveries to SWP contractors.

SWP Operations

SWP operations are affected by the changes in seasonal releases from upstream CVP reservoirs for target flows. These changes to CVP operations shift the timing of flow entering the Delta, and affect the SWP responsibility to help meet in basin water rights and Delta water quality requirements under the COA.

TABLE IV-4

COMPARISON OF SIMULATED AVERAGE ANNUAL CVP REFUGE WATER SUPPLIES

		Refuge Water Supplies (in 1,000 af)	Differences in Refuge Water Supplies in Comparison to the No-Action Alternative (in 1,000 af)	
Contract Years	**Type of Period**	**No-Action Alternative**	**Alternative 1**	**Alternatives 2, 3, and 4**
1922 - 1990	Simulation Period	260	+230	+370
1928 - 1934	Dry Period	230	+200	+330
1967 - 1971	Wet Period	270	+230	+380

Lake Oroville and Feather River Operations. Small differences in SWP Lake Oroville operations are the result of changes in response to the availability of excess water in the Delta, as a function of (b)(2) Water Management and reduced diversions from the Trinity River Basin. These changes in water availability require different Lake Oroville releases to meet COA obligations and/or Delta water quality requirements. Figure IV-2 shows a comparison of the frequency distributions for Lake Oroville end-of-water year storage for Alternative 1 and the No-Action Alternative.

Simulated average monthly flows in the Feather River below Nicolaus in the No-Action Alternative and Alternative 1 are presented in Figure IV-14. The small differences in the flows reflect decreased fall and increased summer upstream lake Oroville releases in response to Delta needs. However, the changes in flow are small in proportion to total flows at Nicolaus.

SWP Delta Operations. Delta inflows during fall and winter months are increased because of greater upstream CVP reservoir releases for target flows. In many years, the additional fall and winter Delta inflow exceeds the pumping capacity of the CVP Tracy Pumping Plant. When this occurs, the SWP has the potential to increase Banks Pumping Plant exports to take advantage of the excess water, or pump at capacity while reducing upstream releases from Lake Oroville. A comparison of frequency distributions of simulated annual exports through Banks Pumping Plant in the No-Action Alternative and Alternative 1 simulations is presented in Figure IV-11. In comparison to the No-Action Alternative, the average annual increase in SWP exports is about 70,000 acre-feet. Figure IV-15 shows a comparison of average monthly Banks exports for the dry, wet, and 69-year simulation period.

It is possible that a portion of the water pumped at the Banks Pumping Plant would be wheeled by the SWP for delivery to CVP Cross Valley Canal contractors.

San Luis Reservoir Operations. The Alternative 1 impacts to SWP storage in San Luis Reservoir are a direct result of changes in Banks Pumping Plant monthly exports. As shown in Figure IV-11, Alternative 1 average monthly SWP San Luis Reservoir storage levels are similar to the No-Action Alternative.

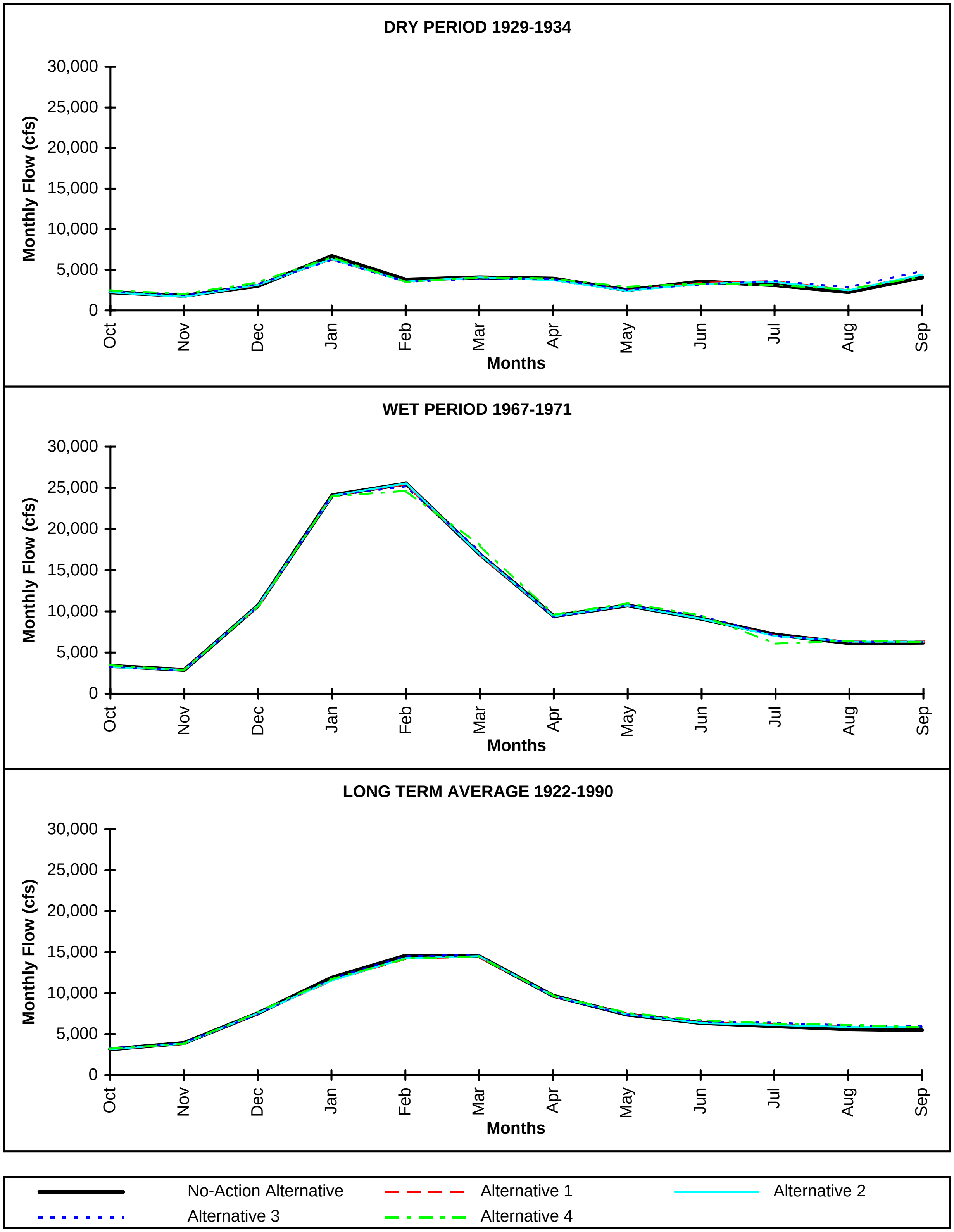


FIGURE IV-14

FEATHER RIVER AT NICOLAUS SIMULATED AVERAGE MONTHLY FLOWS

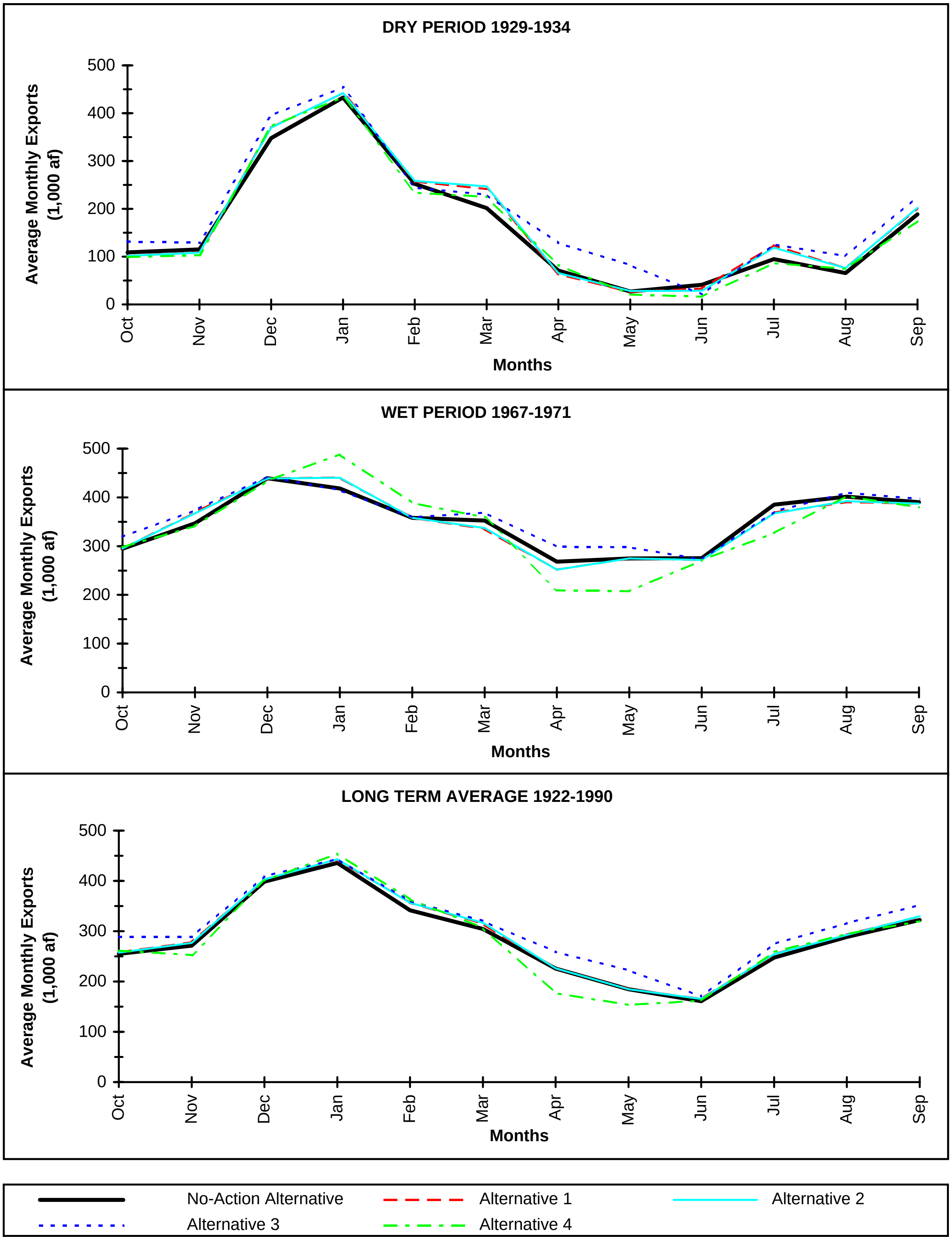


FIGURE IV-15

BANKS PUMPING PLANT SIMULATED AVERAGE MONTHLY EXPORTS

SWP Water Deliveries

Under Alternative 1, SWP deliveries to agricultural and M&I entitlement holders south of the Delta would increase by about 100,000 acre-feet on an average annual basis, as compared to the No-Action Alternative. A comparison of frequency distributions for the simulated percent of full contract delivery in the No-Action Alternative and Alternative 1 is presented in Figure IV-13. The increase in SWP deliveries in Alternative 1 is due to the SWP's ability to adjust operations to take advantage of excess Delta inflows resulting from increased upstream CVP reservoir releases for target flows. If a portion of water pumped at Banks Pumping Plant is wheeled by the SWP for delivery to CVP Cross Valley Canal contractors, then the amount of additional SWP deliveries shown in Table IV-5 would be reduced.

TABLE IV-5

COMPARISON OF SIMULATED AVERAGE ANNUAL SWP DELIVERIES

		SWP Deliveries (in 1,000 af)	Differences in SWP Deliveries in Comparison to the No-Action Alternative (in 1,000 af)			
Contract Years	**Type of Period**	**No-Action Alternative**	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
1922 - 1990	Simulation Period	3,330	+100	+80	+270	-20
1928 - 1934	Dry Period	2,050	+150	+140	+350	0
1967 - 1971	Wet Period	4,140	-40	-70	+60	-150

NOTES:
(1) SWP deliveries include deliveries south of the Delta to entitlement holders. SWP deliveries do not include refuge water supplies.

ALTERNATIVE 2

Alternative 2 includes the CVPIA provisions in Alternative 1, plus the acquisition of surface water from willing sellers toward meeting the delivery of Level 4 water supplies to refuges and meeting target flows for chinook salmon and steelhead trout in Central Valley streams. The Re-operation and (b)(2) Water Management components of Alternative 2 are similar to these components in Alternative 1. Alternative 2 also includes the implementation of the same habitat restoration actions included in Alternative 1.

Under Alternative 2, water would be acquired to provide delivery of Level 4 water supply requirements to wildlife refuges. It is assumed that this water would be acquired from reliable sources within the same geographic region as the refuges.

In addition, Alternative 2 includes the acquisition of water on the Stanislaus, Tuolumne, and Merced rivers, and the release of this water to help meet salmon and steelhead target flows on these streams, primarily the in April through June period, and to provide increased Delta outflow.

Because this water would be acquired for both instream flows and Delta outflow, it could not be pumped by export facilities in the Delta.

Water Acquisition

Water Acquisition for Level 4 Refuge Water Supplies

In Alternative 2, water would be acquired to provide the difference between Level 2 and Level 4 refuge water supply requirements. A summary of assumed acquisition quantities is presented in Table IV-6.

TABLE IV-6

SURFACE WATER ACQUISITION FOR LEVEL 4 REFUGE WATER SUPPLIES

Refuge(s)	Annual Acquisition Amount (in 1,000 af)
Refuges North of the Delta	34.5
Refuges South of the Delta	130.8

Water Acquisition for Target Flows and Delta Outflow

Under Alternative 2, surface water supplies would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced rivers, and would be released to help meet target flows on these streams, and increase Delta outflow. The maximum quantity of water that would be acquired in Alternative 2 is limited by the funds available in the portion of the CVPIA Restoration Fund allocated for surface water acquisition.

For the purposes of this analysis, it is assumed that the maximum quantity of water to be acquired from each source would be the same in all years. This assumption approximates a condition of a long term acquisition agreement that would stipulate a maximum annual quantity. Depending on hydrologic conditions, the actual amount of water that would be acquired in any year could be less than the maximum quantity.

The acquisition targets and long-term average acquisition quantities for water purchased from willing sellers for instream flows on the Stanislaus, Tuolumne, and Merced rivers is shown in Table IV- 7. The acquisition of up to 50,000 acre-feet from sources on the Merced River would occur in addition to the acquisition of 19,000 acre-feet for Level 4 refuge water supplies to the Merced NWR and East Gallo Unit. Therefore, the total amount of water acquired from willing sellers on the Merced would be up to 69,000 acre-feet.

It is assumed that water would be acquired from water rights holders on the Stanislaus, Tuolumne, and Merced rivers that possess diversion and storage rights on these rivers. The acquired water would be stored during the period of a contract year, and released in a manner to increase flows toward meeting the instream flow targets on these rivers and to increase Delta outflow. In effect, the acquisition of water would involve a shift in the release pattern from storage reservoirs, combined with a reduction in diversions by the willing sellers. It is assumed that acquired water would be stored and released from New Melones Reservoir on the Stanislaus River, New Don Pedro Reservoir on the Tuolumne River, and Lake McClure on the Merced River.

TABLE IV-7

SUMMARY OF LONG-TERM AVERAGE ANNUAL WATER ACQUISITION QUANTITIES FOR INSTREAM FLOWS

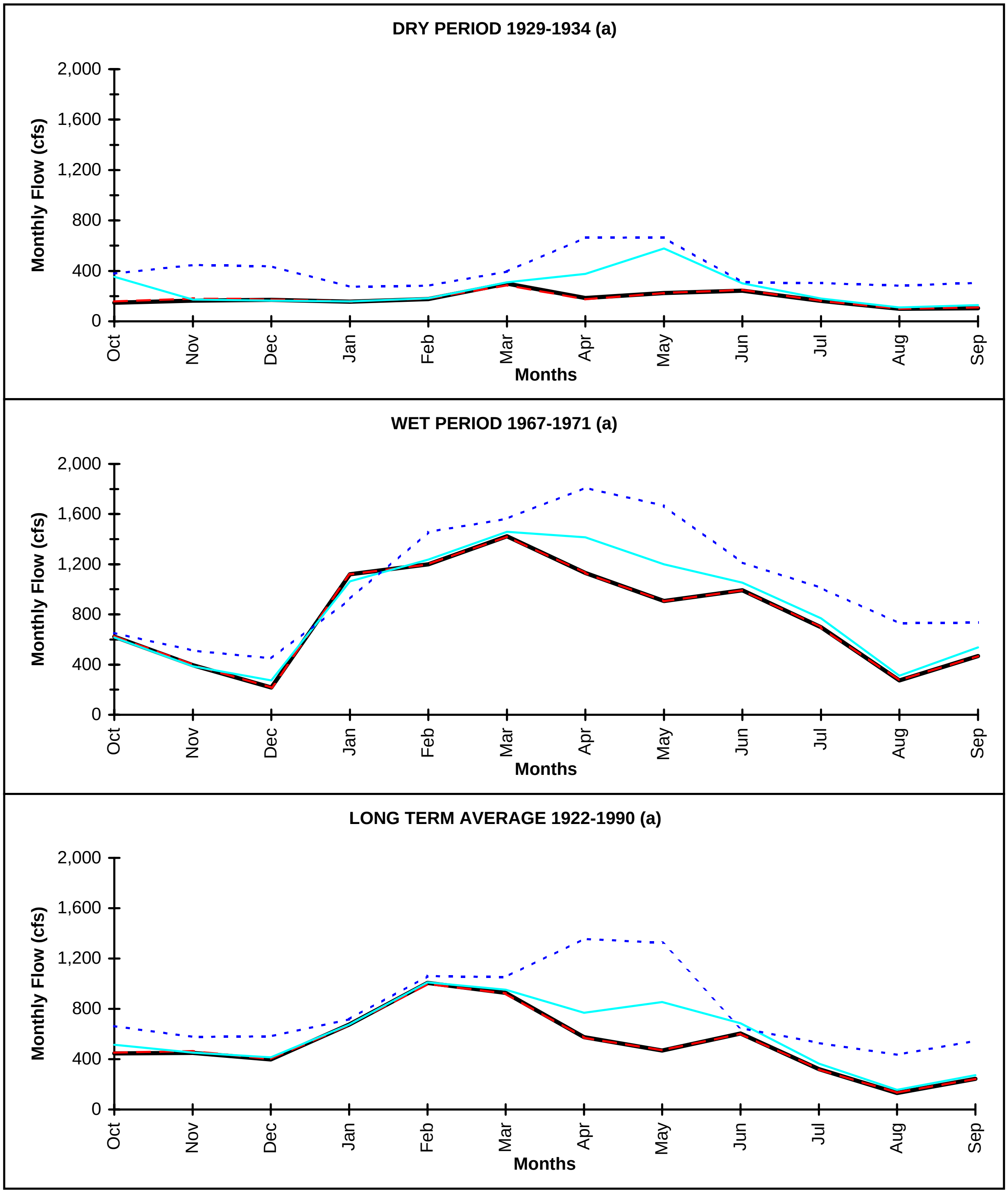
	Alternative 2 (in 1,000 af)		Alternatives 3 and 4 (in 1,000 af)	
Location	**Target**	**Long-Term Average**	**Target**	**Long-Term Average**
Merced River	50	50	200	194
Tuolumne River	60	60	200	197
Stanislaus River	60	49	200	194
Calaveras River	--	--	30	27
Mokelumne River	--	--	70	62
Yuba River	--	--	100	87

Under Alternative 2, the acquisition of water from willing sellers would be associated with reduced agricultural water use, and would therefore result in reduced return flows to downstream portions of the rivers. To avoid unintended impacts to downstream water users not involved in the sale or acquisition of water, base flow conditions would be maintained in portions of rivers that would be affected by the use of acquired water.

The target flows include pulse flow components on the Tuolumne and Merced rivers during April through June. Therefore, the primary emphasis for use of acquired water in Alternative 2 is during the months of April, May, and June. Simulated average monthly flows in the Merced River Below Crocker Huffman Diversion in the No-Action Alternative and Alternative 2 simulations are shown in Figure IV-16. Simulated average monthly flows in the Tuolumne River Below La Grange Dam in the No-Action Alternative and Alternative 2 simulations are shown in Figure IV-16. Simulated average monthly flows in the Tulumne River below La Grange Dam in the No-Action Alternative and Alternative 2 simulations are shown in Figure IV-17. A discussion of the changes in flow on the Stanislaus River and in the Delta are presented in the following section on CVP operations.

CVP Operations and Deliveries

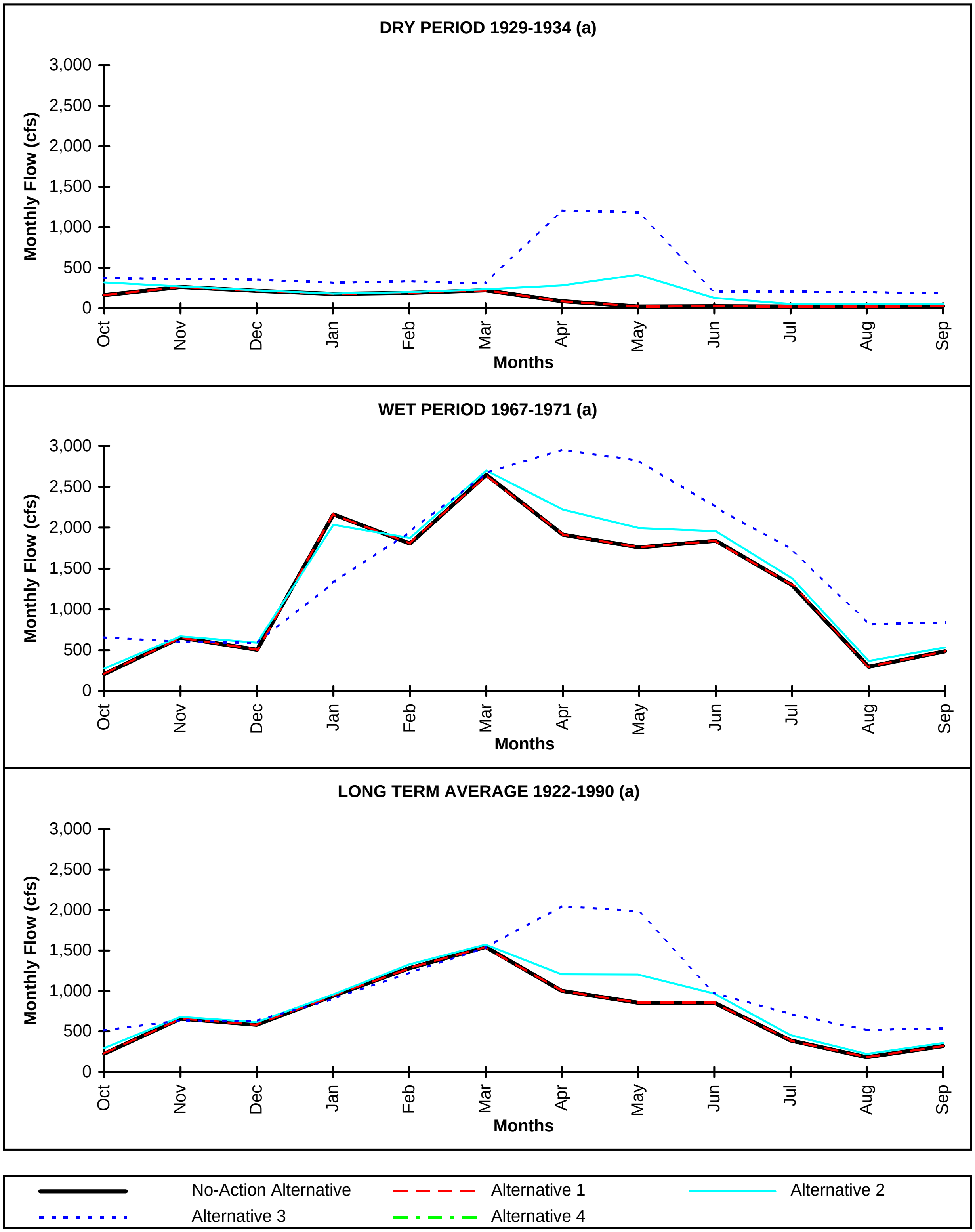
The discussion focuses on reservoir operations, resulting releases, and deliveries of water to CVP contractors. Discussions of the operations of CVP facilities and deliveries to CVP contractors are provided in the following sections.



No-Action Alternative · Alternative 1 · Alternative 2 · Alternative 3 · Alternative 4

NOTE: (a) Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE IV-16
MERCED RIVER BELOW CROCKER HUFFMAN
SIMULATED AVERAGE MONTHLY FLOWS



NOTE: (a) Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE IV-17
TUOLUMNE RIVER BELOW LAGRANGE
SIMULATED AVERAGE MONTHLY FLOWS

CVP Operations

Under surface water acquisitions for target flows and refuge water supplies in Alternative 2, CVP reservoir operations and river flow regimes in the Trinity, Shasta, Sacramento, and West San Joaquin Divisions would be similar to those described in Alternative 1. There would be a minor difference in operations due to a shift in reservoir releases for Level 4 refuge supplies. Figures presented under Alternative 1 also show the results of CVP operations under Alternative 2. Friant Division operations would be similar to the No-Action Alternative. The Delta and Eastside Divisions would be affected by the water acquisitions on the Stanislaus, Tuolumne, and Merced Rivers to help meet target flows on these streams, and increase Delta outflow. A discussion of impacts to operations in the Eastside and Delta Divisions is presented below.

Eastside Division. As described under the operations under Alternative 1, target flows on the Stanislaus River would be met in the July through March period through re-operation and the use of (b)(2) water. Therefore, acquired water would not be required after the month of June to meet the Alternative 2 target flows. As a result, the acquisition and use of surface water on the Stanislaus River in Alternative 2 would result in little or no change in end-of-water year storage levels in New Melones Reservoir, as compared to Alternative 1 as shown in Figure IV-2.

Simulated average monthly flows in the Stanislaus River below Goodwin Dam are shown in Figure IV-7. This figure shows that releases of acquired water under Alternative 2 would increase flows primarily in the April through June period. On an average monthly basis, flows would meet target flows in nearly all months of above and below normal, dry, and critical year types. Although average monthly flows increase in the April through June period in wet year types, they would not meet the target flows.

Simulated average monthly flows in the San Joaquin River at Vernalis are shown in Figure IV-8. In the months of July through March, average monthly flows under Alternative 2 would be similar to those in the No-Action Alternative. In the April through June period, however, the releases of acquired water on the Stanislaus, Tuolumne, and Merced rivers would result in increased flows on the San Joaquin River at Vernalis.

Frequency distributions of simulated monthly water quality on the San Joaquin River at Vernalis during the irrigation and non-irrigation seasons are shown in Figure IV-9. Under Alternative 2 operations, water quality at Vernalis would exceed the applicable water quality standards in approximately the same number of months during the simulation period, as in the No-Action Alternative. During the irrigation season, water quality would be at concentrations below the standard (improved water quality) more frequently under Alternative 2, as compared to the No-Action Alternative. The water quality standard would be exceeded less frequently during the non-irrigation season than under the No-Action Alternative.

Delta Division. Releases of acquired water during April and May would provide increased flows at Vernalis, which would contribute toward meeting the Bay-Delta Plan Accord pulse flow requirements. In Alternative 2, the increase in Delta inflow from the San Joaquin River would not be exported by the CVP or SWP. Therefore, the additional inflows would contribute directly to Delta outflow, increasing average annual Delta outflow by about 80,000 acre-feet.

CVP Deliveries

Under Alternative 2, water would be acquired from willing sellers for delivery to refuges and for release toward meeting the target flows. The release of acquired water on the Stanislaus, Tuolumne, and Merced rivers would not be available for export because this water would be released for both instream flow needs and for Delta outflow purposes. The amount of water that would be available for delivery to the CVP contractors would not be affected, except for the small amount that is assumed to be acquired from willing sellers for Level 4 refuge supplies. Therefore, CVP deliveries under Alternative 2 would be similar to those under Alternative 1 as shown in Table IV-3. Figure IV-13 shows the frequency distributions for water service contractors north and south of the Delta, and in the Eastside Division.

Average annual deliveries to refuges would include Level 4 water as shown in Table IV-4.

SWP Operations and Deliveries

Under Alternative 2, it is assumed that the SWP would not participate as a willing seller because SWP M&I contractors with first right of refusal would purchase the water. In addition, the release of acquired water would be prescribed for instream flows and Delta outflow beneficial uses. Therefore, the impacts to the SWP operations and deliveries would be similar to those described under Alternative 1 as summarized in Table IV-5, and shown in the figures described under the discussion of Alternative 1.

ALTERNATIVE 3

Water management provisions in Alternative 3 include all of the provisions included in Alternative 1, as well the acquisition of surface water from willing sellers toward meeting Level 4 water supplies for refuges, and the acquisition of water for increasing instream flows toward flow targets identified in Attachment G-4. Water would be acquired to improve instream flow conditions on the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Yuba rivers. Under Alternative 3, water acquired for instream purposes may be exported by the CVP and SWP when it flows into the Delta.

The Re-operation and (b)(2) Water Management components of Alternative 3 would be similar to these components in Alternative 1. In Alternative 3 (b)(2) water is used for upstream actions on CVP controlled rivers only, and towards meeting 1995 Water Quality Control Plan requirements.

Water Acquisition

Water Acquisition for Level 4 Refuge Water Supplies

Under Alternative 3, water would be acquired in the same quantities and from the same sources described under Alternative 2, to provide Level 4 water supplies to wildlife refuges.

Water Acquisition For Target Flows

Under Alternative 3, surface water would be acquired from willing sellers on the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Yuba rivers for instream flow purposes. The methodology that was described under Alternative 2 would also be applied to water acquisitions in Alternative 3.

Maximum acquisition quantities for instream flows on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba rivers included in Alternative 3 are shown in Table IV- 7. It is assumed that water would be acquired from agricultural water users on these rivers that possess diversion and storage rights. The acquired water would be stored during the period of a contract year, and released in a manner to increase flows toward the targets. It is assumed that acquired water would be stored and released from Lake McClure on the Merced River, New Don Pedro Reservoir on the Tuolumne River, New Melones Reservoir on the Stanislaus River, New Hogan Reservoir on the Calaveras River, Camanche Reservoir on the Mokelumne River, and New Bullards Bar Reservoir on the Yuba River.

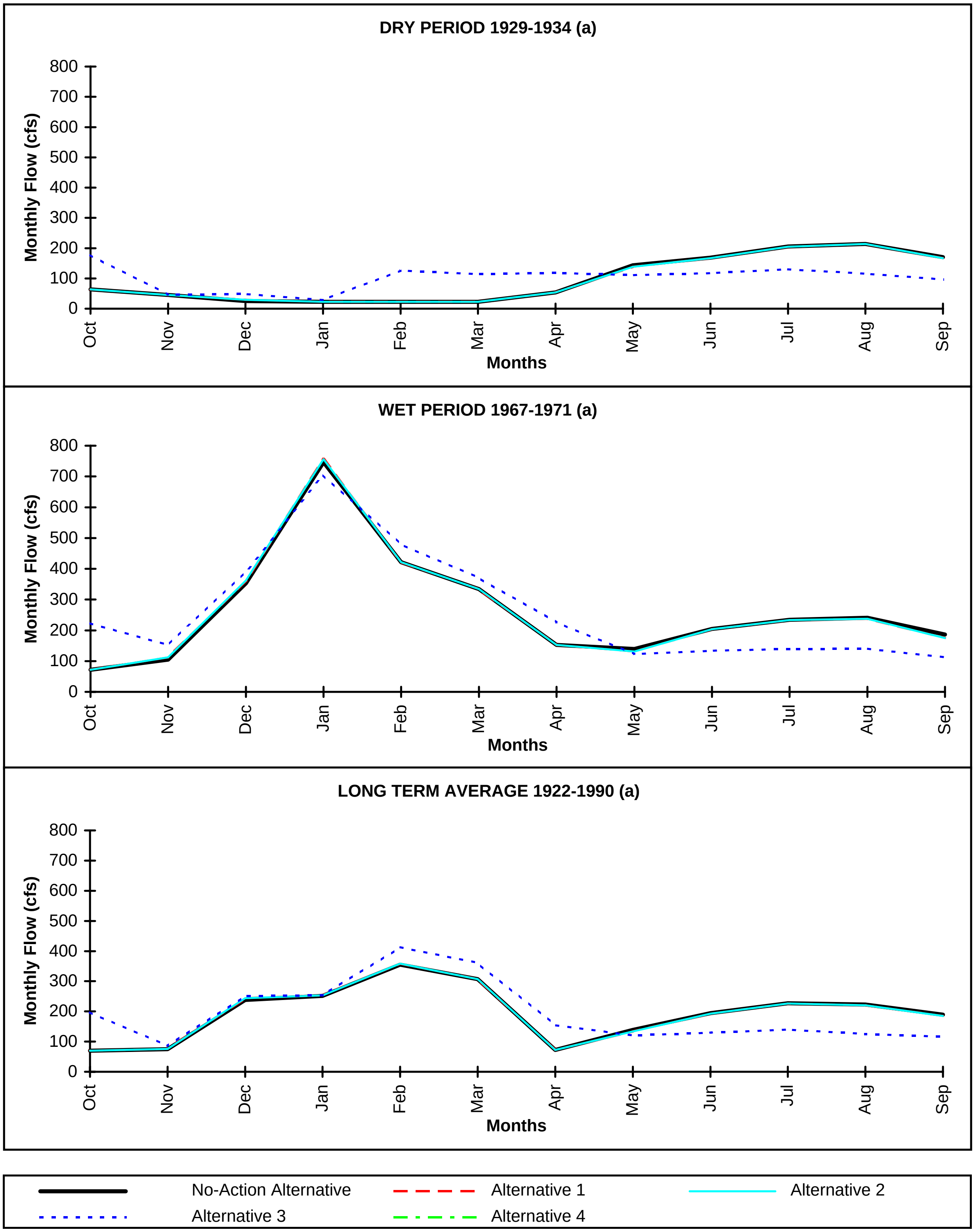
The flow targets for Alternative 3 include spring pulse flow components on the Stanislaus, Tuolumne, and Merced rivers during April through June. Therefore, the primary emphasis for use of acquired water in Alternative 3 is generally during the months of April, May, and June. Releases of acquired water during these months would also provide increased flows at Vernalis, which would contribute toward meeting the Bay-Delta Plan Accord pulse flow requirements, if a portion of the pulse was unmet due to lack of available CVP supplies. A discussion of each of the non-CVP controlled rivers is included below. The Stanislaus River is discussed in the following CVP operations section.

As shown in Figure IV-16, the use of acquired water on the Merced River under Alternative 3 would result in increased flows in all months with the primary emphasis in the April and May, as compared to the No-Action Alternative. During the wet period of 1967-1971, a slight reduction in average flows during January would occur under Alternative 3, as compared to the No-Action Alterative. This would occur primarily as a result of reduced storage conditions that would not require flood control releases. During dry periods, flows would increase in all months.

Similar changes in flow would occur on the Tuolumne River under Alternative 3, as shown in Figure IV-17. Flows would be increased primarily during the April-May spring pulse flow period. Reduced storage levels would reduce required releases for flood control in January. During dry periods, flows would increase in all months.

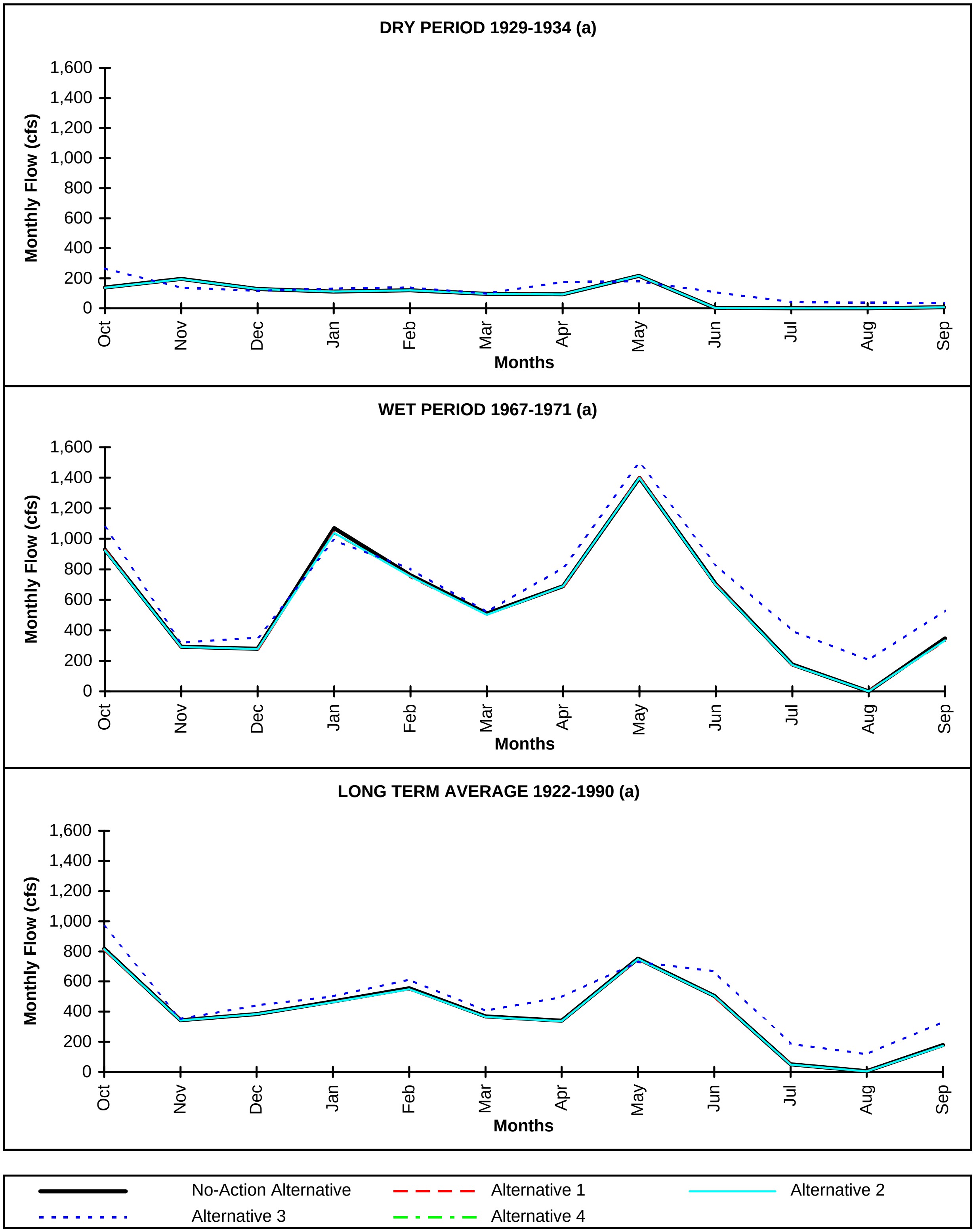
The flow targets on the Calaveras River in Alternative 3 were established for the reach between New Hogan Dam and the Belota Weir. This section of the river conveys releases for downstream agricultural diversion during the summer months. As shown in Figure IV-18, flows on the Calaveras River would increase in the winter and early spring months and decrease in the summer and fall months under Alternative 3 with the use of acquired water.

On the Mokelumne River, releases of acquired water result in increased flows in the fall through spring periods, with the greatest increases in April and May. As shown in Figure IV-19, flows during dry years would not change, due to the limited acquisition quantities during dry years.



NOTE: (a) Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE IV-18
CALAVERAS RIVER BELOW NEW HOGAN
SIMULATED AVERAGE MONTHLY FLOWS



NOTE: (a) Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE IV-19
MOKELUMNE RIVER BELOW WOODBRIDGE
SIMULATED AVERAGE MONTHLY FLOWS

On the Yuba River, releases from New Bullards Bar Reservoir and down stream diversions would be re-operated to provide water toward the flow targets under Alternative 3. As shown in Figure IV-20, the releases of acquired water would result in increased flows in the spring, summer, and fall months, as compared to flows under the No-Action Alternative.

CVP Operations and Deliveries

Under Alternative 3, CVP operations north of the Delta would be similar to those described in Alternative 1. Delta operations and deliveries south of the Delta would change due to the ability to export acquired water in Alternative 3. A brief summary of CVP operations and deliveries is provided below.

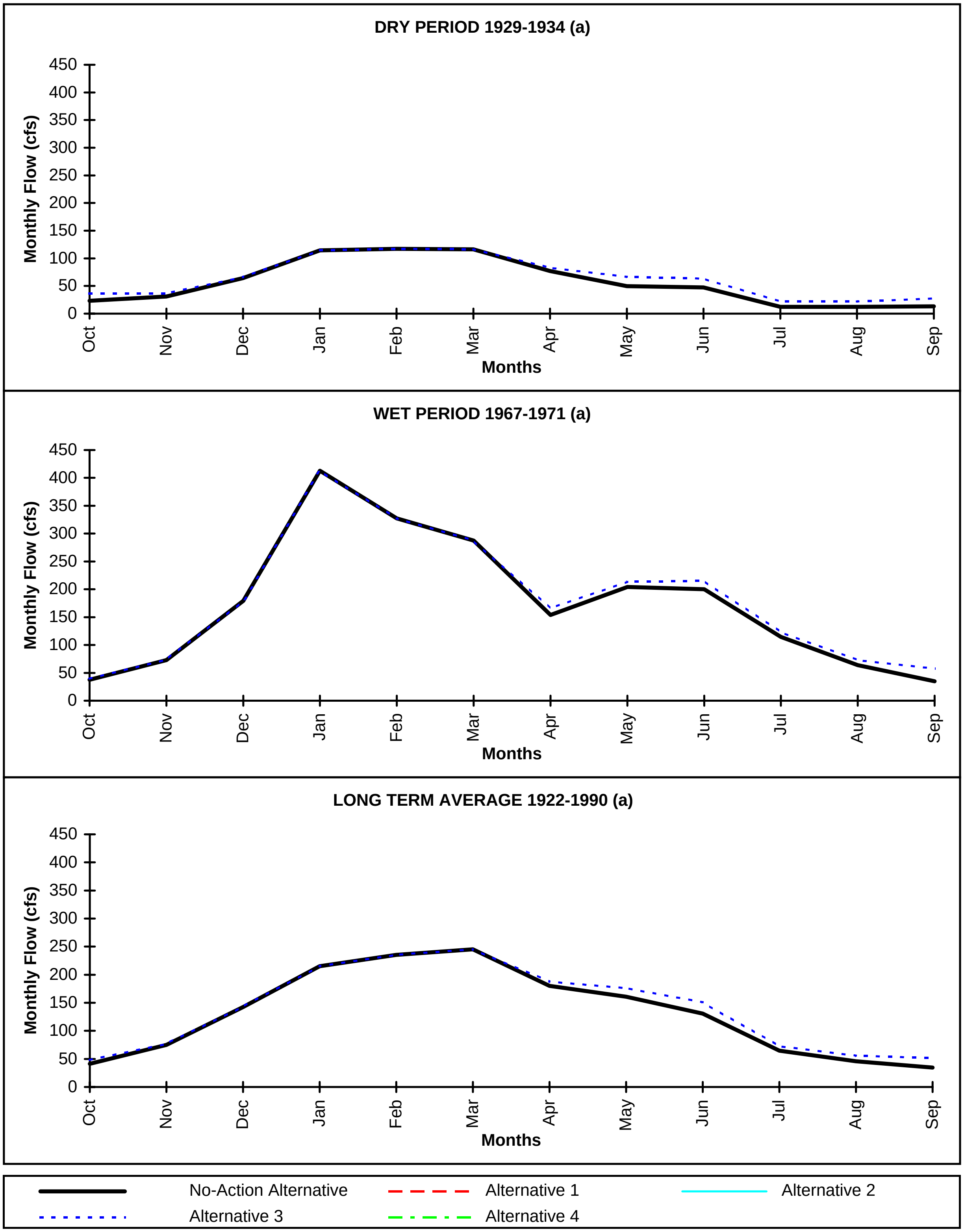
CVP Operations

CVP operations in the Trinity, Shasta, Sacramento River, and American River Divisions would be similar to Alternative 1. Friant Division operations would be similar to the No-Action Alternative. Figures presented in Alternative 1 include the results of Alternative 3 operations and river flows for the these divisions. CVP operations in the Delta, Eastside, and West San Joaquin Divisions would be affected, due to higher San Joaquin River flows and the ability to export acquired water through Tracy Pumping Plant.

Eastside Division. Frequency distributions of simulated end-of-water year storages in New Melones Reservoir are presented in Figure IV-2. As shown on this figure, reservoir storages in Alternative 3 closely resemble storage conditions in Alternative 1, except during periods of near flood control storage levels, and periods with end-of-year storage between 1 and 1.5 million acre-feet. The increases in storage conditions in these circumstances result from a combination of improved flexibility in the operation of New Melones Reservoir due to higher flows on the San Joaquin River upstream of the Stanislaus River, and storage of portions of the acquired water.

The additional flow in the San Joaquin River due to the release of acquired water on both the Merced and Tuolumne rivers would improve water quality conditions, and reduce the quantity of required releases from New Melones necessary to maintain water quality conditions at Vernalis. Under Alternative 3 analysis, New Melones Reservoir operations were modified based on the increased flow on the San Joaquin River. This would result in increasing the frequency that target flows on the Stanislaus River would be met through re-operation and (b)(2) Water Management. End-of-year storage levels in New Melones Reservoir would also increase because a portion of the acquired water would be held through the end of the water year for release in October through December.

As shown in Figure IV-7, simulated average monthly flows in the Stanislaus River below Goodwin Dam under Alternative 3 would increase primarily in the April through June pulse flow period, with additional increases through the fall and winter months, as compared to the No-Action Alternative. The use of acquired water in accordance with biological priorities under Alternative 3 would result in flows below Goodwin Dam greater than 1,500 cfs more frequently than under the No-Action Altnative, or under Alternatives 1 and 2. Historical operations have



NOTE: (a) No-Action Alternative, Alternative 1, and Alternative 2 are identical. Alternative 3 and Alternative 4 are identic

FIGURE IV-20

YUBA RIVER AT MARYSVILLE SIMULATED AVERAGE MONTHLY FLOWS

indicated that flows above 1,500 cfs in this portion of the Stanislaus River can cause seepage and flooding problems to lands adjacent to the river.

The combined contribution of acquired water released on the Merced, Tuolumne, and Stanislaus rivers would result in increased flow in the San Joaquin River at Vernalis, as shown in Figure IV-8. On an average monthly basis, flows on the San Joaquin River at Vernalis would increase in nearly all months, with the increases primarily during April and May. The increased flow would also result in improved monthly water quality conditions, as shown in Figure IV-9. Under Alternative 3, water quality conditions at Vernalis would meet the monthly standards during both the irrigation and non-irrigation seasons in nearly all months of the simulation period.

Delta Division. As a result of upstream water acquisitions, simulated Delta inflows would increase by about 400,000 acre-feet in Alternative 3 as compared to the No-Action Alternative. In Alternative 3 this additional inflow may be exported by the CVP and SWP, as available under the COA. Figure IV-11 shows a comparison of the frequency distributions for simulated Tracy Pumping Plant annual exports. Under Alternative 3, annual exports through the Tracy Pumping Plant would decrease by about 90,000 acre-feet as compared to the No-Action Alternative, and increase by about 170,000 acre-feet as compared to Alternative 1. The CVP ability to export the acquired water is limited because the majority of the acquired water is released in the fall and the spring when Tracy Pumping Plant is already pumping at maximum regulatory or physical capacity. In addition, CVP releases from upstream reservoir cannot be reduced to take advantage of acquired water in the Delta, since (b)(2) water must be released in the fall and spring for upstream flow objectives. Figure IV-10 shows the change in average monthly exports as compared to the No-Action Alternative. Under Alternative 3, simulated Delta outflow would increase by about 200,000 acre-feet as compared to the No-Action Alternative, as shown in Figure IV-12.

West San Joaquin Division. Under Alternative 3, operations of the CVP portion of San Luis Reservoir are similar to those described under Alternative 1. As shown in Figure IV-11, simulated average monthly storage in Alternative 3 would be greater than in the No-Action Alternative, due to a combination of higher fall exports as part of (b)(2) Water Management and higher spring exports of acquired water.

CVP Water Deliveries

The CVP’s ability to export acquired water is limited due to timing, and physical and regulatory limitations. Changes in delivery of water to CVP contractors between Alternative 3 and the No-Action Alternative are summarized in Table IV-3. Deliveries to CVP Sacramento River Water Rights Contractors would be similar to those described in the No-Action Alternative. Deliveries to CVP agricultural and M&I water service contractors north of the Delta and to agricultural water service contractors in the Eastside Division would also be similar to those in Alternative 1, as shown in Figure IV-13.

Deliveries to CVP San Joaquin Exchange Contractors would be similar to those described in the No-Action Alternative. Figure IV-13 shows the comparison of frequency distributions for CVP agricultural and M&I water service contractor deliveries as compared to the No-Action Alternative. The figure shows that water service contractors receive greater deliveries than in

Alternative 1, due to the export of acquired water after it reaches the Delta. Alternative 3 includes annual deliveries of Level 4 water supplies to refuges as shown in Table IV- 4.

SWP Operations and Deliveries

SWP Operations

SWP operations and deliveries under Alternative 3 would be affected by the ability to export acquired water through Banks Pumping Plant. The large capacity of Banks Pumping Plant and the SWP's flexibility to reduce Lake Oroville release would allow the SWP to adapt operations to take advantage of the acquired water as it becomes available in the Delta.

Lake Oroville and Feather River Operations. The slight differences in Lake Oroville end-of -water year storage are shown in a comparison of frequency distributions for Alternative 3 and the No-Action Alternative, in Figure IV-2. The difference in average monthly flows in the Feather River at Nicolaus are shown in Figure IV-14.

Delta Operations. SWP Banks Pumping Plant exports would increase in Alternative 3 by 270,000 acre-feet as compared to the No-Action Alternative. Frequency distributions for annual SWP exports are shown in Figure IV-11, and average monthly Banks Pumping Plant exports are shown in Figure IV-15.

San Luis Reservoir Operations. The Alternative 3 SWP average monthly storage in San Luis Reservoir is similar to the No-Action Alternative as shown in Figure IV-11.

SWP Water Deliveries

Annual deliveries to SWP agricultural and M&I entitlement holders south of the Delta under Alternative 3 would increase by an average of 270,000 acre-feet over the No-Action Alternative. This would occur because acquired water can be exported through Banks Pumping Plant after it reaches the Delta. A comparison of deliveries to SWP contractors in the Alternative 3 simulation, as compared to deliveries in the No-Action Alternative simulation is provided in Table IV-5. Figure IV-13 shows a comparison of the SWP delivery frequency distributions for Alternative 3 and the No-Action Alternative.

ALTERNATIVE 4

Alternative 4 includes (b)(2) Water Management to meet target flows on CVP controlled streams and towards 1995 Water Quality Control Plan requirements, the delivery of firm Level 2 water supplies to wildlife refuges, and the revised minimum streamflow requirements on the Trinity River, as described under Alternative 1. In addition, Alternative 4 includes the acquisition of water for the delivery of Level 4 water supplies to wildlife refuges, as described under Alternative 2, and the acquisition of water for instream flows as described under Alternative 3. In addition, Alternative 4 includes the (b)(2) water managment Delta component and attempts to meet AFRP objectives in the Delta. A simplified version of (b)(2) Water Management was developed that integrated Delta (b)(2) water actions into Alternative 4. In contrast to the proposed preliminary February 1996 Delta (b)(2) actions that were evaluated in

Supplemental Analysis 1a, the Delta (b)(2) actions evaluated in Alternative 4 were developed based on preliminary information released by the Service in October 1996, which is presented in Attachment G-5. The Delta (b)(2) actions outlined in Attachment G-5 are a refinement of the preliminary potential actions originally proposed in February 1996, and represent possible goals for long-term actions.

Water Acquisition

Under Alternative 4, water would be acquired from willing sellers to improve instream flows and to increase Delta outflow. The acquisition quantities, and the use of water for instream flow would be the same as those described under Alternative 3. Water would be acquired for increased instream flows on the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Yuba rivers. Water would also be acquired for delivery of Level 4 water supplies to wildlife refuges, in the same manner as described under Alternative 2. Figures IV-16 through IV-20 show the Alternative 4 flows on the above rivers, except for the Stanislaus River which is described in the section on Eastside Division operations.

CVP Operations and Deliveries

CVP operations and water deliveries under Alternative 4 would be affected by the integrated use of (b)(2) water for upstream and Delta objectives. Deliveries to CVP contractors under Alternative 4 would be similar to deliveries under Alternative 1. Deliveries would not increase in alternative 4 as a result of water acquired from willing sellers, since the water is acquired for instream and Delta outflow purposes, and therefore cannot be exported by the CVP. The CVP does receive some incidental benefit toward meeting Delta water quality and outflow requirements, since the increase in Delta outflow from acquired water improves monthly antecedent conditions in the Delta.

CVP Operations

CVP operations in the Trinity, Shasta, Sacramento River, and American River Divisions would be similar to those described under Alternative 1. Operations of upstream CVP reservoirs would occur due to changes in Delta operations, but because the operation of these reservoirs is dominated by the need to make releases for water rights, upstream (b)(2) water objectives, and biological opinion requirements, the changes would be minor. Figures presented under Alternative 1 show a comparison of Alternative 4 operations and river flows for the above divisions, as compared to the No-Action Alternative. Friant Division operations would be similar to the No-Action Alternative.

Eastside Division operations would be similar to Alternative 3 because of the acquisition of water from willing sellers on the Stanislaus, Tuolumne, and Merced rivers is identical in Alternatives 3 and 4. Operations in the Delta and West San Joaquin Divisions would be the most affected due to higher Delta inflows from acquired water and the additional Delta (b)(2) actions. The operations of these divisions are discussed below.

Delta Division. As a result of upstream water acquisitions, simulated Delta inflows increase by about 400,000 acre-feet in Alternative 4 as compared to the No-Action Alternative.

In Alternative 4 this additional inflow may not be exported by the CVP, since it was acquired for instream and Delta outflow purposes. Tracy Pumping Plant exports decrease by about 300,000 acre-feet as compared to the No-Action Alternative, and decrease by about 40,000 acre-feet as compared to Alternative 1. Figure IV-11 shows the frequency distributions for simulated annual Tracy Pumping Plant exports for Alternative 4 and the No-Action Alternative. The Delta (b)(2) actions in Alternative 4 limit Tracy Pumping Plant exports April 15 through May 15, and require that additional water be released from upstream reservoirs in February through June for additional X2 requirements. Figure IV-10 shows the decrease in average monthly Tracy Pumping Plant exports as compared to the No-Action Alternative.

Simulated Delta outflow increases by about 780,000 acre-feet as compared to the No-Action Alternative. Average monthly Delta outflows in the No-Action Alternative and Alternative 4 simulations are presented in Figure IV-12. The primary increase in Delta outflow occurs in April and May due to the increase in Delta inflows from acquired water upstream releases, the reductions in Tracy and Banks Pumping Plant exports, and additional (b)(2) water releases for increased number of X2 days in May and June.

Some of the Delta (b)(2) actions could not be implemented in all years over the 69-year simulation period due to existing operational constraints and criteria. These constraints include the need to meet water rights requirements, maintain SWP deliveries at the No-Action Alternative level, and maintain Reclamation's ability to provide adequate storage in Shasta Lake to meet Winter Run Biological Opinion temperature control requirements. For a detailed description of the implementation of (b)(2) Water Management in the Delta, see the Surface Water Supplies and Facilities Operations Technical Appendix.

West San Joaquin Division. Operations of the CVP portion of San Luis Reservoir are similar to Alternative 1. As shown in Figure IV-11, Alternative 4 simulated average monthly storage is greater in March than in the No-Action Alternative. This is caused by higher fall exports due to upstream CVP reservoir releases for (b)(2) Water Management. CVP San Luis Reservoir storage is also reduced earlier in the spring due to reduced Tracy Pumping Plant exports in April and May.

CVP Water Deliveries

In Alternative 4, upstream acquired water would not be exported through Tracy Pumping Plant when it reaches the Delta. Therefore the major effect on CVP deliveries is due to the additional (b)(2) actions in the Delta. These actions have minor effects on CVP deliveries north of the Delta, and primarily impact deliveries south of the Delta dependent on Tracy Pumping Plant exports. The changes in water deliveries to CVP contractors between Alternative 4 and the No-Action Alternative are summarized in Table IV-3.

Deliveries to CVP Sacramento River Water Rights Contractors would be similar to those described in the No-Action Alternative. Deliveries to CVP agricultural and M&I water service contractors north of the Delta would be similar to those in Alternative 1. The deliveries to CVP agricultural water service contractors in the Eastside division would be similar to those described in Alternative 1. Figure IV-13 show a comparison of the Alternative 4 and No-Action Alternative percent of full deliveries.

Deliveries to CVP San Joaquin Exchange Contractors would be similar to those described in the No-Action Alternative. Figure IV-13 shows the comparison of frequency distributions for CVP agricultural and M&I water service contractor deliveries as compared to the No-Action Alternative. The figure shows that CVP water service contractors south of the Delta receive lower deliveries than in the No-Action Alternative, and slightly lower than in Alternative 1. The limitations on Tracy Pumping Plant April and May exports directly impact the amount of water that can be delivered to southern water service contractors.

Alternative 4 annual deliveries of Level 4 water supplies to refuges are the same as in Alternatives 2 and 3, as shown in Table IV-4.

SWP Operations and Deliveries

For the purposes of the PEIS (b)(2) Water Management analysis, it was assumed that the SWP would cooperate with implementation of the Delta (b)(2) actions by reducing exports during specified periods and making releases to contribute to additional levels of Delta protection. It was also assumed that any negative impacts to the SWP, due to this cooperation in Alternative 4, would not exceed the benefits shown in Alternative 1. Therefore, there would be no net impact to average annual SWP deliveries as compared to the No-Action Alternative.

SWP Operations

Alternative 4 SWP operations and deliveries are affected by (b)(2) Water Management upstream and in the Delta. The upstream CVP reservoir releases, in the fall for (b)(2) water flow targets, provide additional excess Delta inflow that can exported by the SWP. The Delta (b)(2) actions limit Banks Pumping Plant exports April 15 through May 15, and require SWP releases for the additional number of X2 days in May and June. The increase in Delta outflow due to the acquisition of water from upstream willing sellers provides incidental benefits to the SWP by improving antecedent monthly water quality conditions, so that Lake Oroville releases may be reduced in some months.

The slight differences in simulated Lake Oroville end-of-water year storage are shown in a comparison of frequency distributions for Alternative 4 and the No-Action Alternative, in Figure IV-2. The Alternative 4 simulated Feather River flows at Nicolaus are similar to the No-Action Alternative as shown in the comparison of average monthly flows in Figure IV-14.

Average annual SWP Banks Pumping Plant exports in Alternative 4 are similar to the No-Action Alternative. Figure IV-11 shows a comparison of the frequency distributions for annual SWP exports. The reduction in average monthly Banks Pumping Plant exports in April and May as compared to the No-Action Alternative is shown in Figure IV-15. The Alternative 4 simulated SWP average monthly storage in San Luis Reservoir is similar to the No-Action Alternative as shown in Figure IV-11. SWP storage declines more rapidly in the April and May due to the reduced Banks Pumping Plant exports in those months.

SWP Water Deliveries

Alternative 4 simulated average annual deliveries to SWP agricultural and M&I entitlement holders south of the Delta are similar to the No-Action Alternative. A comparison of deliveries to SWP contractors in the Alternative 4 simulation, as compared to deliveries in the No-Action Alternative simulation, is provided in Table IV-5. Figure IV-13 shows a comparison of the simulated SWP percent of full delivery frequency distributions for Alternative 4 and the No-Action Alternative. Full deliveries are slightly reduced, but deliveries in other years are greater than in No-Action Alternative resulting in similar average annual values.

GROUNDWATER

This section describes changes to groundwater conditions associated with the CVPIA alternatives, as compared to the No-Action Alternative. Changes in groundwater conditions are presented for the study area shown in Figure IV-21, based on a quantitative analysis of the Central Valley region, and a qualitative analysis of groundwater resources associated with CVP service areas in the San Francisco Bay Region. A summary of the assumptions associated with each of the Alternatives and Supplemental Analyses for the groundwater analyses is presented in Table IV-8. A summary of the groundwater impact assessment is presented in Table IV-9.

Groundwater conditions in the Central Valley regional aquifer system were simulated using the Central Valley Groundwater-Surface Water Simulation Model (CVGSM), a monthly planning model developed for the Central Valley regional aquifer system. Groundwater conditions were simulated using a 69-year historic hydrologic period under specified projected-level land use conditions. The 69-year period spans dry, wet, and normal hydrologic conditions. Imposing these conditions on the regional aquifer system provides a range of possible impacts.

Groundwater impacts for each alternative are summarized as changes to groundwater storage, groundwater levels, and land subsidence as compared to the No-Action Alternative. These conditions represent the groundwater basins general response to changes in crop mix and irrigation technologies, surface water and groundwater use, and stream flow. Changes in groundwater storage are summarized for long-term average annual conditions. These changes indicate the ability of a groundwater basin to support water and land use management practices for each alternative. Groundwater levels at the end of the 69-year simulation period are compared between each alternative and the No-Action Alternative. The end of the simulation period was chosen in order to represent long-term differences in groundwater conditions. Groundwater level differences provide a measure of associated groundwater impacts such as pumping costs, changes in groundwater-surface water interaction, migration and up welling of poor-quality groundwater, impairment of subsurface drainage systems in areas of poorly-drained soils, and high groundwater tables adjacent to streams with known seepage-induced waterlogging problems of adjacent low-lying farm lands. These potential problems are all inferred from groundwater level differences between each alternative and the No-Action Alternative and are discussed qualitatively below, with the exception of pumping costs discussed under agricultural economics.

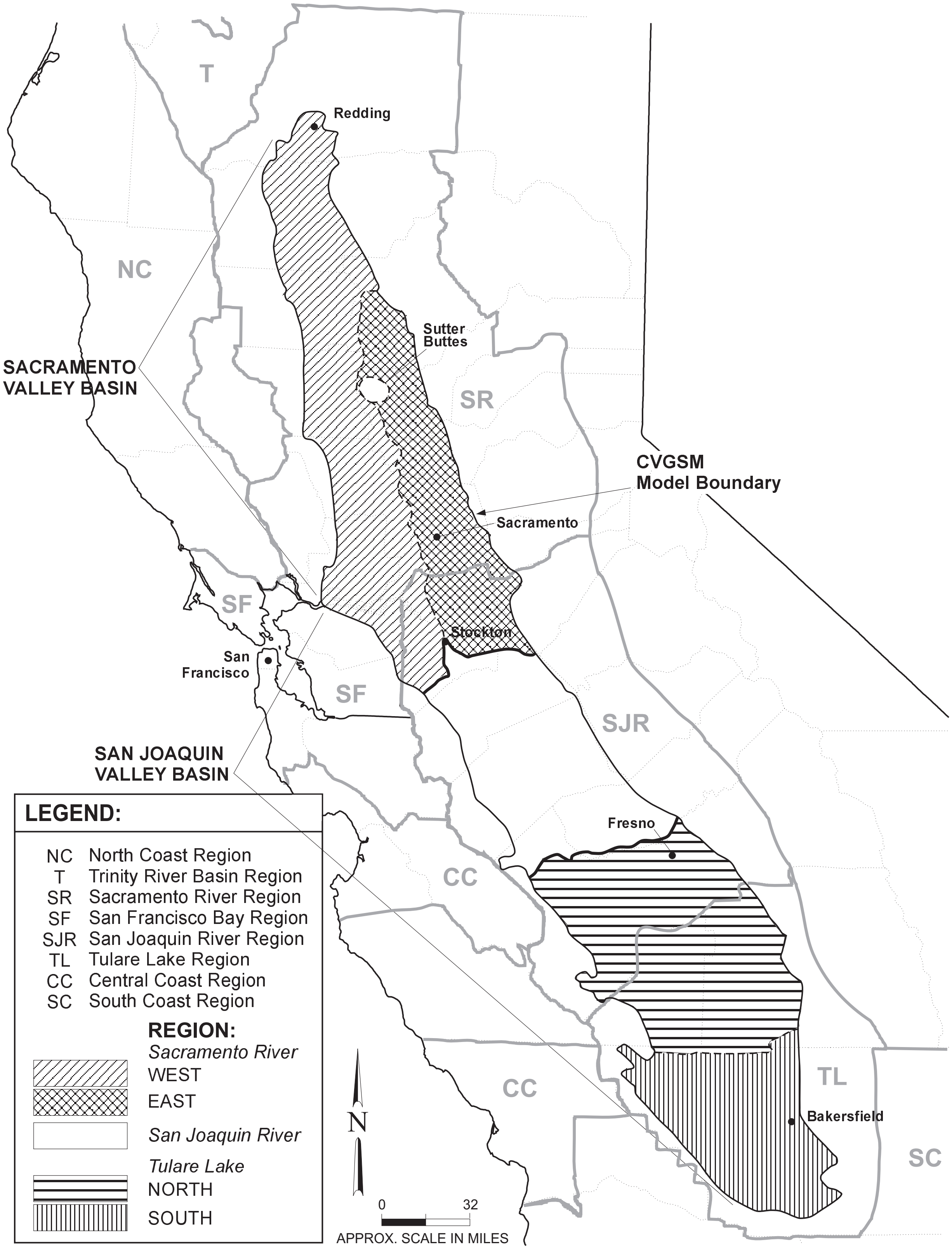


FIGURE IV-21

CVGSM MODEL AREA AND SUBREGION BOUNDARY

TABLE IV-8

SUMMARY OF ASSUMPTIONS FOR GROUNDWATER

Assumptions Common to All Alternatives or Supplemental Analyses	
Water Delivery Information based on Surface Water Analysis. Irrigated land use, applied water, and groundwater use consistent with Agricultural Economics and Land Use analysis.	
Alternative or Supplemental Analysis	**Assumptions Specific to the Alternative or Supplemental Analysis**
No-Action Alternative	Continued use of groundwater per California Department of Water Resources projections in Bulletin 160-93 and economic considerations.
1	Same as No-Action Alternative plus: Allow groundwater withdrawals to replace reductions in CVP deliveries due to implementation of (b)(2), level 2 refuge water supplies, and increased Trinity River instream fishery flows. Decrease groundwater withdrawals in response to implementation of San Joaquin Valley Drainage Program land retirement recommendations.
1a	Increase groundwater withdrawals to replace reductions in CVP deliveries due to implementation of (b)(2) water in the Delta.
1b	Same assumptions as Alternative 1.
1c	Allow groundwater withdrawals to replace reductions in CVP deliveries due to price increases.
1d	Same assumptions as Alternative 1.
1e	Conditions are similar to Alternative 1 except in dry years when site specific transfer operations may lead to reduction in applied water and associated groundwater recharge. Further site specific analysis will be required.
1f	Conditions are similar to Supplemental Analysis 1e.
1g	Same assumptions as Alternative 1.
1h	Same assumptions as Alternative 1.
1i	Same assumptions as Alternative 1.
2	Same as Alternative 1 plus: No increase in groundwater withdrawals to replace acquired surface water. No acquisition of groundwater.
2a	Same as Alternative 2.
2b	Conditions are similar to Alternative X2 except in dry years when site specific transfer operations may lead to reduction in applied water and associated groundwater recharge. Further site specific analysis will be required.
2c	Conditions are similar to Supplemental Analysis 2b.

TABLE IV-8. CONTINUED

Alternative or Supplemental Analysis	Assumptions Specific to the Alternative or Supplemental Analysis
2d	Allow groundwater withdrawals to replace reductions in CVP deliveries due to price increases.
3	Same as Alternative 2 plus: No increase in groundwater withdrawals to replace acquired surface water. No acquisition of groundwater.
3a	No additional groundwater withdrawals due to surface water transfers.
4	Same as Alternative 3 plus: No increase in groundwater withdrawals to replace acquired surface water. No acquisition of groundwater.
4a	No additional groundwater withdrawals due to surface water transfers.

TABLE IV-9

SUMMARY OF IMPACT ASSESSMENT FOR GROUNDWATER

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	**Average Regional Depth to Groundwater** Sacramento River Region (west): 94 feet. Sacramento River Region (east): 100 feet. San Joaquin River Region: 85 feet. Tulare Lake Region (north): 200 feet. Tulare Lake Region (south): 313 feet. **Potential for Long-Term Change in Subsidence** Sacramento River Region: increase above Affected Environment near Davis-Zamora. San Joaquin River Region: increase above Affected Environment on westside. Tulare Lake Region: increase above Affected Environment on westside.
	Changes Compared to the No-Action Alternative
1	**Change in Average Regional Depth to Groundwater** Sacramento River Region (west): no change. Sacramento River Region (east): increase depth 2 percent. San Joaquin River Region: increase depth 2 percent. Tulare Lake Region (north): increase depth 3 percent. Tulare Lake Region (south): decrease depth 1 percent. **Potential for Long-Term Change in Subsidence** Sacramento River Region: same as No-Action Alternative. San Joaquin River Region: increase from No-Action Alternative. Tulare Lake Region: increase from No-Action Alternative.
	Changes Compared to Alternative 1
1a	Conditions are similar to Alternative 1 except in Tulare Lake Region (north) where average regional depth to groundwater increases by 6 percent.
1b	Conditions are similar to Alternative 1.
1c	Changes in groundwater conditions will depend on revised surface water operations. Use of non-delivered CVP water not determined at this time.
1d	Conditions are similar to Alternative 1.
1e	Conditions are similar to Alternative 1, except in dry years when site specific transfer operations may affect surface water operations. Further site specific analyses will be required.
1f	Conditions are similar to Supplemental Analysis 1e.
1g	Conditions are similar to Alternative 1.
1h	Conditions are the same as Alternative 1.
1i	Conditions are the same as Alternative 1.

TABLE IV-9. CONTINUED

	Changes Compared to the No-Action Alternative
2	**Change in Average Regional Depth to Groundwater** Sacramento River Region (west): increase depth 1 percent. Sacramento River Region (east): increase depth 2 percent. San Joaquin River Region: increase depth 3 percent. Tulare Lake Region (north): increase depth 4 percent. Tulare Lake Region (south): decrease depth 1 percent. **Potential for Long-Term Change in Subsidence** Sacramento River Region: same as No-Action Alternative. San Joaquin River Region: similar to Alternative 1. Tulare Lake Region: similar to Alternative 1.
	Changes Compared to Alternative 2
2a	Conditions are similar to Alternative 2.
2b	Conditions are similar to Alternative 2, except in dry years when site specific transfer operations may affect surface water operations. Further site specific analyses will be required.
2c	Conditions are similar to Supplemental Analysis 2b.
2d	Changes in groundwater conditions will depend on revised surface water operations. Use of non-delivered CVP water not determined at this time.
	Changes Compared to the No-Action Alternative
3	**Change in Average Regional Depth to Groundwater** Sacramento River Region (west): increase depth 1 percent. Sacramento River Region (east): increase depth 5 percent. San Joaquin River Region: increase depth 4 percent. Tulare Lake Region (north): increase depth 1 percent. Tulare Lake Region (south): decrease depth 3 percent. **Potential for Long-Term Change in Subsidence** Sacramento River Region: same as No-Action Alternative. San Joaquin River Region: less than Alternative 1. Tulare Lake Region: less than Alternative 1.
3a	Conditions are similar to Alternative 3, except in dry years when site specific transfer operations may affect groundwater operations. Further site specific analyses will be required.
	Changes Compared to the No-Action Alternative
4	**Change in Average Regional Depth to Groundwater** Sacramento River Region (west): increase depth 1 percent. Sacramento River Region (east): increase depth 5 percent. San Joaquin River Region: increase depth 5 percent. Tulare Lake Region (north): increase depth 5 percent. Tulare Lake Region (south): decrease depth 1 percent. **Potential for Long-Term Change in Subsidence** Sacramento River Region: same as No-Action Alternative. San Joaquin River Region: similar to Alternative 1. Tulare Lake Region: increase from Alternative 1.
4a	Conditions are similar to Alternative 4, except in dry years when site specific transfer operations may affect groundwater operations. Further site specific analyses will be required.

Declining groundwater levels can also be indicative of potential land subsidence in areas where clay and silt lenses susceptible to compaction are prevalent. The occurrence of land subsidence can damage water conveyance facilities, flood control and drainage levee systems, groundwater well casings, and other infrastructure. The CVGSM model simulates land subsidence based on aquifer compaction theory developed by the USGS. Potential land subsidence impacts for each alternative as compared to the No-Action Alternative are based on long-term land subsidence, which for this analysis is derived from the end of the 69-year simulation period.

NO-ACTION ALTERNATIVE

Central Valley Region

Groundwater levels representing the end of the 69-year simulation of the No-Action Alternative are shown in Figure IV-22. Along the west side of the Sacramento River Region the groundwater gradient tends to follow surface hydrographic features, except for a groundwater depression in the Yolo County area. This type of groundwater gradient suggests that groundwater conditions are near a state of equilibrium, as supported by the small change in the long-term average annual groundwater storage shown in Table IV-10. The hydraulic connection between streams and the underlying groundwater tables in these areas would be maintained similar to recent historic conditions. Groundwater levels on the east side of the Sacramento River Region are dominated by groundwater level depressions occurring north and south of the City of Sacramento, and in eastern San Joaquin County. These conditions are a reflection of groundwater use in excess of groundwater recharge, and would result in an average annual groundwater storage decline of 60,000 acre-feet. Hydraulic disconnection between stream reaches and underlying groundwater tables has developed historically in these areas, and under the No-Action Alternative would likely expand to affect larger reaches of these streams.

Land subsidence is known to occur in central Yolo County (see Davis-Zamora area, Figure VI-22). Under the No-Action Alternative, with groundwater levels declining in this area, increased land subsidence would likely occur relative to recent historic conditions. Groundwater quality would likely be degraded due to the induced migration of groundwater, high in total dissolved solids (TDS), known to exist south of the Sutter Buttes and southern Yolo County, towards depressed groundwaters to the south and east of this areas. Potential Boron problems in central Yolo County could also contribute to groundwater quality degradation from this induced migration. Agricultural subsurface drainage problems in the Sacramento River Region would not be altered as a result of prevailing groundwater conditions, and are expected to be similar to recent historic conditions. Average flows in the Sacramento River are similar or lower than recent historic conditions in isolated areas subject to seepage-induced waterlogging. In addition, high groundwater tables did not encroach on these areas.

It is expected that waterlogging of low-lying farm land in these areas under the No-Action Alternative in the Sacramento River Region would not be altered as a result of prevailing groundwater conditions.

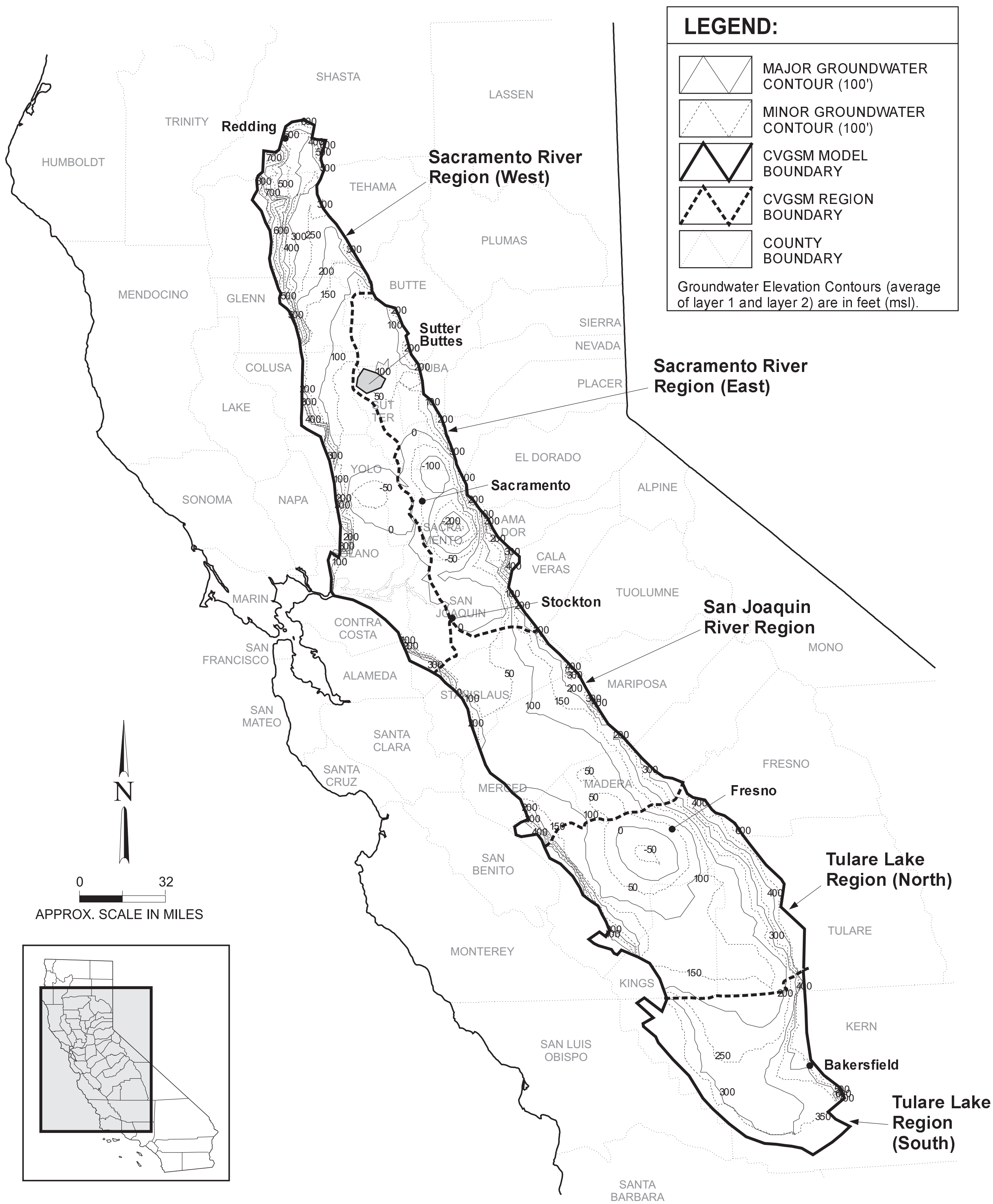


FIGURE IV-22

END OF SIMULATION GROUNDWATER ELEVATIONS FOR NO-ACTION ALTERNATIVE

TABLE IV-10

AVERAGE ANNUAL CENTRAL VALLEY GROUNDWATER CONDITIONS 1922-1990 FOR ALTERNATIVES 1 THROUGH 4 AS COMPARED TO THE NO-ACTION ALTERNATIVE

	ALTERNATIVE (a)					DIFFERENCE (Alternative minus No-Action Alternative) (a)			
	No-Action	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Sacramento River Region (West)									
Total Recharge	2034	2066	2065	2057	2062	32	31	23	28
Total Discharge	2038	2076	2074	2066	2071	38	36	28	33
Change in Groundwater Storage	-4	-10	-9	-9	-9	-6	-5	-5	-5
Sacramento River Region (East)									
Total Recharge	1725	1753	1760	1802	1803	28	35	77	78
Total Discharge	1785	1817	1825	1870	1872	32	40	85	87
Change in Groundwater Storage	-60	-64	-65	-68	-69	-4	-5	-8	-9
San Joaquin River Region									
Total Recharge	1849	1883	1894	1912	1902	34	45	63	53
Total Discharge	1875	1915	1928	1949	1944	40	53	74	69
Change in Groundwater Storage	-26	-32	-34	-37	-42	-6	-8	-11	-16
Tulare Lake Region (North)									
Total Recharge	3799	3833	3844	3802	3846	34	45	3	47
Total Discharge	4043	4129	4145	4057	4162	86	102	14	119
Change in Groundwater Storage	-244	-296	-301	-255	-316	-52	-57	-11	-72
Tulare Lake Region (South)									
Total Recharge	1529	1513	1518	1490	1521	-16	-11	-39	-8
Total Discharge	1411	1380	1384	1337	1395	-31	-27	-74	-16
Change in Groundwater Storage	118	133	134	153	126	15	16	35	8

NOTES:

(a) All values in 1,000 acre-feet/year. For the purposes of presenting model results, data presented here have been rounded to the nearest 1,000 acre-feet. This may introduce small rounding error into the reported values.

Under the No-Action Alternative groundwater levels at the end of the 69-year simulation on the east side of the San Joaquin River and Tulare Lake regions also generally follow hydrographic features associated with the San Joaquin River major tributaries and Tulare Lake Region streams. The hydraulic connection between San Joaquin River tributaries and underlying groundwater tables is similar to recent historic conditions. Portions of east side streams are hydraulically disconnected from underlying groundwater tables under recent conditions. From Madera County south to the Tulare-Kern County boundary, simulated groundwater levels are lower in comparison to recent historic conditions, increasing the extent of this hydraulic disconnection.

Along the west side of the San Joaquin River Region groundwater levels vary gradually over much of the region. Groundwater levels in the extreme northern end decline towards groundwater depression areas in eastern San Joaquin County, and in the southern end they decline in the direction of depressed groundwater levels occurring in Fresno County. This large depression area is associated with an average annual groundwater storage decline that would occur in the Tulare Lake Region (North) of 243,000 acre-feet, the largest regional storage decline of the No-Action Alternative. Much of the available water supplies have been augmented historically with surface water imported through the San Luis Canal and Friant-Kern Canal. However, under the No-Action Alternative projected level conditions, groundwater pumping would still occur at a rate in excess of groundwater storage replenishment.

Land subsidence is known to occur along the west side of the San Joaquin River and Tulare Lake regions as well as the southwestern portion of Tulare County and the southern end of Kern County. For the No-Action Alternative, increased land subsidence in this area would likely occur relative to recent historic conditions. Groundwater quality, under the No-Action Alternative for the San Joaquin River Region, would be similar to recent historic conditions. However, in the Tulare Lake Region groundwater quality would most likely be degraded due to the induced migration of groundwater with high TDS levels along the west side into the depressed groundwater levels in the mid-valley area, and possible up welling of saline groundwater into productive groundwater zones. Groundwater contaminated with dibromochloropropane in eastern Fresno County could also be mobilized towards these depressed groundwater level areas. Some improvement of historic drainage and seepage problems would be expected as a result of regional groundwater level declines along the west side of the southern San Joaquin River Region and the west side of the Tulare Lake Region. However, increases in groundwater levels in the southern end of the Tulare Lake Region could possibly hinder agricultural subsurface drainage in areas of poorly-drained soils.

San Francisco Bay Region

Groundwater resources of the San Francisco Bay Region are addressed qualitatively for areas receiving CVP project water. For the purposes of this analysis, present groundwater conditions described in Affected Environment are used as a frame of reference for determining potential impacts due to changes in CVP deliveries.

Groundwater resources in Santa Clara and San Benito counties are currently managed to minimize groundwater overdraft, land subsidence, and groundwater quality degradation. This task is facilitated by CVP project water imports via the San Felipe Division. Groundwater resources in parts of Alameda and Contra Costa counties are limited due to availability of supply, and poor water quality, and can result in groundwater overdraft and land subsidence in the absence of alternative supplies. The continued importation of CVP project water supplements these limited supplies and reduces the likelihood of further groundwater-related impacts.

ALTERNATIVE 1

The groundwater analysis for the Central Valley regional aquifer assumes groundwater pumping would increase to replace reductions in CVP or SWP deliveries to the extent that groundwater is economically feasible. In addition, Alternative 1 assumes that approximately 30,000 acres of land would be retired in the San Joaquin Valley in accordance with the San Joaquin Valley Drainage Program recommendations (SJVDP, 1990). This action results in reduced groundwater pumping in areas with retired lands.

Central Valley Region

The difference in groundwater levels at the end of the 69-year simulation between Alternative 1 and the No-Action Alternative are shown in Figure IV-23. This comparison indicates long-term regional groundwater conditions in the Sacramento River and San Joaquin River regions would be similar to the No-Action Alternative, with the exception of several isolated cases where groundwater levels would be lower by 10 to 20 feet. These differences would occur in response to reduced CVP project deliveries relative to the No-Action Alternative. These small declines would increase seepage rates of streams in contact with underlying groundwater tables. Regionally, the extent of hydraulic connection would not be greatly affected by these groundwater level changes, and would be similar to the No-Action Alternative. In the Sacramento River Region no additional land subsidence or changes in agricultural subsurface drainage conditions in comparison to the No-Action Alternative would occur. In the Sacramento River and San Joaquin River regions no change in groundwater quality or seepage-induced waterlogging relative to the No-Action Alternative would occur. Agricultural subsurface drainage conditions in the San Joaquin River Region would improve relative to the No-Action Alternative as a result of land retirement of approximately 1,200 acres in areas of poorly-drained soils.

Groundwater levels for Alternative 1 would be lower in comparison to the No-Action Alternative along the west side of the Tulare Lake Region, particularly in the northern portion of this region where differences exceeded 80 feet at the end of the 69-year simulation period. The groundwater budget for Tulare Lake Region (North) shows an overall increase in total recharge, but a larger increase in pumping. An increase in groundwater pumping of approximately 15 percent above the No-Action Alternative would occur in areas of this region receiving CVP project water. This increase is in response to decreased CVP Delta exports to these areas due to the dedicated water component of Alternative 1. This increase would be partially offset by decreased groundwater pumping in areas with land retirement. Total land retirement in the Tulare Lake Region (North) is approximately 17,200 acres. Average annual groundwater storage would decline an additional 20 percent relative to the No-Action Alternative.

The groundwater budget for the Tulare Lake Region (South) indicates groundwater recharge and pumping would decrease under Alternative 1 in comparison to the No-Action Alternative. The decrease in average groundwater pumping would occur in response to additional SWP Delta

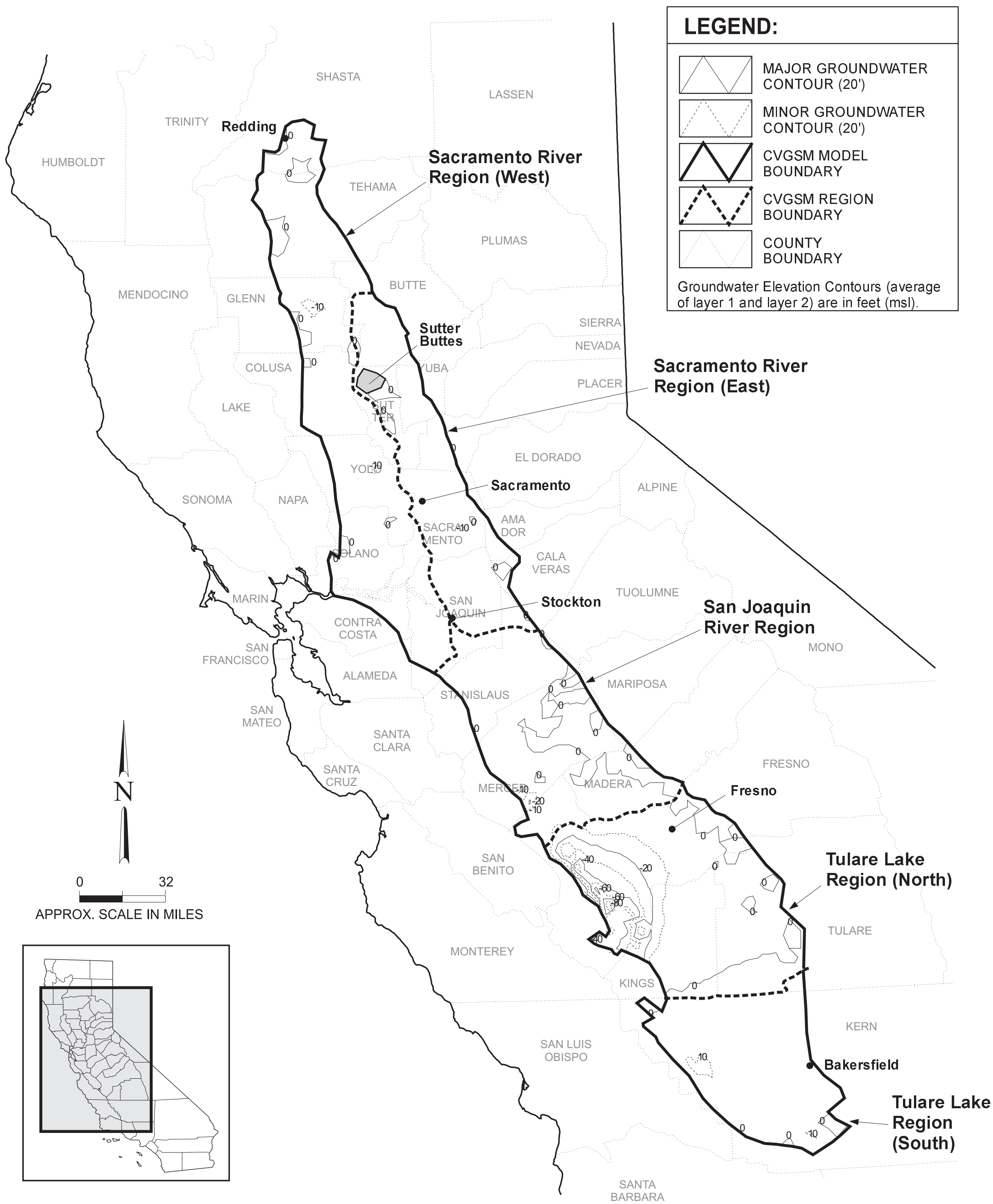


FIGURE IV-23

DIFFERENCES IN END OF SIMULATION GROUNDWATER ELEVATIONS FOR ALTERNATIVE 1 AS COMPARED TO NO-ACTION ALTERNATIVE

exports and land retirement. Total land retirement in the Tulare Lake Region (South) is approximately 11,600 acres. Groundwater levels in this area generally increased slightly in comparison to the No-Action Alternative.

The groundwater level differences along the west side of the southern San Joaquin River Region and the northern Tulare Lake Region would result in additional land subsidence, as shown in Figure IV-24, and would occur in the vicinity of the Delta-Mendota Canal and California Aqueduct. The presence of lower groundwater levels along the west side of the Tulare Lake Region in relation to No-Action Alternative could possibly cause additional up welling of poor-quality groundwater into productive groundwater zones. Agricultural subsurface drainage problems would improve in comparison to the No-Action Alternative as a result of land retirement of approximately 28,800 acres in areas of poorly-drained soils, and relative declines in groundwater levels. There are presently no regional seepage-induced waterlogging problems in the Tulare Lake Region and none of the options associated with Alternative 1 would initiate any seepage problem in comparison to the No-Action Alternative.

San Francisco Bay Region

Under Alternative 1, CVP deliveries to Santa Clara and San Benito counties would decrease on average 18,000 acre-feet per year relative to the No-Action Alternative. Local regulations of groundwater extraction by means of pump taxes, such as those levied by the Santa Clara Valley Water District, would discourage replacement of this CVP water with groundwater. For the purpose of this programmatic level of analysis it is assumed that any increase in groundwater pumping to offset these reduced CVP deliveries would be minimal. A small impact to groundwater conditions could occur in the vicinity of spreading basins as a result of lost deep percolation associated with the reduced CVP deliveries.

Under Alternative 1 CVP deliveries to Alameda and Contra Costa counties would be similar to the No-Action Alternative. Under these conditions no net impact to groundwater storage, levels, and quality would occur, and no additional land subsidence would occur in these areas.

ALTERNATIVE 2

Alternative 2 assumes that CVP water supplies would be replaced by increased groundwater pumping. However, the act does not allow increased groundwater pumping for purposes of replacement of acquired surface water. The analysis assumed that long-term average annual groundwater pumping under Alternative 1 would serve as the upper limit in areas of acquired water. However, economic incentive, triggered by other regions retiring lands due to water acquisitions, was responsible for increases in certain crop types in some areas resulting in increased groundwater pumping in these areas. The acquired water results in changes in crop mix and crop acreage, and irrigation technology impact which are reflected as changes in water and land use practices in the groundwater analysis. All remaining assumptions underlying this analysis are the same as those for Alternative 1.

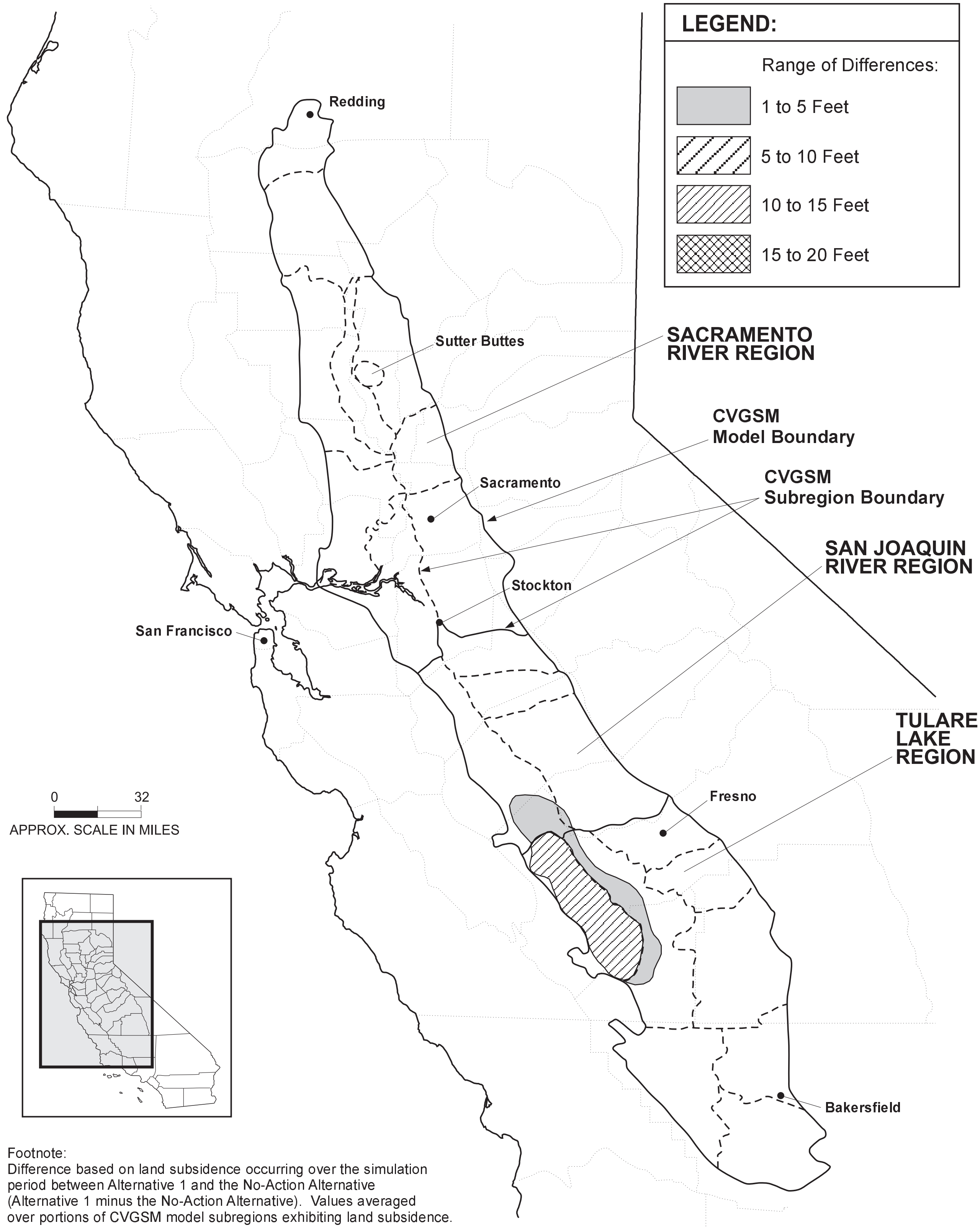


FIGURE IV-24

REGIONAL DIFFERENCES IN SIMULATED LAND SUBSIDENCE IN ALTERNATIVE 1 FROM NO-ACTION ALTERNATIVE

Central Valley Region

Differences in Alternative 2 groundwater levels, as compared to the No-Action Alternative for the end of the 69-year simulation are shown in Figure IV-25. Groundwater levels and quality, subsurface drainage conditions, and potential seepage problems in the Sacramento River Region would be similar to the No-Action Alternative, and in the Tulare Lake Region would be similar to Alternative 1.

Regional groundwater conditions in the San Joaquin River Region are generally similar to the No-Action Alternative. One difference occurs in the vicinity of the San Joaquin River basin tributaries where increased stream flows associated with acquired water would result in groundwater level increases relative to the No-Action Alternative. These increases would occur near areas of the San Joaquin River that have historically been sensitive to seepage-induced waterlogging problems. However, a comparison of flows in the San Joaquin River at Vernalis under Alternative 2 and the No-Action Alternative indicate no discernable differences. Based on this analysis, seepage problems to low-lying farm lands along the Stanislaus River and the lower reaches of the San Joaquin River are not expected to noticeably differ from the No-Action Alternative. These small differences in groundwater levels from the No-Action Alternative would not result in any changes in groundwater quality or agricultural subsurface drainage.

Additional land subsidence in comparison to the No-Action Alternative would occur in the San Joaquin River and Tulare Lake regions similar to Alternative 1.

San Francisco Bay Region

Changes in CVP deliveries to the San Francisco Bay Region would be the same as in Alternative 1. Impacts to groundwater resources as compared to the No-Action Alternative would be similar to those described for Alternative 1.

ALTERNATIVE 3

A key distinction of Alternative 3 from Alternative 2 is the assumption that the acquired water, once reaching the Delta, can be repumped as export deliveries out of the Delta. The groundwater analysis of Alternative 3 assumes groundwater pumping would be reduced as imported surface water supplies increased. The increased acquired water quantities also result in changes in crop mix and crop acreage, and irrigation technology. The groundwater analysis incorporates this information in the form of crop acreage and demands, and irrigation efficiencies. All remaining assumptions underlying this analysis are the same as those for Alternative 1 and 2.

Central Valley Region

Differences in the groundwater levels for the end of the 69-year simulation for Alternative 3 are shown in Figure IV-26. Groundwater conditions for the west side of the Sacramento River Region would be similar to the No-Action Alternative. Groundwater levels in the southeastern portion of the Sacramento River Region near the Calaveras River area of Eastern San Joaquin County in comparison to the No-Action Alternative would increase over the long-term approximately 5 to 10 feet on a regional basis, primarily as a result of increased stream seepage

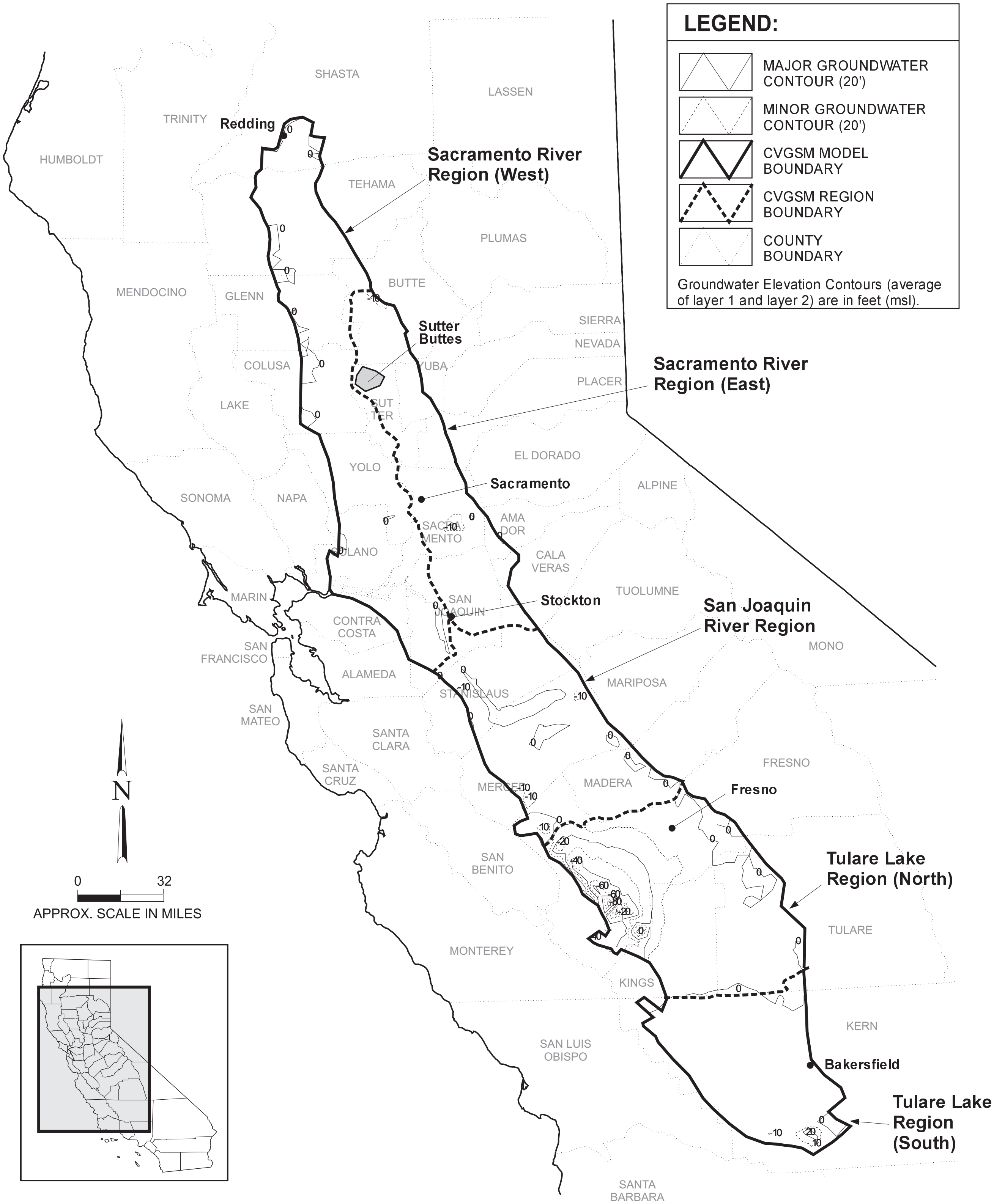


FIGURE IV-25

DIFFERENCES IN END OF SIMULATION GROUNDWATER ELEVATIONS FOR ALTERNATIVE 2 AS COMPARED TO NO-ACTION ALTERNATIVE

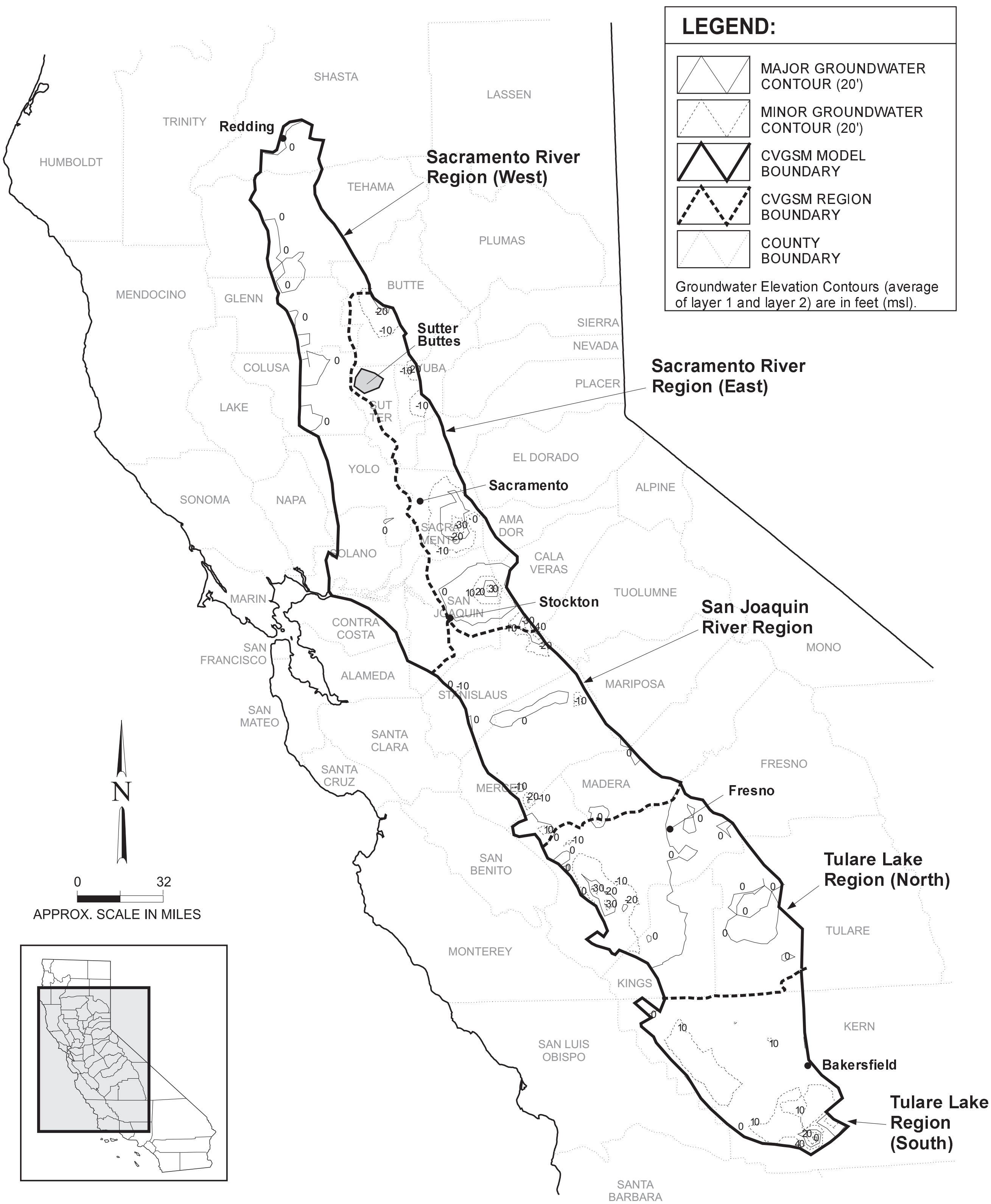


FIGURE IV-26

DIFFERENCES IN END OF SIMULATION GROUNDWATER ELEVATIONS FOR ALTERNATIVE 3 AS COMPARED TO NO-ACTION ALTERNATIVE

from streams with increased flows from acquired water. Decreases in long-term groundwater levels of approximately 10 to 20 feet would occur on a regional basis in some areas along the east side from north of the Sutter Buttes to south of the City of Sacramento. This decrease would occur as a result of reduced deep percolation due to land fallowing associated with the acquisition of water, and increased groundwater pumping. Economic incentive to grow certain crop types, triggered by other regions retiring lands due to water acquisitions, was responsible for increases in groundwater pumping in these areas.

No additional land subsidence, or changes in groundwater quality, agricultural drainage, or seepage-induced waterlogging impacts would occur in the Sacramento River Region in comparison to the No-Action Alternative.

Groundwater conditions for the San Joaquin River Region would be similar to Alternative 2, for different reasons however. In comparison to Alternative 2, Alternative 3 indicates less deep percolation from conveyance seepage. This is a result of reduced deliveries associated with water acquisitions. In contrast, alternative 3 exhibits more recharge from stream seepage and subsurface flow from adjacent regions to the northeast, both a result of higher flows on streams with acquired water.

Long-term groundwater levels for the Tulare Lake Region would be lower in comparison to the No-Action Alternative along the west side, with differences exceeding 30 feet. This is primarily due to increased groundwater pumping in response to a reduction in imported CVP supplies. However, the decline in groundwater levels in this area would be smallest under this alternative in comparisons to all other alternatives because of the assumption that acquired water passing through the Delta can be repumped, which result in greater surface water deliveries to this area, and a reduction in groundwater pumping as compared to all other alternatives. This assumption is also responsible for the higher groundwater levels observed in the southern end of Tulare Lake Region in comparison to the No-Action Alternative. SWP deliveries to this area would increase under Alternative 3. These higher groundwater levels could possibly hinder agricultural subsurface drainage in this area relative to the No-Action Alternative. The groundwater budget for Tulare Lake Region (North) shows groundwater storage conditions are similar to the No-Action Alternative, however, groundwater levels are lower on the west side. The Tulare Lake Region (South) shows a decrease in recharge, but a larger decrease in pumping, which would result in an increase in groundwater storage, as compared to the No-Action Alternative.

Additional land subsidence in comparison to the No-Action Alternative is shown in Figure IV-27. The area of land subsidence surrounds major conveyance facilities including the Delta-Mendota Canal and the California Aqueduct, however the smaller groundwater level declines in this area would lead to a smaller area of these aqueducts being subject to land subsidence damage. Changes to groundwater quality, agricultural subsurface drainage, and seepage-induced waterlogging would be similar to Alternative 1.

San Francisco Bay Region

Changes in CVP deliveries to the San Francisco Bay Region would be 10,000 acre-feet less than No-Action Alternative. Impacts to groundwater resources as compared to the No-Action Alternative would be similar to those described for Alternative 1.

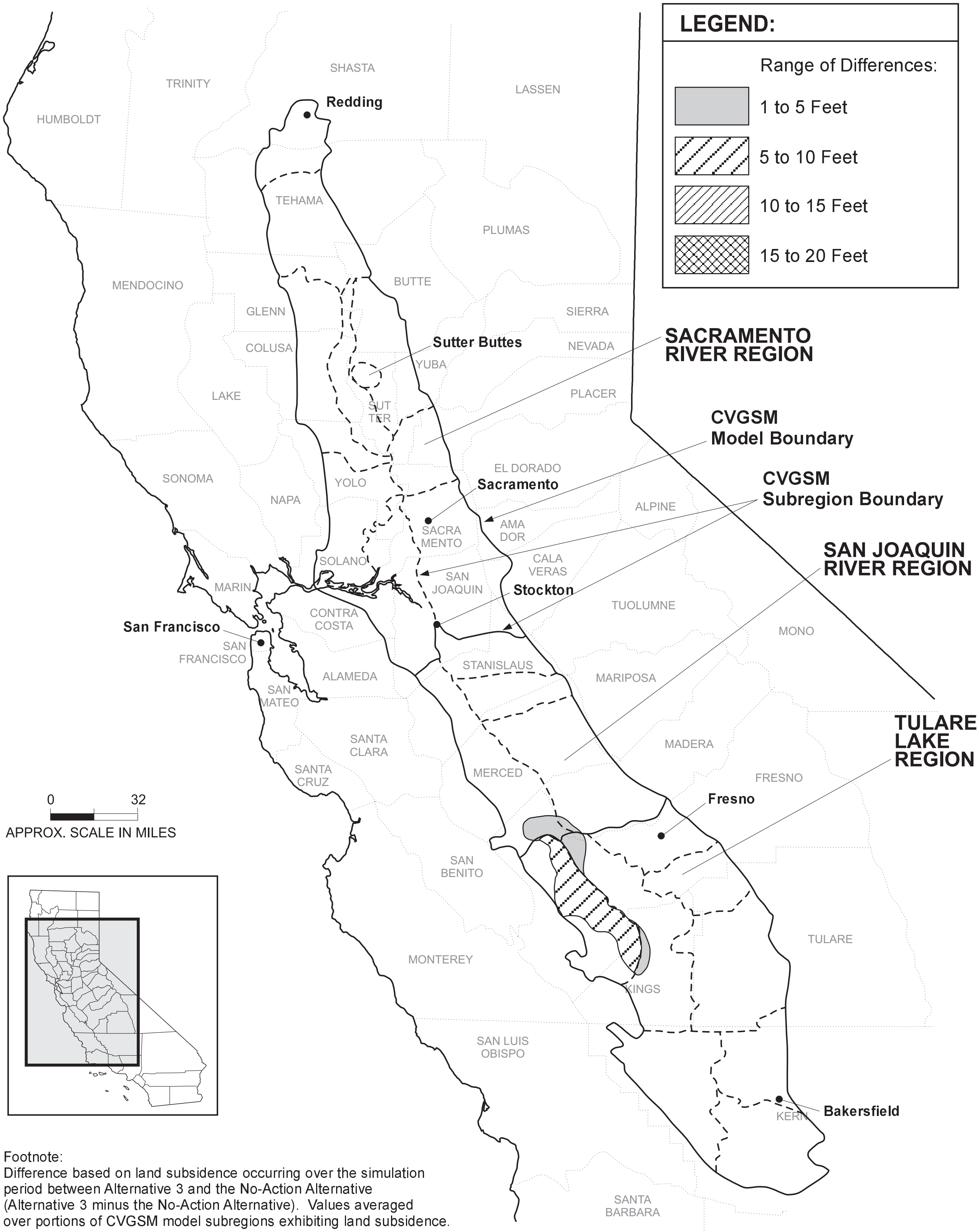


FIGURE IV-27

REGIONAL DIFFERENCES IN SIMULATED LAND SUBSIDENCE IN ALTERNATIVE 3 FROM NO-ACTION ALTERNATIVE

ALTERNATIVE 4

Alternative 4 combines the effects of using dedicated water to meet a portion of AFRP Delta outflow requirements assumed in Supplemental Analysis 1a with the elements of acquired water from willing sellers assumed in Alternative 3. However, like in Alternative 2, the acquisition water was not allowed to be repumped as exports once reaching the Delta. Under this condition groundwater pumping would increase CVP deliveries are reduced, as long as economically feasible. All remaining assumptions underlying this analysis are the same as those for Alternatives 1, 2, and 3.

Central Valley Region

Differences in the groundwater levels for the end of the 69-year simulation for Alternative 4 are shown in Figure IV-28. Groundwater conditions for the Sacramento River Region would be similar to those described under Alternative 3. For the San Joaquin River Region groundwater levels in the north half of the region would be similar to Alternative 3. In the southern half of the region, groundwater levels under Alternative 4 would be lower than the No-Action Alternative by approximately 5 feet regionally, and by 10 feet in several locations in central Madera County and northwestern Fresno County. These additional declines would occur in response to increased groundwater pumping and increased subsurface flow south towards declining groundwater levels in the Tulare Lake Region. Groundwater level declines in Madera County would possibly result in migration of poor-quality groundwater, reported to contain elevated levels of nitrates in this area, into areas of better quality groundwater.

In areas of the northern Tulare Lake Region dependent on CVP deliveries, increases in groundwater pumping would occur in comparison to the No-Action Alternative. Groundwater storage in the Tulare Lake Region (North) declines an additional 30 percent relative to the No-Action Alternative. This is the largest decline in groundwater storage of all the alternatives. In the South Tulare Lake Region, groundwater pumping would decrease resulting in a rise in groundwater levels in comparison to the No-Action Alternative.

The potential for additional land subsidence in comparison to the No-Action Alternative is similar to Alternative 1. It is likely that a small increase in the area affected by land subsidence would occur. Changes in agricultural subsurface drainage, groundwater quality, and seepage-induced waterlogging would be similar to Alternative 1.

San Francisco Bay Region

Changes in CVP deliveries to the San Francisco Bay Region would be similar to Alternative 1. Impacts to groundwater resources as compared to the No-Action Alternative would be similar to those described for Alternative 1.

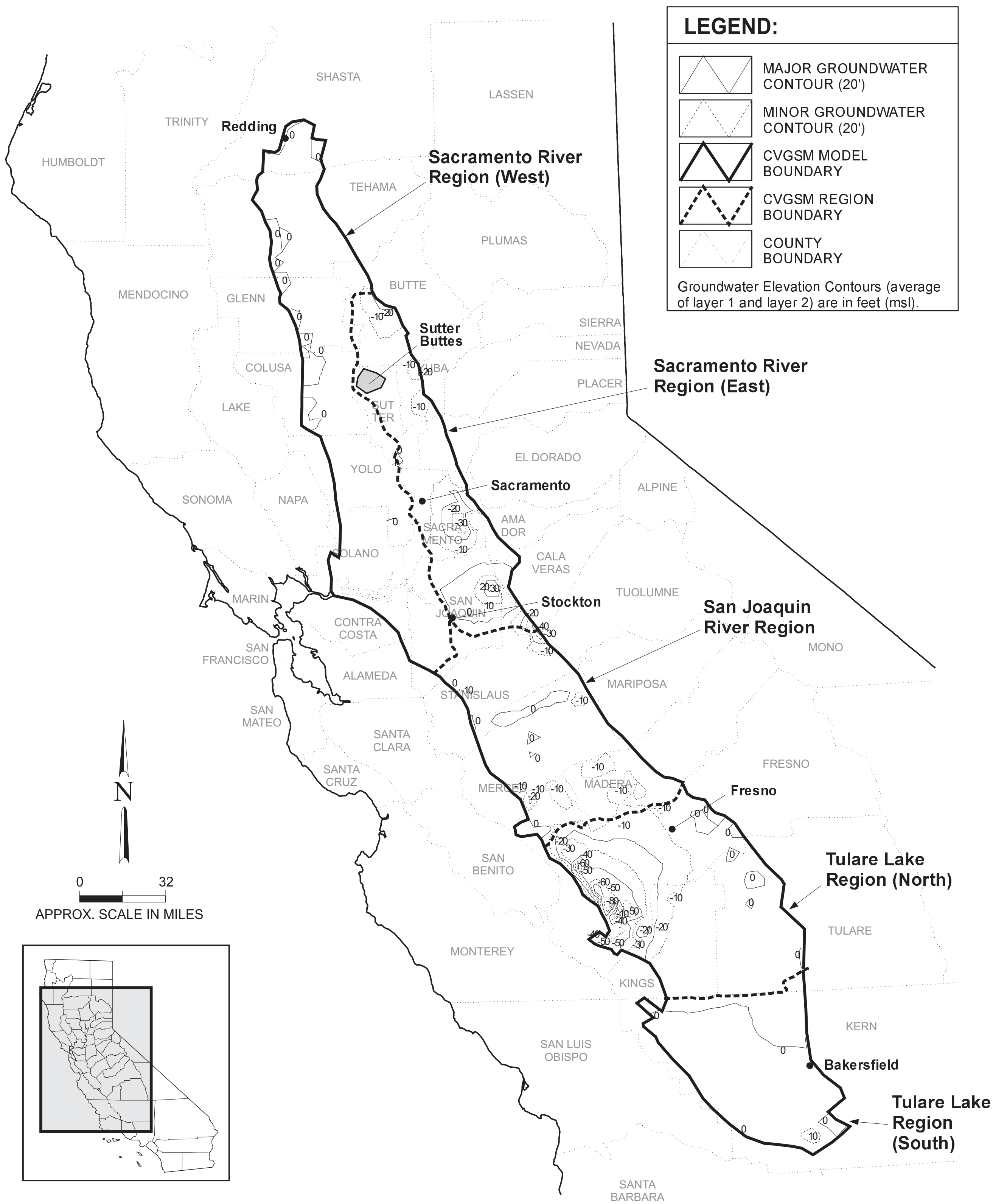


FIGURE IV-28

DIFFERENCES IN END OF SIMULATION GROUNDWATER ELEVATIONS FOR ALTERNATIVE 4 AS COMPARED TO NO-ACTION ALTERNATIVE

FISHERY RESOURCES

The fisheries impact assessment presented in this chapter qualitatively describes the changes in ecosystem conditions affecting fish species that are expected to occur with adoption of each of the alternatives. These changes are always compared with conditions under the No-Action Alternative.

Flow-related actions included under the alternatives consist of:

- changing reservoir operations and
- changing the timing and quantity of water diversions.

Structure-related actions include:

- relocating and consolidating water diversions,
- constructing and operating fish barriers,
- constructing and improving fish screens, and
- operating multilevel reservoir release structures to adjust water temperature downstream.

Habitat-related actions include:

- improving water quality (e.g., implementing programs to address contamination from wastewater discharge and urban and agricultural runoff), and

- restoring physical habitat (e.g., implementing watershed management programs and restoring riparian zones, meander belts, and spawning and rearing habitats).

Species management actions include:

- modifying management of fish hatcheries, and

- imposing restrictions on the introduction of non-native species.

For more detailed information regarding CVPIA actions, please see Chapter II. A summary of the assumptions associated with each of the alternatives is presented in Table IV-11. Table IV-12 presents a summary of the impact assessment for fisheries resources.

Some of the CVPIA actions have not yet been defined in enough detail to allow even a general qualitative assessment. For that reason, the following actions are not assessed in this PEIS: measures to reduce illegal fishing, management of ocean and river fishing, and changes in artificial production (i.e., rehabilitation and expansion of Coleman National Fish Hatchery, striped bass pen rearing, and hatchery programs) (Service, 1995a, 1995b). All of these actions potentially affect natural production and may need to be evaluated in site-specific documents.

Harvest includes commercial fishing, sport fishing, and illegal fishing activities that cause or contribute to the mortality of individuals in a species population. Artificial production is the human-aided production of a species in a facility isolated to some degree from the natural

TABLE IV-11

SUMMARY OF ASSUMPTIONS FOR FISHERY RESOURCES

Assumptions Common to All Alternatives and Supplemental Analyses
Continued CVP Operations under CVP-operations criteria and plan, October 1992. Regulatory operational criteria provided in D-1422, Bay-Delta Plan Accord, and WR 95-01. Winter-Run Biological Opinion as amended in 1995. Shasta Temperature Control Device in operation. Continued annual installation of a barrier at the head of Old River in late summer and removal in late fall to improve water quality in the Stockton ship channel. Changes in reservoir operations, river flows, and diversions based on Surface Water Supplies and Facilities Operations analyses.

Alternative or Supplemental Analysis	**Assumptions Specific to the Alternative or Supplemental Analysis**
No-Action Alternative	Common assumptions only.
1	CVP Reoperation and (b)(2) Water Management toward increased implementation of AFRP Actions relating to target flows for CVP-controlled streams (Attachment G, PEIS). Increased Trinity River instream fishery flow. Full implementation of AFRP Actions relating to structures (Attachment F, PEIS). Full implementation of AFRP Actions relating to habitat restoration (Attachment F, PEIS).
1a	
1b	Alternative 1 assumptions, plus Fish barrier Georgiana Slough that operates in conjunction with Delta Cross Channel facility (Sacramento River). Seasonal operation during April and May of the Old River barrier (San Joaquin River).
1c	Same as Alternative 1 plus Some of the non-delivered CVP water would increase instream flows and Delta outflow.
1d	Same as Alternative 1.
1e	Same as Alternative 1 plus Conveyance of transferred water in a manner to avoid impacts to fisheries.
1f	Same as Supplemental Analyses 1e.
1g	Same as Alternative 1.
1h	Same as Alternative 1.
1i	Same as Alternative 1.

TABLE IV-11. CONTINUED

Alternative or Supplemental Analysis	Assumptions Specific to the Alternative or Supplemental Analysis
2	Alternative 1 assumptions, plus Use acquired water to improve flows in the Stanislaus, Tuolumne, and Merced Rivers.
2a	Alternative 2 assumptions plus Fish barriers at Georgiana Slough that operates in conjunction with Delta Cross Channel facility (Sacramento River). Seasonal operation during April and May of the Old River barrier (San Joaquin River).
2b	Same as Alternative 2 plus Conveyance of transferred water in a manner to avoid impacts to fish.
2c	Same as Supplemental Analyses 2b.
2d	Same as Alternative 2 plus Some of the non-delivered CVP water would increase instream flows and Delta outflow.
3	Alternative 1 assumptions, plus Use acquired water to improve flows on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba rivers. Acquired water may be exported by Delta pumping facilities.
3a	Same assumptions as Alternative 3 plus Conveyance of transferred water in a manner to avoid impacts to fisheries.
4	Alternative 1 assumptions, plus Implement (b)(2) Water Management actions in the Delta in addition to Bay-Delta Plan Accord. Use acquired water to improve flows on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba rivers. Acquired water may not be exported by Delta pumping facilities.
4a	Same as Alternative 4 plus Conveyance of transferred water in a manner to avoid impacts to fisheries.

TABLE IV-12

SUMMARY OF IMPACT ASSESSMENT FOR FISHERY RESOURCES

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	Improved downstream temperature conditions in the Sacramento River due to operation of the Shasta Temperature Control Device which provides increased flexibility in the maintenance and use of the cold water pool in Shasta Lake.
Changes Compared to the No-Action Alternative	
1	Stream flow improvements, due to (b)(2) Water Management, combined with structural and other habitat restoration actions in Clear Creek and in the Sacramento, American, and Stanislaus rivers would improve environmental conditions such as river temperature, diversion entrainment, short-term fluctuations in river level, increased flows providing better movement and habitat quality and quantity, and food web support. These environmental conditions would benefit all life stages of representative fish species including chinook salmon, steelhead trout, sturgeon, American Shad and striped bass. Increases in the Trinity River fishery flow pattern would increase transport for salmon and steelhead trout. Increases in river flows and structural actions would improve passage and access to previously unavailable or under used stream habitats in Clear Creek and in the American and Stanislaus rivers for adult, egg, and juvenile life stages of representative species. Conditions related to downstream fish movement would decline in the Sacramento River as a result of decreased flows and lower exports from the Trinity River basin. Structural actions would provide improved passage to previously unavailable or under used stream habitats in the minor tributaries to the Sacramento, Yuba, and San Joaquin rivers, and the Delta for adult, egg, and juvenile life stages of representative species. Fish screen construction or improvements on the Sacramento, Feather, Yuba, Bear, American, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, and San Joaquin rivers, and the Delta would benefit juvenile and adult life stages of representative species. Reductions in Delta exports in April through September would decrease entrainment mortality losses of juvenile and adult life stages of representative species. Increased Delta exports in October through February could increase entrainment mortality, but improved fish screens would reduce entrainment mortality for screenable life stages of representative species. Juvenile chinook salmon and steelhead that use the Delta for temporary residence and estuarine species residing in the Delta would benefit from a change in entrainment mortality.

TABLE IV-12. CONTINUED

Alternative or Supplemental Analysis	Impact Assessment
Changes Compared to the No-Action Alternative	
1	Reductions in the frequency of short-term charges in river surface levels in the Sacramento, Yuba, American, Tuolumne, Merced rivers, and the Delta would reduce redd dessication, stranding, and risk to mortality for egg, larval, and juvenile life stage chinook salmon and steelhead trout. Increased flows and/or restoration of riparian vegetation that increases stream shading would decrease river water temperatures on Clear Creek, minor tributaries to the Sacramento River, the Yuba and Stanislaus rivers. Reduced summer flows on the American River during June through September, would increase water temperatures and adversely affect rearing juvenile steelhead trout. Actions to reduce predation at diversion facilities and limit predator habitat would improve survival of juvenile life stages of representative species in the Sacramento River and its minor tributaries, and the Yuba, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin rivers , as well as in the Delta. The combined effects of increased instream flows, lower instream water temperatures, habitat restoration, and structural improvements would collectively improve habitat quality and quantity for representative species in all study area rivers except the Merced River. Restoration of riparian vegetation and instream habitat would increase the input of nutrients and food organisms and provide improved food web support for representative species in all study area rivers.
Changes Compared to Alternative 1	
1a	Further reductions in exports at Delta pumping facilities during April and May would decrease entrainment mortality of representative species. Juvenile chinook salmon and steelhead trout that use the Delta for temporary residence and estuarine species residing in the Delta would benefit from a decrease in entrainment mortality. Increases in Delta outflow in January through June would improve movement from less productive habitat in the central and south Delta towards more productive habitat near Suisun Bay for egg, larval, and juvenile life stages of representative species during temporary residence in the Delta. Increases in Delta outflow would also improved survival conditions for representative species in the Delta. Increased Delta outflow, reduced exports, and extension of X2 (2 ppt isohaline) farther downstream during April and May would increase Delta habitat quality and quantity for representative species during temporary residence in the Delta.

TABLE IV-12. CONTINUED

Alternative or Supplemental Analysis	Impact Assessment
Changes Compared to Alternative 1	
1b	A decrease in flow into the central Delta from the Sacramento River would reduce juvenile life stage diversion-related losses and improve downstream movement of fish in the Sacramento River. Representative species would be transported towards more productive habitat near Suisun Bay, rather than entering the central Delta. The Old River barrier facility would reduce exposure to SWP and CVP pumping facilities and assist the successful outmigration of juvenile salmon from the San Joaquin River. Closure of the DCC barrier would increase the losses of striped bass and delta smelt rearing in the north and central Delta.
1c	Use of non-delivered CVP water is not determined at this time. Potential changes in surface water operations and the affect on fisheries resources will require further site specific analyses.
1d	Conditions would be similar to Alternative 1.
1e	Conditions would be similar to Alternative 1, except in dry years when site specific transfer operations could affect reservoir operations, river flows, and Delta exports.
1f	Conditions would be similar to Supplemental Analysis 1e.
1g	Conditions would be similar to Alternative 1.
1h	Conditions would be similar to Alternative 1.
1i	Red Bluff Diversion Dam gates would no longer be closed during the summer, thereby reducing mortality of juvenile chinook salmon and steelhead trout that migrate downstream to rear. Restoration of the river reach affected by Lake Red Bluff would create additional spawning and rearing habitat, and reduce predation losses.

TABLE IV-12. CONTINUED

Alternative or Supplemental Analysis	Impact Assessment
Changes Compared to the No-Action Alternative	
2	General benefits to fisheries as a result of (b)(2) Water Management, increased Trinity River flows, structural actions, and habitat restoration would provide general benefits to fisheries through improved habitat quality and quantity, passage to under-used habitat, improved survival through fish screen improvements, and improved instream and riparian habitat conditions that would improve survival conditions for all life stages of representative species. These flow, structural, and habitat restoration actions would be similar to Alternative 1, plus Improved flows during April through June on the Tuolumne, Merced, and Stanislaus rivers, would improve water temperature conditions and provide improved survival conditions for juvenile chinook salmon and steelhead trout and life stages of other species using these streams. Increased river flows in the Stanislaus, Tuolumne, Merced, and lower San Joaquin rivers would improve downstream movement of juvenile life stages of representative species in these rivers. Greater flows from the San Joaquin River towards Suisun Bay would further improve Delta flow conditions, reduce diversion-related losses, and facilitate the movement of organisms into more productive habitat located near Suisun Bay. The combined effects of the flow, structural, and habitat restoration actions in Alternative 2 would further improve habitat quality and quantity in the Bay-Delta and in the Stanislaus, Tuolumne, Merced, and lower San Joaquin rivers. The combined effects would also provide further improvement in food web support in the Bay-Delta and in the Stanislaus, Tuolumne, Merced, and lower San Joaquin rivers.
Changes Compared to Alternative 2	
2a	The decrease in flow into the central Delta from the Sacramento River would reduce juvenile life stage diversion-related losses and improve downstream movement of egg, larval, and juvenile life stages of representative species. Representative species would be transported towards more productive habitat near Suisun Bay, rather than less productive habitat in the central Delta. The Old River barrier facility would assist the outmigration of juvenile chinook salmon and steelhead trout from the San Joaquin River. Old River barrier would also reduce exposure of representative species to SWP and CVP pumping facilities. Closure of the DCC barrier would increase losses of striped bass and delta smelt rearing in the north and central Delta.
2b	Conditions are similar to Alternative 2, except in dry years when site specific transfer operations may affect reservoir operations, river flows, and Delta exports
2c	Conditions are similar to Supplemental Analysis 2b.

TABLE IV-12. CONTINUED

Alternative or Supplemental Analysis	Impact Assessment
Changes Compared to Alternative 2	
2d	Use of non-delivered CVP water is not determined at this time. Potential changes in surface water operations and the affect on fisheries resources will require further site specific analyses.
Changes Compared to the No-Action Alternative	
3	(b)(2) Water Management, increased Trinity River flows, structural actions, and habitat restoration would provide general benefits to fisheries through improved habitat quality and quantity, passage to under-used habitat, improved survival through fish screen improvements, and increase instream and riparian habitat conditions that would improve survival conditions for all life stages of representative species. These flow, structural, and habitat restoration actions would be similar to Alternative 1, plus Increased spring stream flows in combination with habitat restoration actions, would further improve temperature conditions on the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers and benefit rearing fry and juvenile chinook salmon and steelhead trout. Reduced diversions on the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers would benefit migrating juvenile chinook salmon and steelhead trout. Increased Delta outflow would further improve overall conditions affecting diversion-related losses of representative species in the Delta, even though there would be increased Delta exports of acquired water in August through May. Reduced flow fluctuations on the Yuba and Mokelumne rivers would reduce stranding and benefit egg, fry, and juvenile life stages of chinook salmon and steelhead trout. Pulse flows on the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced, and San Joaquin rivers would primarily benefit outmigration of fall-run juvenile chinook salmon.
	Change Compared to Alternative 3
3a	Conditions would be similar to Alternative 3, except in dry years when site specific transfer operations may affect reservoir operations, river flows, and Delta exports.

TABLE IV-12. CONTINUED

Alternative or Supplemental Analysis	Impact Assessment
Changes Compared to the No-Action Alternative	
4	(b)(2) Water Management, increased Trinity River flows, structural actions, and habitat restoration would provide general benefits to fisheries through improved habitat quality and quantity, passage to under-used habitat, improved survival through fish screen improvements, and increase instream and riparian habitat conditions that would improve survival conditions for all life stages of representative species. These flow, structural, and habitat restoration actions would be similar to Alternative 3, plus The combination of actions would reduced Delta exports and increase in Delta outflow which would shift the distribution of Delta species downstream into more productive habitat and away from the influence of Delta diverions. The Delta Cross Channel would be closed during November through January of wetter years to facilitate the outmigration of juvenile chinook salmon and steelhead trout down the Sacramento River. This structural action would improve survival and reduce the movement of these species into less productive habitat located in the central Delta, and expose these species to increased diversions and predation. Increased Delta outflow in all months would shift estuarine salinity downstream and increase habitat quality and quantity for Sacramento splittail, delta smelt, longfin smelt, and striped bass. Decreased diversions in the Delta would reduce the entrainment of food web organisms and nutrients, thereby increasing food web support in the Delta. Also, the downstream shift in estuarine salinity would increase production of prey organisms and benefit rearing life stages of all representative species.
Changes Compared to Alternative 4	
4a	Conditions would be similar to Alternative 4, except in dry years when site specific transfer operations may affect reservoir operations, river flows, and Delta exports.

ecosystem (e.g., fish hatchery, rearing pen). Exclusion of harvest and artificial production from this impact assessment (although both processes are mentioned briefly under "Cumulative Impacts") does not imply that harvest and artificial production have minimal effects on species populations or that harvest and artificial production would not affect the outcome of implementing CVPIA actions. CVPIA actions that could affect harvest and artificial production have not yet been clearly defined and are not included in the PEIS analysis.

IMPACT ASSESSMENT METHODOLOGY

This analysis qualitatively describes the beneficial and adverse impacts of each of the alternatives on the distribution and abundance of fish species. These effects are always determined by comparison of conditions that would occur under an alternative to the conditions that would occur under the No-Action Alternative.

Each of the CVPIA alternatives consists of proposed actions. These actions, either individually or in combination, would affect one or more environmental conditions. For the purposes of this analysis, environmental conditions are defined as aspects of the aquatic ecosystem that may change in response to implementing the actions contained in the alternatives, and that may in turn cause beneficial or adverse effects on representative aquatic species. Assessment relationships are used that describe how changes in environmental conditions lead to responses by the representative species Figure IV-29. The specific relationships used in the assessment are applicable to each species and life stage based on geographic and monthly occurrence.

For example, a CVPIA action (install or improve fish screens) would cause a change in an environmental condition (diversion conditions). A specific assessment relationship (installation of fish screens decreases entrainment losses for species life stages that are too large to pass through the screen) leads to a change in the ecosystem condition (reduced fish mortality at certain diversions), resulting in benefits to individual species (reduced entrainment loss of specific life stages of specific species). In more complex situations, one action may affect several environmental conditions (for instance, reoperation of a reservoir may affect river temperature, diversion conditions, and physical habitat), or one environmental condition may be affected by several actions (diversion conditions may be affected by changes in flow and installation of fish screens).

Table IV-13 summarizes the environmental ecosystem conditions assessed to determine impacts on and benefits to representative species. Detailed definitions of environmental conditions and specific assessment relationships are provided in the Fisheries Technical Appendix.

Representative Species

The assessment method is applied to those life stages of each representative species that are present in each river reach during the months when the actions would apply. The selection of representative species allows the analysis to be focused while representing ecosystem responses to the full range of changing conditions. The representative species and populations were selected because they depend on ecological processes and habitats throughout the ecosystem and are sensitive to an important cross section of affected environmental conditions. Species

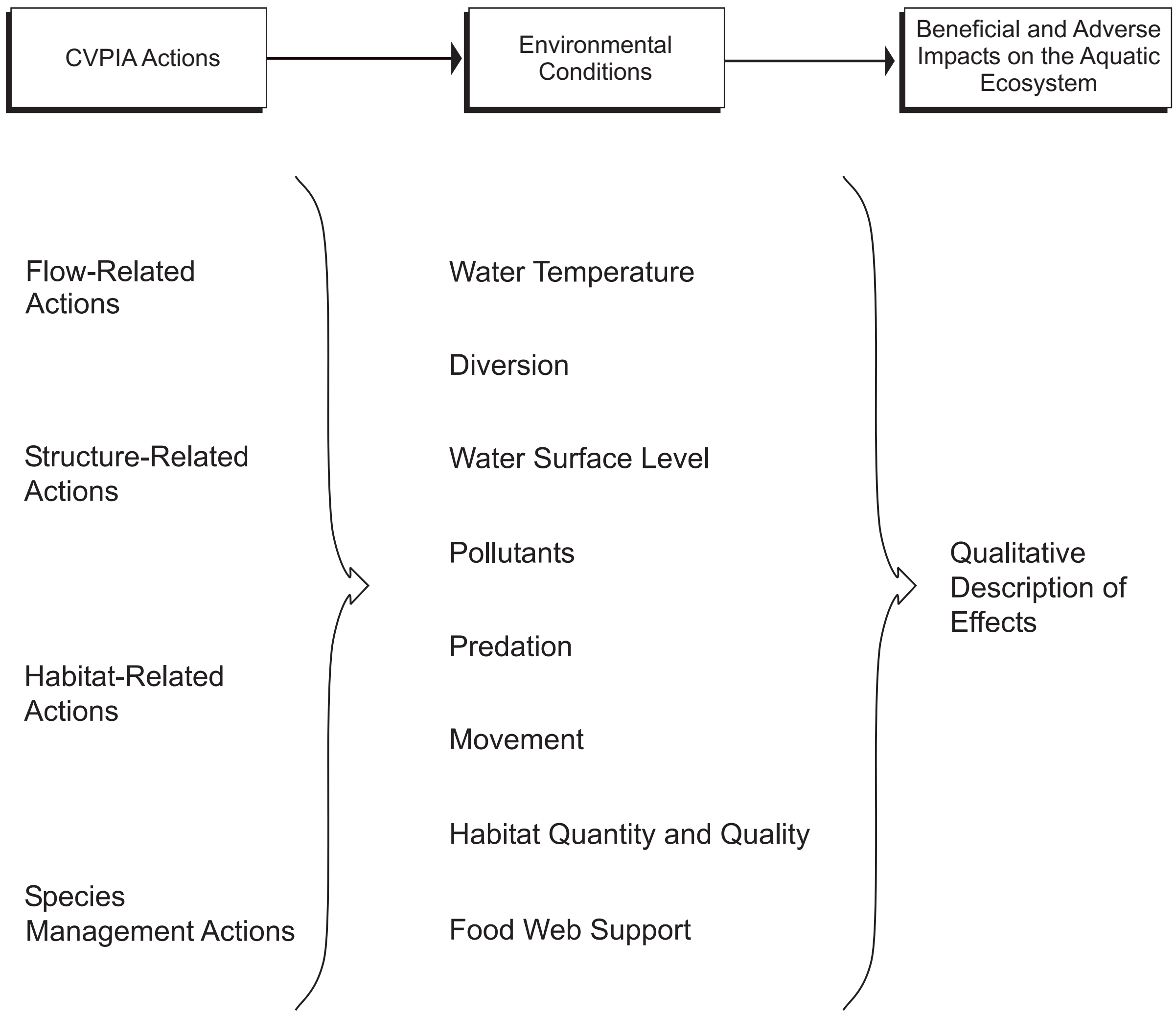
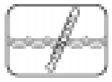
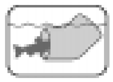
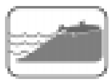
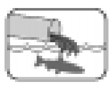


FIGURE IV-29

LINKAGE OF CVPIA ACTIONS TO BENEFICIAL AND ADVERSE IMPACTS

TABLE IV-13

DEFINITIONS OF ENVIRONMENTAL CONDITIONS

Condition		Definition
Water temperature		Water temperature that exceeds the metabolic tolerances of a species causes or contributes to mortality. Water temperature is primarily a concern for chinook salmon and steelhead trout.
Diversion		Diversions cause fish mortality through entrainment (removal from the ecosystem), impingement on fish screens, abrasion, stress from handling, and increased predation. Diversion is a concern for all representative fish species.
Change in water surface level		Change in water surface level may cause mortality by exposing nests, stranding individuals, and reducing or eliminating cover. The effects of changes in water surface levels are assessed for representative species in rivers and reservoirs.
Pollution		Pollution includes the entry of substances into the aquatic ecosystem that cause the death of organisms. Increased flow, reduced use of potential pollutants, and actions to clean up pollutant sources reduce the effect of pollution on aquatic organisms.
Predation		Predation is a natural ecosystem function; however, predation may increase to adverse levels through changes in ecosystem structure that increase prey vulnerability or increase predator feeding efficiency.
Movement		Movement, both active and passive, includes the transport of planktonic eggs and larvae and migration to habitat essential for completing an organism's life cycle. Movement is a concern for all representative species.
Habitat quantity and quality		Habitat quantity and quality relate to physical, chemical, and biological conditions that support essential organism activities, including spawning, feeding, respiration, assimilation, predator avoidance, and resting. Habitat quantity and quality are critical in maintaining and increasing all fish populations.
Food web support		Food web support includes nutrient availability, food production, and food availability. Organisms that provide the food base for fish species are affected by the same habitat and ecosystem processes critical to the maintenance and restoration of fish populations. Food web support is essential to maintain all species populations.

represented in the analysis are distributed over a range of habitats potentially affected by CVPIA actions. Anadromous species specifically identified in the CVPIA are:

- chinook salmon (*Oncorhynchus tshawytscha*), including fall, late fall, winter, and spring runs
- steelhead trout (*Oncorhynchus mykiss*)
- sturgeon (both green sturgeon [*Acipenser medirostris*] and white sturgeon [*A. trans-montanus*])
- American shad (*Alosa sapidissima*)
- striped bass (*Morone saxatilis*)

Representative species for the Bay-Delta estuary (in addition to the anadromous species identified in the CVPIA) are:

- delta smelt (*Hypomesus transpacificus*)
- longfin smelt (*Spirinchus thaleichthys*)
- Sacramento splittail (*Pogonichthys macrolepidotus*)

Representative species for reservoirs are:

- spotted bass (*Micropterus punctulatus*)
- largemouth bass (*M. salmoides*)

The geographic distribution of the representative species throughout the study area is shown in Figure IV-30.

Programmatic Level of Detail

The assessment method provides enough information to allow a general and qualitative description of ecosystem conditions potentially affecting the representative species under each alternative. CVPIA actions and potential effects on environmental conditions are described at a level of detail consistent with the needs of a programmatic document. Furthermore, although the direction of a species' response to changes in environmental conditions is generally supported by available species-specific information for most ecosystem conditions, available information is not sufficient to quantify such changes.

Benefits will occur to fishery resources in the Trinity River in an Identical manner in all of the alternatives as compared to the No-Action Alternative. These impacts are being addressed in a separate environmental document.

NO-ACTION ALTERNATIVE

The No-Action Alternative represents conditions in the future without implementation of the CVPIA. However, the No-Action Alternative does incorporate those provisions of the CVPIA that have been identified previously as necessary to protect winter-run chinook salmon (a species listed as endangered).

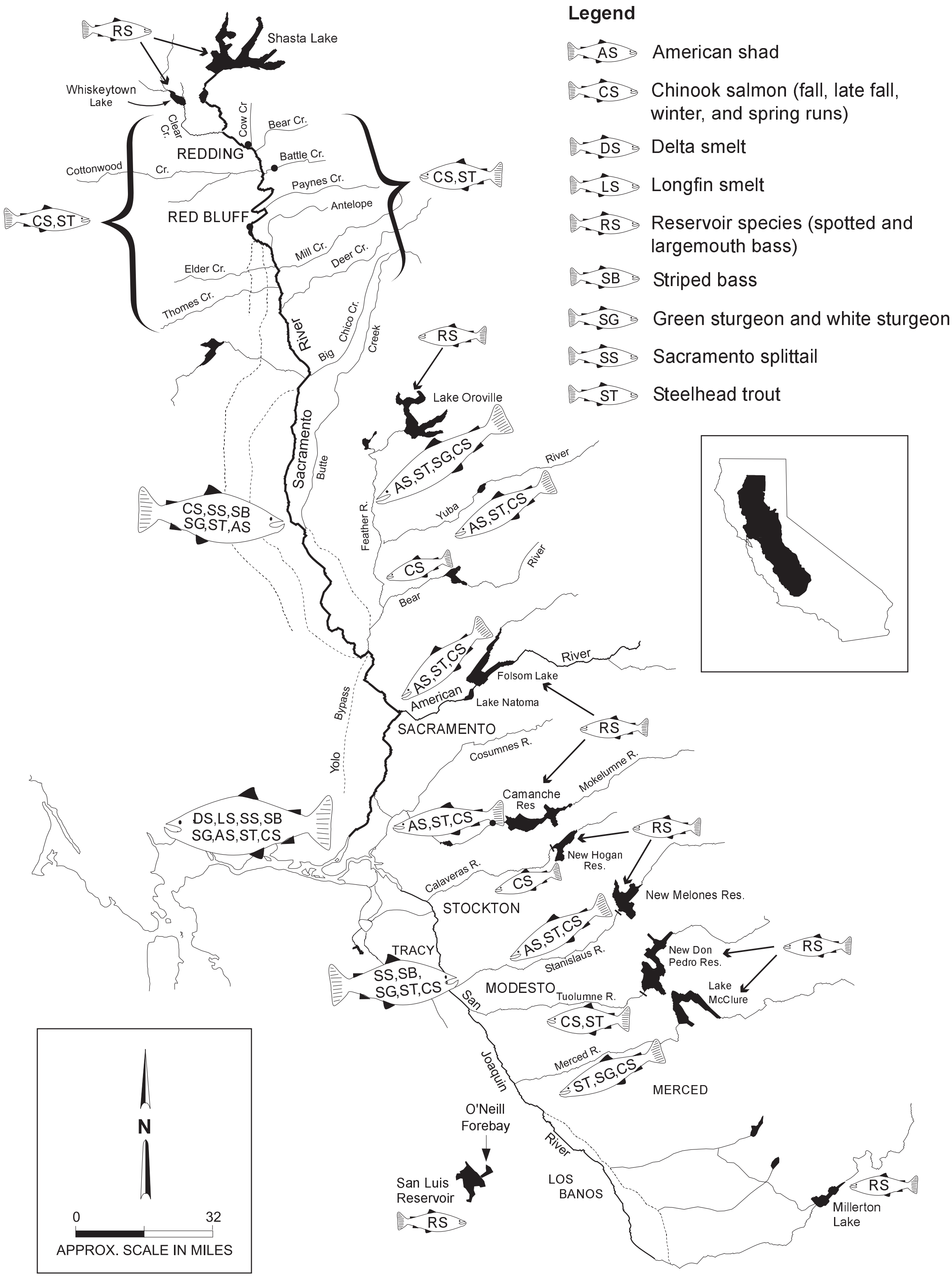


FIGURE IV-30

POTENTIAL AND EXISTING DISTRIBUTION OF FISH SPECIES ANALYZED IN THE PEIS

Under the No-Action Alternative, water temperature in the upper Sacramento River (below Shasta Lake) would be maintained by the temperature control structure on Shasta Dam in compliance with the 1993 Winter-Run Chinook Salmon Biological Opinion. This management action would benefit all runs of chinook salmon and steelhead trout.

Under the No-Action Alternative, modifying the operation and structure of the ACID dam, the RBDD, and the Keswick Reservoir stilling basin to protect winter-run chinook salmon should help improve conditions affecting entrainment in diversions, predation, and essential movement for all chinook salmon runs, steelhead trout, and sturgeon. Changes in operation of the ACID and RBDD diversion structures may also improve access to upstream habitat for chinook salmon and sturgeon. Improvements in fish screens and bypass flows are also expected to occur under the No-Action Alternative at the RBDD and the ACID and GCID diversions, providing additional protection for winter-run chinook salmon and reducing entrainment losses of other chinook salmon runs and steelhead trout.

ALTERNATIVE 1

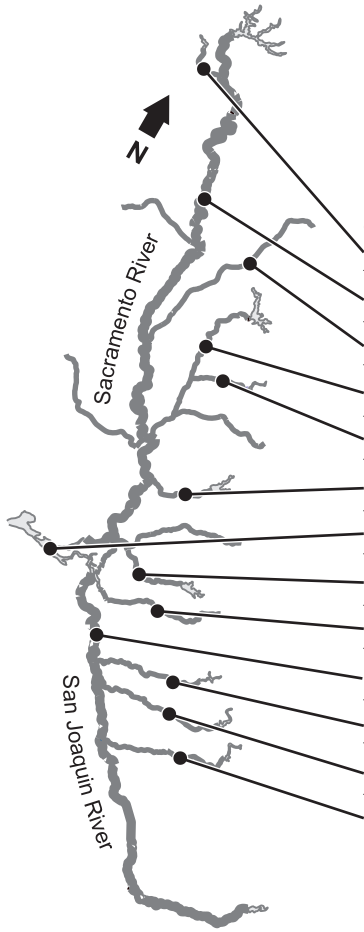
Compared with the No-Action Alternative, actions that would be implemented under Alternative 1 (indicated in Figure IV-31 and discussed in Chapter II) would clearly benefit all of the representative species in riverine and estuarine habitats of the Central Valley. These actions would improve ecosystem conditions, including increasing habitat availability and improving habitat quality (Figure IV-32). The improved ecosystem conditions would benefit most representative species compared with conditions under the No-Action Alternative (Figure IV-33).

Changes in reservoir operation under Alternative 1 would have minimal effects on reservoir habitat and associated species compared with the No-Action Alternative. Monthly and annual variability in reservoir surface elevation would be substantial under the No-Action Alternative, reflecting a response to weather conditions and water storage and flood control operations. Because Alternative 1 would involve little change in reservoir operation and resulting habitat conditions relative to the No-Action Alternative, effects on reservoir species are not described here; the Fisheries Technical Appendix provides additional information on the effects of the alternatives on reservoir species.

The effects of actions that would be implemented under Alternative 1 are discussed below for each ecosystem condition defined in Table IV-13.

Water Temperature

Although modeling was not performed for all rivers, it is considered likely that temperature conditions would improve survival, growth, and reproductive success for steelhead trout and all chinook salmon runs in most rivers affected by the CVPIA actions. Several actions that may be implemented under Alternative 1 could affect water temperatures: changing reservoir operations; installing or modifying multilevel release shutters; restoring riparian areas, meander belts, and watersheds; and controlling and relocating agricultural return flows.



Watershed	Structure		Habitat Improvements			Flow			Species Interactions
	Fish Screens	Improved Passage	Instream	Riparian	Water Quality	Increased Flow	Reduced Fluctuation	Reduced Diversion	Predator Control
Clear Creek		■	■	■	■	■	■		
Sacramento R.	■		■	■	■	■	■		
*Minor Tributaries	■	■	■	■	■	■			
Feather R.	■	■	■			■			
Yuba River	■	■	■	■			■		
American R.	■		■	■		■	■		
Bay-Delta	■		■	■	■	■			
Mokelumne R.	■	■	■	■	■				
Calaveras R.	■	■							
San Joaquin R.	■	■		■	■	■			
Stanislaus R.	■		■	■		■			■
Tuolumne R.	■		■	■	■		■		■
Merced R.	■	■	■	■	■		■		■

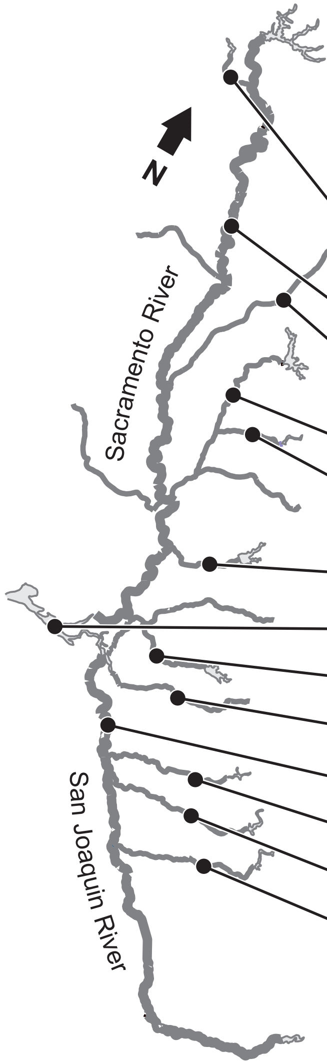
■ = Action implemented under Alternative 1

No Symbol = No action implemented

*Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-31

CVPIA ACTIONS IMPLEMENTED TO BENEFIT FISH AND AQUATIC RESOURCES UNDER ALTERNATIVE 1



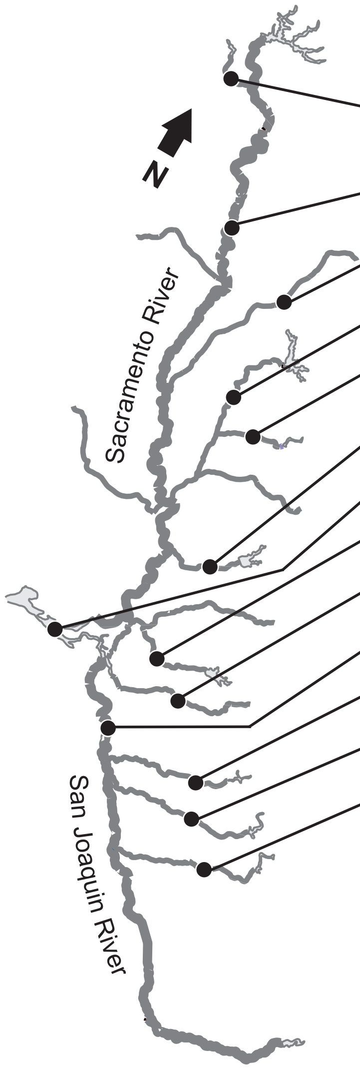
Watershed	River Water Temperature	Diversion	River Surface Level Changes	Pollutants	Predation	Movement	Habitat Quality and Quantity	Food Web Support
Clear Creek	✓	✓	✓			✓	✓	✓
Sacramento R.		✓	✓	✓	✓	✖	✓	✓
*Minor Tributaries	✓	✓			✓	✓	✓	✓
Feather R.		✓					✓	✓
Yuba River	✓	✓			✓	✓	✓	✓
American R.	✖	✓	✓			✓	✓	✓
Bay-Delta		✓		✓	✓	✓	✓	✓
Mokelumne R.		✓		✓	✓		✓	✓
Calaveras R.		✓					✓	✓
San Joaquin R.		✓		✓	✓	✓	✓	✓
Stanislaus R.	✓	✓			✓	✓	✓	✓
Tuolumne R.		✓	✓	✓	✓		✓	✓
Merced R.	✖	✓	✓	✓	✓		✖	

✓ = New benefit compared to the No-Action Alternative
No Symbol= No change
✖= Adverse change compared to the No-Action Alternative

*Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-32

CHANGES IN ENVIRONMENTAL CONDITIONS AFFECTING FISH POPULATIONS UNDER ALTERNATIVE 1 COMPARED TO THE NO-ACTION ALTERNATIVE



Watershed	Chinook Salmon	Steelhead Trout	Sacramento Splittail	Sturgeon	Striped Bass	American Shad	Delta Smelt	Longfin Smelt
Clear Creek	✓	✓	--	--	--	--	--	--
Sacramento R.	✓	✓	✓	✓	✗[1]	✗[1]	--	--
*Minor Tributaries	✓	✓	--	--	--	--	--	--
Feather R.	✓	✓	--	--	--	✓	--	--
Yuba River	✓	✓	--	--	--	✓	--	--
American R.	✓	✗[2]	--	--	--	✗[1]	--	--
Bay-Delta	✓	✓	✓	✓	✓	✓	✓	✓
Mokelumne R.	✓	--	--	--	--	--	--	--
Calaveras R.	✓	--	--	--	--	--	--	--
San Joaquin R.	✓	--	✓	--	--	--	--	--
Stanislaus R.	✓	--	--	--	--	--	--	--
Tuolumne R.	✓	--	--	--	--	--	--	--
Merced R.	✗[2]	--	--	--	--	--	--	--

✓ = New benefit compared to the No-Action Alternative

✗ = Adverse change compared to the No-Action Alternative

-- = Species does not occur or occurrence is minor

* Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

1) Adverse conditions are a result of degraded flow conditions affecting movement of eggs and larvae. See text for discussion.

2) Adverse conditions are a result of degraded temperature conditions and habitat quality and quantity. See text for discussion.

FIGURE IV-33

BENEFICIAL AND ADVERSE CHANGES TO FISH SPECIES UNDER ALTERNATIVE 1 COMPARED TO THE NO-ACTION ALTERNATIVE

The effect of water project operations on water temperature conditions was determined by simulation of water temperatures in Clear Creek and the Sacramento, Feather, American, and Stanislaus rivers. Potential temperature-related effects of reservoir operations and flow, riparian restoration, and reduced agricultural return flow are evaluated qualitatively for other rivers.

Riparian and meander belt restoration actions are identified in the CVPIA for the Sacramento River and its minor tributaries; for the Yuba, American, and Mokelumne rivers; and for the Delta (Figure IV-31). Restoration of riparian vegetation could shade and cool minor tributaries (Figure IV-32). Watershed restoration actions and actions to control or relocate agricultural return flow could reduce warm-water inflow to the Sacramento and San Joaquin rivers and some tributary streams.

In the Sacramento River, protective water temperature criteria stipulated in the 1993 Biological Opinion minimize changes in simulated water temperatures and associated temperature conditions during all life stages of fall-, late fall-, winter-, and spring-run chinook salmon and steelhead trout. Temperature conditions in the Sacramento River under Alternative 1 would be similar to those under the No-Action Alternative (Figure IV-32). Restoration of the meander belt could increase the amount of cool microhabitat available along the open channel of the Sacramento River.

In Clear Creek, water temperatures would generally be lower under Alternative 1 than under the No-Action Alternative because of increased flow. Lower temperatures would benefit fall-, late fall-, and spring-run chinook salmon and steelhead trout (Figures IV-32 and IV-33). For the Yuba River, reservoir operations and use of the multilevel release shutter would improve temperature conditions for fall-run chinook salmon and steelhead trout.

On the American River, simulated water temperatures under Alternative 1 increase during October (in wetter and cooler years) and November compared with conditions under the No-Action Alternative, indicating potential adverse impacts on fall-run chinook salmon spawning. Elevated water temperatures are also indicated between June and September, and these conditions would adversely affect steelhead trout (Figure IV-32 and Figure IV-33). An adverse impact on temperature conditions is identified. However, actions for reoperating or reconfiguring the multilevel release shutters may be implemented at Folsom Dam, and these could improve water temperatures compared with conditions indicated by the simulation. During most years, including drier and warmer years, water temperature during October is reduced compared with temperature under the No-Action Alternative, indicating a potential benefit to spawning fall-run chinook salmon. Overall, water conditions would generally improve and, in combination with improvements to other habitat conditions, would result in benefits to fall-run chinook salmon (Figure IV-33).

For the Stanislaus River, the temperature simulation indicates that lower water temperatures would benefit juvenile fall-run chinook salmon during April and May. During October and November, slightly higher temperatures could lead to increased mortality during fall-run spawning and incubation. However, because the change is relatively small, it may be possible to operate the reservoir to meet the AFRP target of 56 degrees Fahrenheit on October 15, improve overall temperature conditions, and provide benefits to fall-run chinook salmon (Figures IV-32 and IV-33).

Reduced flows in the Merced River during April and May under Alternative 1 may occur because of additional groundwater pumping souther of the Merced River. The additional pumping may reduce groundwater accretions into the Merced River. The reduced flows would increase water temperatures and adversely affect fall-run chinook salmon by increasing the mortality of rearing juveniles (Figure IV-32). In October, lower simulated flows and lower amounts of reservoir storage (in drier years) indicate a potential water temperature increase and adverse effects on the spawning success of fall-run chinook salmon compared with conditions under the No-Action Alternative. The degraded temperature conditions would cause adverse impacts on fall-run chinook salmon (Figure IV-33).

Under Alternative 1, water temperature conditions in the Feather, Mokelumne, Calaveras, San Joaquin, and Tuolumne rivers resulting from reservoir operations would be similar to those under the No-Action Alternative (Figure IV-32).

Diversion

Diversions cause fish mortality through entrainment, impingement on fish screens, abrasion, stress from handling, and increased predation. Under Alternative 1, diversion conditions would improve throughout the Sacramento and San Joaquin river basins (Figure IV-32). Actions implemented under Alternative 1 that would improve diversion conditions include constructing and improving fish screens, redesigning the diversion facility to discourage predation, reducing diversion volumes, and increasing flows to maintain estuarine salinity downstream of the Delta (thereby shifting the distribution of species vulnerable to entrainment in Delta diversions downstream and away from diversion intakes).

Fish screens would benefit the juvenile and adult life stages of the representative species but would provide little or no benefit to planktonic egg and larval life stages. Under Alternative 1, fish screens would be constructed or improved for diversions on the Sacramento, Feather, Yuba, Bear, American, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, and San Joaquin rivers and in the Sacramento-San Joaquin Delta estuary (Figure IV-31). In addition, constructing or improving fish screens on diversions in the minor tributaries to the Sacramento River, including Clear, Cow, Butte, Big Chico, and Battle creeks, would benefit fall- and spring-run chinook salmon and steelhead trout. Actions to reduce predation at Woodbridge Dam on the Mokelumne River would primarily benefit fall-run chinook salmon.

Compared with the No-Action Alternative, Alternative 1 would result in less water being diverted from the Delta (primarily through the CVP and SWP pumping facilities) from April through September, and more water being diverted from October through February. Lower diversions from April through September would reduce entrainment loss of striped bass eggs, larvae, and juveniles; delta smelt adults, larvae, and juveniles; longfin smelt adults, larvae, and juveniles; American shad eggs, larvae, and juveniles; juvenile steelhead trout; juvenile chinook salmon from all runs; juvenile sturgeon; and juvenile and adult Sacramento splittail.

Higher diversions from October through February could increase entrainment losses, but most fish present would be small enough to benefit from installation of new, improved fish screens that would reduce entrainment. The species and life stages affected include juvenile striped bass; juvenile and adult delta smelt; adult longfin smelt; juvenile American shad; juvenile steelhead trout; and juvenile late fall-, winter-, and spring-run chinook salmon in the central and south Delta.

Water Surface Level

In rivers, a primary cause of fish mortality is short-term (e.g., hourly, daily) changes in water surface level that may strand fish and dry up redds. Changes in water surface level may cause mortality of egg, larval, and juvenile life stages of chinook salmon and steelhead trout. Sacramento splittail spawning, incubation, and larval life stages can also be affected by fluctuations in water surface level.

The CVPIA identifies the need to reduce water surface level fluctuations in the Sacramento, Yuba, American, Tuolumne, and Merced rivers (Figure IV-31). Under Alternative 1, the reoperation of reservoirs to minimize abrupt changes in water surface level would improve conditions related to water surface level (Figure IV-32) and reduce mortality during spawning, incubation, rearing, and adult life stages for steelhead trout and chinook salmon.

Pollutants

Reduced application of pesticides (e.g., as a result of reduced agricultural acreage) and actions that reduce input of pollutants under Alternative 1 would improve water quality conditions in rivers and streams compared with conditions under the No-Action Alternative (Figure IV-32). Although CVPIA actions addressing pollutant input and actual changes in pesticide application may be minimal, representative species would benefit to some extent.

Restoring meander belts, riparian habitat, and shallow water habitat on rivers and streams and in the Delta can, by restoring ecosystem functions that remove pollutants from the ecosystem, lead to improved water quality conditions and result in subsequent benefits to survival, growth, and reproduction of fish. Actions addressing erosion control in watersheds and at gravel mining sites may also reduce pollutant input. Potential actions on the Sacramento River address toxicant problems associated with metal sludge in Keswick Reservoir and discharge from the ACID canal.

Predation

Predation on some species may decrease if the ecosystem structure is changed to decrease those species' vulnerability to predation or to decrease predator feeding efficiency. CVPIA actions under Alternative 1 would reduce predation at diversion facilities and dams (see "Diversion" and "Movement") (Figure IV-32). Other CVPIA actions include modifying physical habitat to isolate ponds from the main channels of the Stanislaus, Tuolumne, and Merced rivers. The ponds support warm-water species that prey on juvenile fall-run chinook salmon. Under Alternative 1, actions to isolate ponds from the main river flow would reduce predator habitat and, therefore, reduce predation on juvenile fall-run chinook salmon.

Movement

Conditions that support passive and active movement, both of which are essential to organism survival, growth, and reproduction, are assessed in this section. Movement is affected by flow (including velocity, turbulence, and direction), diversion, barriers, water quality, and physical habitat conditions.

River flow over barriers and the predation associated with these barriers increase mortality during the downstream migration of juvenile chinook salmon and steelhead trout. CVPIA actions under Alternative 1 include removal of barriers on minor tributaries (e.g., Mill and Butte creeks) and modification of the spill structure at Daguerre Point Dam on the Yuba River (Figure IV-31). These actions would improve conditions affecting downstream movement (Figure IV-32) and benefit juvenile fall- and spring-run chinook salmon and juvenile steelhead trout.

This analysis assumes that constructing barriers that block adult migration to unproductive habitat would increase movement to productive habitat, increase survival, and improve reproductive success for chinook salmon and steelhead trout. CVPIA actions implemented under Alternative 1 would include constructing barriers on minor tributaries of the Sacramento River (Crowley Gulch on Cottonwood Creek, Grover Diversion Dam and Coleman Powerhouse on Battle Creek) and on the mainstem San Joaquin River upstream of its confluence with the Merced River (Figure IV-31). These barriers would have beneficial effects on movement to productive habitat (Figure IV-32) and increase spawning and rearing success of adult fall-run chinook salmon. On Battle Creek, barriers would benefit spring-run chinook salmon and steelhead trout.

Pulse flows provide cues for migration to downstream habitat, increasing survival of outmigrant juvenile chinook salmon. Under Alternative 1, increased flows pulse flows or would be provided on Clear Creek and the American and Stanislaus rivers (Figure IV-31 and IV-32). These pulse flows would primarily benefit migration of juvenile fall-run chinook salmon, although ecosystem processes that maintain habitat conditions for other life stages and species may also improve.

Striped bass spawn in the Sacramento River during late April, May, and June. Under Alternative 1, Sacramento River flow during April through June would be reduced. Reduced flow (Figure IV-31) would slow the movement of eggs toward the Delta and adversely affect survival of striped bass eggs and larvae (Figures IV-32 and IV-33) compared with conditions under the No-Action Alternative. Sacramento River flows would be lower under Alternative 1 primarily because less water would be exported from the Trinity River basin to the Sacramento River.

American shad spawn from May through July. As with striped bass, reduced Sacramento River flows during May and June would adversely affect movement (Figure IV-32) and therefore adversely affect the survival of American Shad eggs and larvae (Figure IV-33). Compared with the No-Action Alternative, Alternative 1 results in simulated American River flows that are lower during June and July, potentially slowing movement and adversely affecting egg and larval survival in the American River.

In the Delta, outmigrating juvenile chinook salmon, juvenile steelhead trout, and striped bass eggs and larvae are assumed to enter the DCC and Georgiana Slough in the same proportion as flow from the Sacramento River. Organisms transported into the central Delta from the DCC and Georgiana Slough are exposed to additional diversions, adverse water temperature, and increased predation compared with organisms that continue down the Sacramento River. Under Alternative 1, the proportion of Sacramento River flow entering the DCC and Georgiana Slough is similar to the proportion under the No-Action Alternative except during June, July, and October. During October, migration of species susceptible to movement into the central Delta is minimal and effects of the change in flow division at the DCC and Georgiana Slough would be similar under Alternative 1 and the No-Action Alternative.

An increase in the proportion of flow entering the DCC and Georgiana Slough in June and July could transport juvenile fall-run and late fall-run chinook salmon and striped bass eggs and larvae into the central Delta and increase exposure to adverse habitat conditions. Increased movement through the DCC and Georgiana Slough, however, would be offset by improved conditions in the central Delta associated with reduced diversions (see “Diversion”) and increased flow out of the central Delta.

Net Delta channel flow toward Suisun Bay is assumed to provide cues that increase the movement of organisms toward the Bay and away from more adverse habitat conditions in the central Delta. As indicated by a higher QWEST from May through August, flow out of the central Delta would increase under Alternative 1 and could increase movement toward the Bay (Figure IV-32). Larval and juvenile striped bass and delta smelt, and juvenile chinook salmon and steelhead trout would benefit from conditions increasing movement out of the central and south Delta and toward Suisun Bay.

Improved conditions affecting movement of striped bass and delta smelt, however, would be moderated by an upstream shift in estuarine salinity in response to reduced Delta outflow during July, August, and September. The upstream shift in salinity could cause juvenile striped bass and delta smelt to remain in the Delta, where entrainment loss at diversions is higher.

Compared with the No-Action Alternative, Alternative 1 would result in lower QWEST, lower Delta outflow during October and November, and higher diversions from October through February, which could delay movement out of the central Delta and increase mortality of juvenile striped bass; delta smelt; American shad; steelhead trout; and late fall-, winter-, and spring-run chinook salmon. Movement out of the central Delta is most important during spring, however, because life stages vulnerable to entrainment are present in higher numbers. Increased flow toward the Bay from May through August would offset the adverse effects of reduced flow toward the Bay during October through February.

Habitat Quantity and Quality

In the Sacramento and San Joaquin river basins, habitat loss has been a factor in the decline of many species, and providing habitat is critical to maintain and increase current populations. Habitat quantity and quality in the Sacramento-San Joaquin river basin would increase and improve under Alternative 1 for several reasons. Actions affecting habitat quantity and quality include structural changes, such as constructing fish ladders and removing barriers; improving habitat through instream and riparian restoration; and increasing flow.

Nonflow Changes. Actions to improve access to upstream habitat would be implemented on Clear Creek and the minor tributaries to the Sacramento River, as well as on the Feather, Yuba, Mokelumne, and Calaveras rivers (Figure IV-31). A fish ladder would be constructed at McCormick-Saeltzer Dam on Clear Creek. On Battle Creek, passage at Coleman National Fish Hatchery and Eagle Canyon would be modified and improved. Dams on Mill and Butte creeks would be removed, a fish ladder and fishway would be installed at Iron Canyon and Lindo Channel on Big Chico Creek, and fish ladders would be installed on Butte Creek. Passage would also be improved at Daguerre Point Dam on the Yuba River and around diversion dams on the Calaveras River. On the Feather River, improved passage for sturgeon is an identified action under Alternative 1. All these actions would increase habitat quantity by increasing access to existing habitat and would benefit primarily chinook salmon and steelhead trout; however, sturgeon, American shad, and Sacramento splittail may also benefit.

In the Sacramento River, restoring spawning gravel would increase spawning habitat for chinook salmon and steelhead trout, thereby increasing habitat quantity (Figure IV-32). Restoring the meander belt on the Sacramento River from Keswick Reservoir to Chico would increase habitat complexity and restore natural river processes (e.g., erosion, seasonal flooding). The meander belt would increase rearing habitat for juvenile chinook salmon (all runs), steelhead trout, American shad, and sturgeon. Restoring the meander belt may also provide additional spawning and rearing habitats for Sacramento splittail.

The availability of rearing habitat for fry and juvenile fall-run and spring-run chinook salmon and steelhead trout in the tributaries to the Sacramento River would also be improved under Alternative 1. Restoring channel habitat on Antelope Creek; enhancing spawning gravel on Mill, Deer, and Big Chico creeks; and improving pool-cleaning procedures on Big Chico Creek would increase or improve habitat quantity and quality under Alternative 1. Spawning gravel and channel habitats would be restored and enhanced and erosion control measures initiated for Clear Creek and the adjacent watershed.

On the Feather River, enhancing spawning gravel would increase habitat quantity and benefit spring- and fall-run chinook salmon. Fall-run chinook salmon and steelhead trout would also benefit from actions implemented on the Yuba River, including purchasing land for conservation easements, restoring channels and riparian habitat, and creating secondary channels to increase the amount of spawning and rearing habitats. On the American River, the program to remove woody debris would be terminated, and channels and riparian habitat would be restored, including the creation of side channels. The spawning and rearing life stages of chinook salmon and steelhead trout would benefit from increased habitat availability and improved habitat quality.

Habitat quantity would also increase in the San Joaquin River and its tributaries (Figure IV-32). Restoration actions on the Merced, Tuolumne, Stanislaus, Mokelumne, and mainstem San Joaquin rivers would include improving watersheds, restoring and protecting instream and riparian habitats, possibly restoring spawning gravels, preventing illegal stream alterations, and limiting future bank protection activities. These actions would benefit the spawning and rearing life stages of fall-run chinook salmon, American shad, sturgeon, and Sacramento splittail.

Delta and estuarine habitats are critical to all the representative species. Actions to restore habitats would include restricting dredging, restoring riparian vegetation, limiting bank protection, and restoring tidal shallow water habitat. Restoring shallow water habitat would increase the availability of rearing habitat for all species and the availability of spawning habitat for delta smelt, longfin smelt, and Sacramento splittail.

Flow Changes. For the purposes of the PEIS, increasing flow is assumed to increase habitat availability for chinook salmon, steelhead trout, striped bass, American shad, green sturgeon, white sturgeon, and Sacramento splittail. Site-specific analysis (e.g., ongoing instream flow studies on the American and Sacramento rivers) will be required, however, to determine specific flow needs and to address the specific impacts and benefits of meeting those needs.

In the Sacramento River, flows would be higher under Alternative 1 than under the No-Action Alternative during seven months of the year and lower than under the No-Action Alternative during the remaining months. Increased habitat quality and quantity would result from higher flows from October through April (Figure IV-32). More spawning habitat would be available for fall-, late fall-, and spring-run chinook salmon and steelhead trout and possibly also for Sacramento splittail and sturgeon. Higher flows may provide additional rearing habitat for all runs of chinook salmon, steelhead trout, sturgeon, and Sacramento splittail.

Reduced flows and higher water temperatures in the Sacramento River from May through September, compared with conditions under the No-Action Alternative, would reduce habitat availability for fall-, late fall-, winter-, and spring-run chinook salmon and steelhead trout. Higher water temperatures may reduce the downstream extent of habitat suitable for juvenile late fall- and spring-run chinook salmon and steelhead trout, particularly in reaches downstream of the RBDD. Because most fall-run chinook salmon outmigrate before mid-June, the fall run would be affected less than other runs by changes in rearing habitat availability.

Habitat availability in Clear Creek would improve greatly under Alternative 1 because of higher flows. This would apply particularly to rearing fry and juvenile fall- and spring-run chinook salmon and steelhead trout. Simulated flows are higher for all months compared with flows under the No-Action Alternative, increasing the availability of habitat.

Simulated data show little difference in flow between Alternative 1 and the No-Action Alternative for the Feather and Yuba rivers. In the American River, higher flows from October through March may provide more spawning and rearing habitats for fall-run chinook salmon and steelhead trout. Lower flows from June through September would primarily reduce the availability of rearing habitat for steelhead trout.

On the Tuolumne River, flows under Alternative 1 would be similar to those under the No-Action Alternative. On the Stanislaus River, higher flows from February through June would improve and increase rearing habitat, benefitting juvenile fall-run chinook salmon and possibly American shad. Higher flows in October may increase spawning habitat and benefit fall-run chinook salmon. On the Merced River, lower flows during April and May would reduce the availability of rearing habitat and increase water temperature, potentially reducing the downstream extent of habitat suitable for rearing juvenile fall-run chinook salmon (Figure IV-32). Lower flow during October may reduce spawning habitat and adversely affect fall-run chinook salmon (Figure IV-33).

Higher Delta outflows and the shift of estuarine salinity downstream of the Delta and into Suisun Bay would increase habitat quantity. Estuarine salinity would shift farther downstream during January, February, and March during low-outflow years and would increase spawning and early rearing habitat for Sacramento splittail, delta smelt, and longfin smelt. Habitat quality would also improve, primarily because of potential reductions in diversion-related mortality and increased food web support.

From July through September, Delta outflow under Alternative 1 would be less than outflow simulated for the No-Action Alternative and estuarine salinity would shift upstream. These upstream salinity shifts would reduce habitat availability and quality for striped bass and delta smelt.

Food Web Support

Organisms that provide the food base for fish species are affected by the same ecosystem functions that affect the representative fish species discussed previously. Restoring the meander belt from Keswick Reservoir to Chico, restoring riparian habitat, creating secondary channels, terminating the program to remove woody debris, improving watersheds, restoring and protecting instream habitat, and limiting future bank protection activities would increase food web support for representative species in the Sacramento River and its tributaries under Alternative 1 (Figures IV-31 and IV-32). These actions would increase the input of nutrients, organic carbon, and food organisms to the aquatic ecosystem. In addition, reducing pollutant input to the system would increase food organism survival and food web support for riverine species.

Food web support would also increase for representative species in the Delta. CVPIA actions to restore habitat, including actions that may restrict dredging, restore riparian vegetation, limit bank protection, and restore tidal shallow water habitat would increase the input of nutrients, organic carbon, and food organisms to the Delta and would increase food web support for representative species. In addition, upstream restoration actions described previously would increase the input of nutrients, organic carbon, and food organisms to the Delta. Food web support in the Delta would also benefit from reduced pollutant input from the Sacramento and San Joaquin rivers and their tributaries that drain to the Delta.

Reduced entrainment in diversions under Alternative 1 would affect food web support in the Delta. Compared with conditions under the No-Action Alternative, diversions from the Delta (primarily through the CVP and SWP pumping facilities) under Alternative 1 would be lower from April through September and higher from October through February. Because of their small size, food web organisms would generally not benefit from installation of new or improved fish screens, but decreased diversions would reduce entrainment of food web organisms, nutrients, and organic carbon. Reduced diversions during April through September generally coincide with the main period of primary productivity in the Delta.

Compared with the No-Action Alternative, estuarine salinity under Alternative 1 would shift farther downstream during January through March of low-outflow years. The downstream shift in estuarine salinity may increase food web support for species geographically associated with specific salinity levels because productivity is generally higher in the shallow shoal habitats of Suisun Bay than in the Delta. Food web support would increase for Sacramento splittail, delta smelt, and longfin smelt. From July through September, simulated Delta outflow would be less under Alternative 1 than under the No-Action Alternative, and estuarine salinity would shift upstream. The upstream shift would affect production of food organisms that require specific salinity conditions and would reduce food web support for striped bass, delta smelt, and other species.

ALTERNATIVE 2

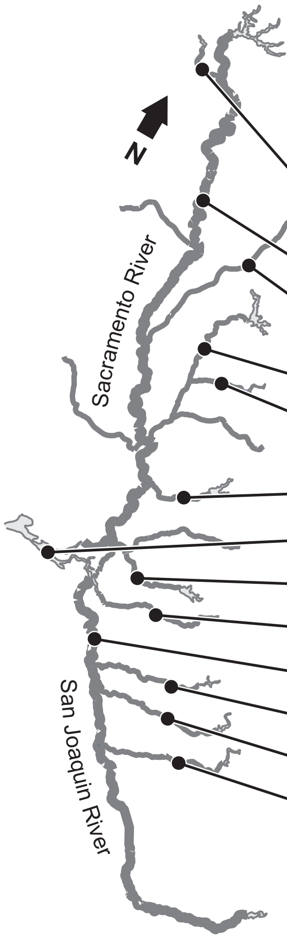
Alternative 2 includes all Alternative 1 actions and would provide similar benefits associated with those actions (Figure IV-34). Flow acquisition on the San Joaquin River tributaries provides additional benefits not discussed for Alternative 1. Increased flows in the San Joaquin River Region would occur in Alternative 2. The combination of actions (structures, habitat, and flow improvements) and species interactions would improve ecosystem conditions, including increased habitat quantity and quality (Figure IV-35). The improved ecosystem conditions would benefit most representative species compared with conditions under the No-Action Alternative (Figure IV-36).

Water Temperature

Several actions implemented under Alternative 2 could affect water temperatures: changing reservoir operations; changing flows; installing or modifying multilevel release shutters; restoring riparian areas, meander belts, and watersheds; and controlling and relocating agricultural return flows (Figure IV-34). The benefits of all of these actions are discussed for Alternative 1. This section discusses only the additional benefits provided by the changes in reservoir operations and flow on San Joaquin River tributaries.

Alternative 2 should improve water temperature conditions compared with Alternative 1 and the No-Action Alternative (see discussion of Alternative 1). Increased flow in the Stanislaus, Tuolumne, Merced, and San Joaquin rivers should improve water temperature conditions and benefit rearing fall-run chinook juveniles and fry.

For the Stanislaus River, the temperature simulation indicates that reduced water temperatures would benefit juvenile fall-run chinook salmon during April and May. During October and November, slightly higher temperatures could lead to increased mortality during spawning and incubation of the fall run. However, because this change is relatively small, it may be possible that actual reservoir operations could be refined to meet the AFRP target of 56 degrees Fahrenheit on October 15, whereas modeled reservoir operations could not. Similar benefits and effects are likely on the Merced and Tuolumne rivers.



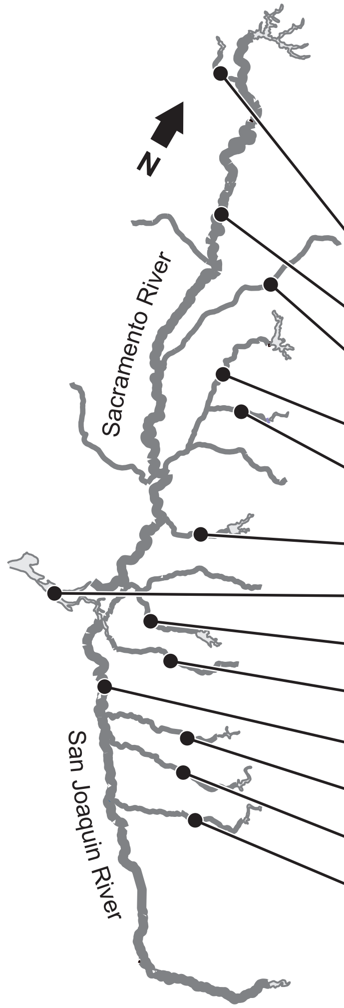
Watershed	Structure: Fish Screens	Structure: Improved Passage	Habitat Improvements: Instream	Habitat Improvements: Riparian	Habitat Improvements: Water Quality	Flow: Increased Flow	Flow: Reduced Fluctuation	Flow: Reduced Diversion	Species Interactions: Predator Control
Clear Creek		☐	☐	☐	☐	☐	☐		
Sacramento R.	☐		☐	☐	☐	☐	☐		
*Minor Tributaries	☐	☐	☐	☐	☐	☐			
Feather R.	☐	☐	☐			☐			
Yuba River	☐	☐	☐	☐			☐		
American R.	☐		☐	☐		☐	☐		
Bay-Delta	☐		☐	☐	☐	☐			
Mokelumne R.	☐	☐	☐	☐	☐				
Calaveras R.	☐	☐							
San Joaquin R.	☐	☐		☐	☐	■			
Stanislaus R.	☐		☐	☐		■			☐
Tuolumne R.	☐		☐	☐	☐	■	☐		☐
Merced R.	☐	☐	☐	☐	☐	■	☐		☐

■ = Actions in addition to those under Alternative 1
☐ = Action implemented under Alternative 1
No Symbol = No action implemented

*Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-34

CVPIA ACTIONS IMPLEMENTED TO BENEFIT FISH AND AQUATIC RESOURCES UNDER ALTERNATIVE 2



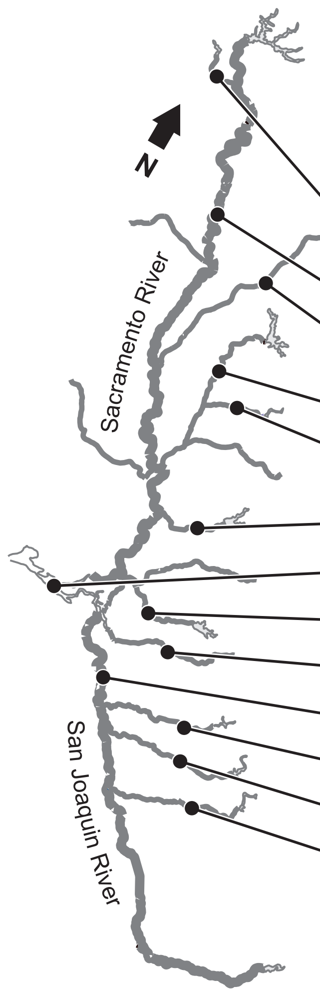
Watershed	River Water Temperature	Diversion	River Surface Level Changes	Pollutants	Predation	Movement	Habitat Quality and Quantity	Food Web Support
Clear Creek	✓	✓	✓			✓	✓	✓
Sacramento R.		✓	✓	✓	✓	✗	✓	✓
*Minor Tributaries	✓	✓			✓	✓	✓	✓
Feather R.		✓					✓	✓
Yuba River	✓	✓			✓	✓	✓	✓
American R.	✗	✓	✓			✓	✓	✓
Bay-Delta		★		✓	✓	★	★	★
Mokelumne R.		✓		✓	✓		✓	✓
Calaveras R.		✓					✓	✓
San Joaquin R.		✓		✓	✓	★	★	★
Stanislaus R.	★	✓			✓	★	★	★
Tuolumne R.	✔	✓	✓	✓	✓	✔	★	★
Merced R.	✔	✓	✓	✓	✓	✔	✔	✔

★ = Greater benefit compared to Alternative 1
✔ = New benefit compared to Alternative 1
✓ = Equivalent to benefit shown for Alternative 1
No Symbol = No change
✗ = Adverse change compared to the No-Action Alternative, but not greater than under Alternative 1

* Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-35

CHANGES IN ENVIRONMENTAL CONDITIONS AFFECTING FISH POPULATIONS UNDER ALTERNATIVE 2 COMPARED TO THE NO-ACTION ALTERNATIVE AND ALTERNATIVE 1



Watershed	Chinook Salmon	Steelhead Trout	Sacramento Splittail	Sturgeon	Striped Bass	American Shad	Delta Smelt	Longfin Smelt
Clear Creek	✓	✓	--	--	--	--	--	--
Sacramento R.	✓	✓	✓	✓	✗	✗	--	--
*Minor Tributaries	✓	✓	--	--	--	--	--	--
Feather R.	✓	✓	--	--	--	✓	--	--
Yuba River	✓	✓	--	--	--	✓	--	--
American R.	✓	✗	--	--	--	✗	--	--
Bay-Delta	★	★	★	★	★	★	★	★
Mokelumne R.	✓	--	--	--	--	--	--	--
Calaveras R.	✓	--	--	--	--	--	--	--
San Joaquin R.	★	--	★	--	--	--	--	--
Stanislaus R.	★	--	--	--	--	--	--	--
Tuolumne R.	★	--	--	--	--	--	--	--
Merced R.	✔	--	--	--	--	--	--	--

★ = Greater benefit compared to Alternative 1
✔ = New benefit compared to Alternative 1
✓ = Equivalent to benefit shown for Alternative 1
✗ = Adverse change compared to the No-Action Alternative, but not greater than Alternative 1
-- = Species does not occur or occurrence is minor

* Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-36

BENEFICIAL AND ADVERSE CHANGES TO FISH SPECIES UNDER ALTERNATIVE 2 COMPARED TO THE NO-ACTION ALTERNATIVE AND ALTERNATIVE 1

Diversion

Actions implemented under Alternative 2 that may improve diversion conditions include constructing and improving fish screens, redesigning facilities to discourage predation, reducing diversion volume, and improving flow conditions toward Suisun Bay. Alternative 2 includes all actions from Alternative 1 that affect mortality attributable to diversion structure and operation. Diversion volumes under Alternative 2 are similar to Alternative 1 levels. However, the greater flow toward Suisun Bay under Alternative 2 would provide additional benefits in the Delta relative to conditions described under Alternative 1 (Figure IV-35).

Greater flows from the San Joaquin River and tributaries would improve flow conditions in the Delta, reducing exposure to diversions. Exposure to diversions is higher in the central and southern portions of the Delta and, therefore, species entering and using Delta habitat would benefit from flow conditions favoring movement to Suisun Bay. Increased QWEST from March to August would facilitate the movement of organisms out of the central and southern Delta toward Suisun Bay (see “Movement”), resulting in reduced entrainment losses for egg and larval

striped bass, American shad, delta smelt, and longfin smelt. Reduced QWEST from October to December would reduce movement toward Suisun Bay and increase exposure to entrainment losses. However, fish present in the Delta at that time would be large enough to benefit from fish screen improvements.

Changes in Water Surface Level

Alternative 2 would include implementation of all Alternative 1 actions addressing changes in water surface level (Figure IV-34) and would provide benefits similar to those described under Alternative 1 (Figure IV-35).

Pollutants

Reduced application of pesticides (e.g., as a result of reduced agricultural acreage) and actions that reduce input of pollutants under Alternative 2 would improve water quality conditions in rivers and streams (Figure IV-34). Although CVPIA actions addressing pollutant input and actual changes in pesticide application may be minimal, representative species would benefit to some extent. Benefits would be similar to those identified for Alternative 1 (Figure IV-35).

In addition, increased flows in the Stanislaus, Tuolumne, Merced, and San Joaquin rivers, although small relative to flows under Alternative 1 (see Chapter II), would dilute toxicant concentration levels, thus possibly providing an additional benefit relative to conditions described for Alternative 1.

Predation

The CVPIA actions affecting predation under Alternative 2 and their benefits are the same as those described for Alternative 1.

Movement

Conditions that support passive and active movement, both of which are essential to organism survival, growth, and reproduction, are similar to conditions discussed for Alternative 1 (Figure IV-35).

In addition to the beneficial and adverse effects discussed for Alternative 1, Alternative 2 actions would increase flows in the Stanislaus, Tuolumne, and Merced rivers (Chapter II). Simulated flows increase under Alternative 2 on the Stanislaus River in October and from January to June; on the Tuolumne River from April to October; on the Merced River in October, April, and May; and on the lower San Joaquin River in October and from January through June. Hence, outmigration of juvenile fall-run chinook salmon could be facilitated by increasing flow to the Delta. Flows would decrease on the lower San Joaquin River during August and September, but fall- and late fall-run juvenile chinook salmon do not migrate during that period.

As indicated by increased QWEST from March to August, conditions affecting movement out of the central Delta under Alternative 2 could increase survival of larval and juvenile striped bass, delta smelt, and longfin smelt and juvenile chinook salmon and steelhead trout. Similar to conditions under Alternative 1, however, improved conditions affecting movement of striped bass and delta smelt under Alternative 2 would be moderated by an upstream shift in estuarine salinity in response to reduced Delta outflow during July, August, and September. The upstream shift in salinity could cause juvenile striped bass and delta smelt to remain in the Delta, where entrainment loss in diversions is higher.

Provision of Habitat

Alternative 2 incorporates all Alternative 1 actions that would affect habitat and provides additional habitat benefits through greater flows on San Joaquin River tributaries. Greater flows into the Delta from the San Joaquin River could shift estuarine salinity downstream, resulting in greater habitat availability in the Delta (Figures IV-34 and IV-35).

The quantity of habitat on the San Joaquin River and tributaries would increase with the provision of higher flows in the Stanislaus River during October and from January to June; in the Tuolumne River from April to October; in the Merced River during October and from April to May; and in the lower San Joaquin River in October and from January through June. Increased flows would benefit rearing fall-run chinook fry and juveniles through greater habitat availability.

In addition, spawning and rearing habitat for Delta species may increase because of higher flows in the San Joaquin River under Alternative 2. Compared with conditions under the No-Action Alternative, estuarine salinity under Alternative 2 would shift downstream from January through June and would increase the availability and quality of spawning and early rearing habitat for Sacramento splittail, delta smelt, striped bass, American shad, and longfin smelt. As under Alternative 1, Delta outflow under Alternative 2 would be less than outflow simulated for the No-Action Alternative from July through September and estuarine salinity would shift upstream. Upstream shifts in estuarine salinity would reduce the availability and quality of habitat for striped bass and delta smelt. Habitat quality is related to shallow water habitat availability, potential entrainment losses in diversions, and food web support.

Food Web Support

Under Alternative 2, changes in conditions affecting food web support would be similar to conditions described for Alternative 1. Increased flow in the Stanislaus, Tuolumne, Merced, and San Joaquin rivers would increase habitat area for prey organisms. Increased Delta outflow and a downstream shift in estuarine salinity may increase food web support for rearing life stages of all the representative species by increasing production of food web organisms.

ALTERNATIVE 3

Alternative 3 would incorporate all of the actions described for Alternatives 1 and 2 and would provide similar benefits. In addition, Alternative 3 would build on Alternatives 1 and 2 through assumed acquisition of additional water, primarily on the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers (Figure IV-37; also see Chapter II). Flows in the minor tributaries could also be increased. Consequently, Alternative 3 would provide increased flow-related benefits not discussed for Alternatives 1 and 2 (Figure IV-38) and would provide additional benefits to representative species in some watersheds (Figure IV-39).

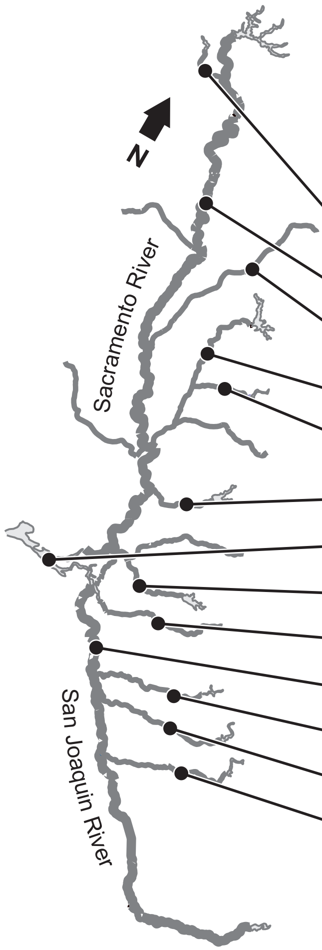
Water Temperature

Most actions assumed to be implemented under Alternative 3 have already been discussed for Alternatives 1 and 2. This section discuss only the additional benefits that would be provided by the changes in reservoir operations and flow on Sacramento and San Joaquin river tributaries (Figure IV-37).

Under Alternative 3, water temperature conditions would improve compared with conditions described for Alternatives 1 and 2 and compared with the No-Action Alternative. Increased spring flows on the Yuba, Mokelumne, Calaveras, Stanislaus, Tuolumne, and Merced rivers should reduce water temperatures and benefit rearing juvenile and fry chinook salmon and steelhead trout. Temperature modeling indicates that water temperatures on the Stanislaus River would be similar to those under Alternative 1. Although not specifically modeled, it is expected that flows and water temperatures may also improve on the Bear, Mokelumne, and Calaveras rivers (see Chapter II), which would benefit fall-run chinook salmon.

Diversion

Actions implemented under Alternative 3 that may improve diversion conditions include constructing and improving fish screens, redesigning facilities to discourage predation, reducing diversion volume, and improving flow conditions toward Suisun Bay. Alternative 3 includes all actions from Alternatives 1 and 2 that affect mortality attributable to diversion structure and operation, and would provide similar benefits (Figure IV-38). Diversion volumes under Alternative 3 are also similar to Alternative 1 levels. Diversions may be reduced in the Yuba, Mokelumne, and Calaveras rivers and increased in the Delta. Increased flow toward Suisun Bay under Alternative 3 would provide benefits related to diversion conditions in addition to those described for Alternatives 1 and 2 (Figure IV-38).



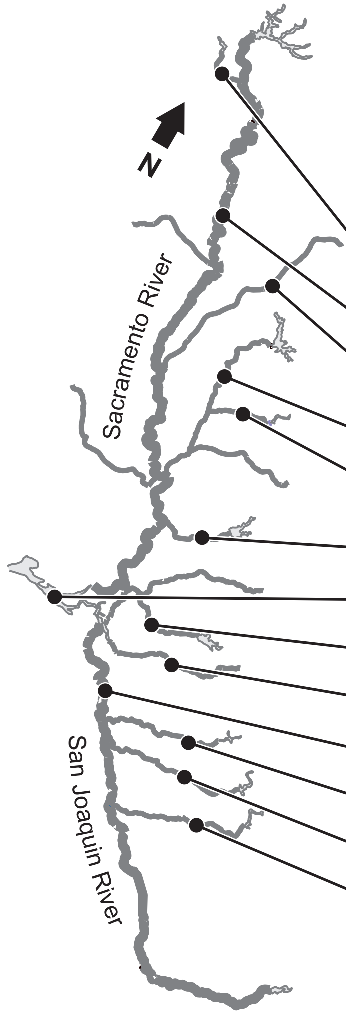
Watershed	Structure: Fish Screens	Structure: Improved Passage	Habitat Improvements: Instream	Habitat Improvements: Riparian	Habitat Improvements: Water Quality	Flow: Increased Flow	Flow: Reduced Fluctuation	Flow: Reduced Diversion	Species Interactions: Predator Control
Clear Creek		☐	☐	☐	☐	☐	☐		
Sacramento R.	☐		☐	☐	☐	☐	☐		
*Minor Tributaries	☐	☐	☐	☐	☐	■			
Feather R.	☐	☐	☐			☐			
Yuba River	☐	☐	☐	☐		■	■		
American R.	☐		☐	☐		☐	☐		
Bay-Delta	☐		☐	☐	☐	☐			
Mokelumne R.	☐	☐	☐	☐	☐	■	■		
Calaveras R.	☐	☐				■			
San Joaquin R.	☐	☐		☐	☐	■			
Stanislaus R.	☐		☐	☐		■			☐
Tuolumne R.	☐		☐	☐	☐	■	☐		☐
Merced R.	☐	☐	☐	☐	☐	■	☐		☐

■ = Actions in addition to those under Alternative 2
☐ = Action implemented under Alternatives 1 and 2
No Symbol = No action implemented

*Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-37

CVPIA ACTIONS IMPLEMENTED TO BENEFIT FISH AND AQUATIC RESOURCES UNDER ALTERNATIVE 3



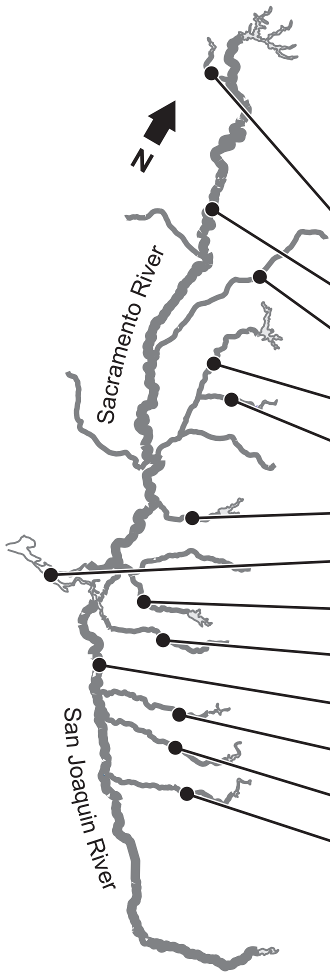
Watershed	River Water Temperature	Diversion	River Surface Level Changes	Pollutants	Predation	Movement	Habitat Quality and Quantity	Food Web Support
Clear Creek	✓	✓	✓			✓	✓	✓
Sacramento R.		✓	✓	✓	✓	✗	✓	✓
*Minor Tributaries	✓	✓			✓	✓	✓	✓
Feather R.		✓					✓	✓
Yuba River	★	✓	**✓**		✓	★	★	★
American R.	✗	✓	✓			✓	✓	✓
Bay-Delta		★		✓	✓	★	★	★
Mokelumne R.	**✓**	✓	**✓**	✓	✓	**✓**	★	★
Calaveras R.	**✓**	✓					✓	✓
San Joaquin R.		✓		✓	✓	★	★	★
Stanislaus R.	★	✓			✓	★	★	★
Tuolumne R.	★	✓	✓	✓	✓	★	★	★
Merced R.	★	✓	✓	✓	✓	★	★	★

★ = Greater benefit compared to Alternative 2
✓ = New benefit compared to Alternative 2
✓ = Equivalent to benefit shown for Alternative 2
No Symbol = No change
✗ = Adverse change compared to the No-Action Alternative, but not greater than under Alternative 2

* Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-38

CHANGES IN ENVIRONMENTAL CONDITIONS AFFECTING FISH POPULATIONS UNDER ALTERNATIVE 3 COMPARED TO THE NO-ACTION ALTERNATIVE AND ALTERNATIVE 2



Watershed	Chinook Salmon	Steelhead Trout	Sacramento Splittail	Sturgeon	Striped Bass	American Shad	Delta Smelt	Longfin Smelt
Clear Creek	✓	✓	--	--	--	--	--	--
Sacramento R.	✓	✓	✓	✓	✗	✗	--	--
*Minor Tributaries	✓	✓	--	--	--	--	--	--
Feather R.	✓	✓	--	--	--	✓	--	--
Yuba River	★	★	--	--	--	✓	--	--
American R.	✓	✗	--	--	--	✗	--	--
Bay-Delta	★	★	★	★	★	★	★	★
Mokelumne R.	★	--	--	--	--	--	--	--
Calaveras R.	★	--	--	--	--	--	--	--
San Joaquin R.	★	--	★	--	--	--	--	--
Stanislaus R.	★	--	--	--	--	--	--	--
Tuolumne R.	★	--	--	--	--	--	--	--
Merced R.	★	--	--	--	--	--	--	--

★ = Greater benefit compared to Alternative 2
✔ = New benefit compared to Alternative 2
✓ = Equivalent to benefit shown for Alternative 2
✗ = Adverse change compared to the No-Action Alternative, but not greater than Alternative 2
-- = Species does not occur or occurrence is minor

* Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-39

BENEFICIAL AND ADVERSE CHANGES TO FISH SPECIES UNDER ALTERNATIVE 3 COMPARED TO THE NO-ACTION ALTERNATIVE AND ALTERNATIVE 2

Although diversion volumes may be reduced on the Yuba, Mokelumne, and Calaveras rivers, new fish screens and fish screen improvements would provide the primary benefit for fish of the appropriate size, similar to the benefit described for Alternatives 1 and 2. Yuba River diversions would decrease from October to December and from April to September, benefitting migrating juvenile fall-run chinook and steelhead. Mokelumne River diversions would decrease in October and December and from April to September, benefitting migrating fall-run chinook salmon in April and May.

Part of the acquired flow entering the Delta from the San Joaquin River under Alternative 3 would be exported from the Delta, increasing Delta diversions from August through May compared with diversions under the No-Action Alternative. Although increased diversions could have adverse effects on San Joaquin River chinook salmon, higher San Joaquin River inflow, increased QWEST, and higher Delta outflow would offset the effects of increased diversions on most species. Overall, conditions affecting diversion losses would improve for all species, and entrainment losses would be lower under Alternative 3 than under the No-Action Alternative (Figure IV-38).

Changes in Water Surface Level

Alternative 3 would include all Alternative 1 actions addressing changes in water surface level (Figure IV-37) and would provide benefits similar to those described for Alternative 1 (Figure IV-38). In addition, Alternative 3 would reduce flow fluctuations on the Yuba and Mokelumne rivers. Reduced flow fluctuations would reduce stranding and drying out of redds, providing benefits to egg, fry, and juvenile life stages of fall-run chinook salmon and steelhead trout (Figures IV-37 and IV-38).

Pollutants

Conditions affected by pollutants under Alternative 3 would be similar to those described for Alternatives 1 and 2 (Figure IV-38). In addition, increased flows in the Stanislaus, Tuolumne, Merced, and San Joaquin rivers (see Chapter II) would dilute pollutant concentration levels, thus providing a slight additional benefit relative to conditions described for Alternatives 1 and 2.

Predation Losses

Alternative 3 would involve implementing all actions affecting predation described for the previous alternatives and would have similar benefits (Figure IV-38).

Movement

Conditions that would support passive and active movement essential to organism survival, growth, and reproduction under Alternative 3 would be similar to those discussed for Alternatives 1 and 2 (Figure IV-37). Alternative 3 would include pulse flows on the Yuba, Mokelumne, Calaveras, and Stanislaus rivers and supplemental pulse flows on the Tuolumne and Merced rivers (see Chapter II). Pulse flows would primarily benefit outmigration of juvenile fall-run chinook salmon, although pulse flows may also benefit ecosystem processes that maintain habitat conditions for other life stages and species. Under Alternative 3, Yuba River flows would increase in October, November, June, and September and decrease in April, July, and August. Higher flows in June would improve transport of American shad eggs and larvae. However, reduced river flow in April and July could reduce transport and increase mortality of American shad eggs and larvae spawned in the Yuba River.

In the Delta, net channel flows toward Suisun Bay are assumed to provide cues that increase the movement of organisms out of the central Delta. As indicated by a higher QWEST compared with those under the previous alternatives, flow conditions under Alternative 3 may increase movement of larval and juvenile striped bass, delta smelt, and longfin smelt and juvenile chinook salmon and steelhead trout out of the central and southern Delta and toward Suisun Bay from December through August. Movement out of the central Delta would increase survival because of reduced diversion effects and increased productivity in Suisun Bay. Although reduced QWEST may reduce movement and increase mortality of some species in the central Delta during November, movement out of the central Delta is most important during spring and early summer because of the greater incidence of life stages vulnerable to entrainment in diversions.

Habitat Quantity and Quality

Alternative 3 includes all actions described for Alternatives 1 and 2 affecting habitat (Figure IV-37). In addition, implementing Alternative 3 actions would increase flows on minor tributaries to the Sacramento River and the Yuba, Mokelumne, Calaveras, San Joaquin, Stanislaus, Tuolumne, and Merced rivers (Figure IV-37). Increased river flow would contribute to increased Delta outflow and result in a downstream shift of estuarine salinity. The increased flows would increase habitat availability and quality and would benefit most of the representative species (Figures IV-38 and IV-39).

Yuba River flow would increase from September to November, potentially increasing habitat availability for spawning and incubation life stages of fall-run chinook salmon and fry and juvenile rearing life stages of steelhead. However, Yuba River flow would decrease in June and July, reducing habitat availability for steelhead fry and juvenile rearing life stages. Under Alternative 3, channel restoration on the Yuba River would increase habitat availability and offset the habitat reduction that may be attributable to decreased flows.

Mokelumne River flow would increase from December to April, increasing habitat availability for fall-run chinook salmon, and decrease from May to September, potentially reducing habitat availability for the juvenile fall-run chinook salmon rearing life stage during June. Alternative 3 also would include habitat restoration actions discussed for Alternative 1 on the Mokelumne River, thus offsetting habitat losses attributable to reduced flow from May through September.

Under Alternative 3, Calaveras River flow would increase from October to April compared with levels under the No-Action Alternative, thus increasing habitat availability for fall- and winter-run chinook salmon. Flows from May to September would decrease and could affect habitat availability for winter-run chinook salmon. Management of Calaveras River flows, however, would require site-specific evaluations to address the needs of applicable species.

Stanislaus River flow would increase from September to June compared with conditions under the No-Action Alternative, increasing habitat availability for fall-run chinook salmon. San Joaquin, Tuolumne, and Merced river flows would increase in all months compared with No-Action Alternative conditions, benefitting fall-run chinook salmon by increasing habitat availability. Although Merced River flows during June would decline compared with conditions under the No-Action Alternative, rearing juvenile chinook salmon are less likely to be present at that time than during the preceding months, and effects on survival and growth would be minimal.

San Joaquin River inflow to the Delta would increase relative to inflow under the No-Action Alternative and Alternatives 1 and 2. Increased flows on the Merced, Tuolumne, and Stanislaus rivers contribute to increased Delta inflow. Although part of the inflow is exported (see "Diversions" above), increased Delta outflow under Alternative 3 would shift estuarine salinity farther downstream from November through June compared with conditions under the No-Action Alternative. The downstream shift in estuarine salinity would increase freshwater habitat availability and improve habitat conditions for Sacramento splittail, delta smelt, striped bass, American shad, and longfin smelt. The effects of reduced Delta outflow from July through September compared with outflow under the No-Action Alternative would be the same as described for Alternative 1.

Food Web Support

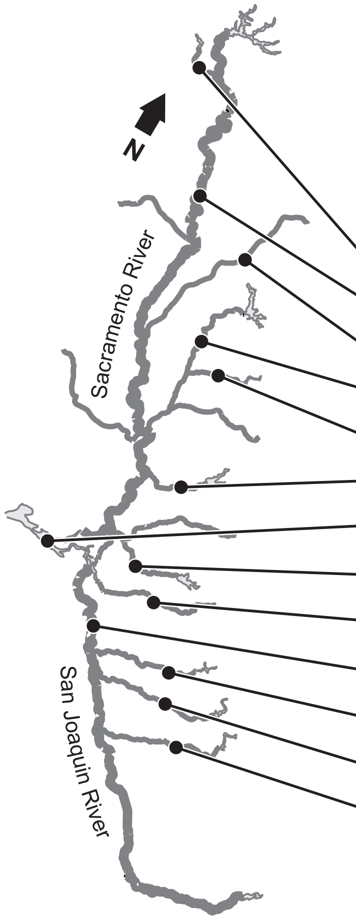
Under Alternative 3, changes in conditions affecting food web support would be similar to conditions described for Alternatives 1 and 2. Under Alternative 3, increased flow on the minor tributaries of the Sacramento River and on the Yuba, Mokelumne, Calaveras, San Joaquin, Stanislaus, Tuolumne, and Merced rivers would increase the quantity and quality of habitat available for prey organisms and increase food web support (Figure IV-38). Increased Delta outflow and a downstream shift in estuarine salinity may increase food web support for rearing life stages of all the representative species by increasing production of food web organisms.

ALTERNATIVE 4

Alternative 4 would include all actions described for Alternatives 1, 2, and 3 and would provide similar benefits. In addition, Alternative 4 would improve on Alternative 3 conditions by allowing water acquired upstream of the Delta to flow through the Delta to the Bay (Figure IV-40). Alternative 4 also wold modify DCC operations to provide additional benefits for Sacramento River system species. In general, flows allocated to fish habitat improvements in the Delta would increase under Alternative 4 and provide additional benefits relative to conditions described under the No-Action Alternative and Alternatives 1, 2, and 3 (Figure IV-41). Implementation of Alternative 4 would have beneficial effects on all of the representative species occurring in the Delta (Figure IV-42).

Water Temperature

Alternative 4 would incorporate all actions from Alternatives 1, 2, and 3 affecting water temperature and would have the same benefits in habitats upstream of the Delta (Figures IV-40 and IV-41).



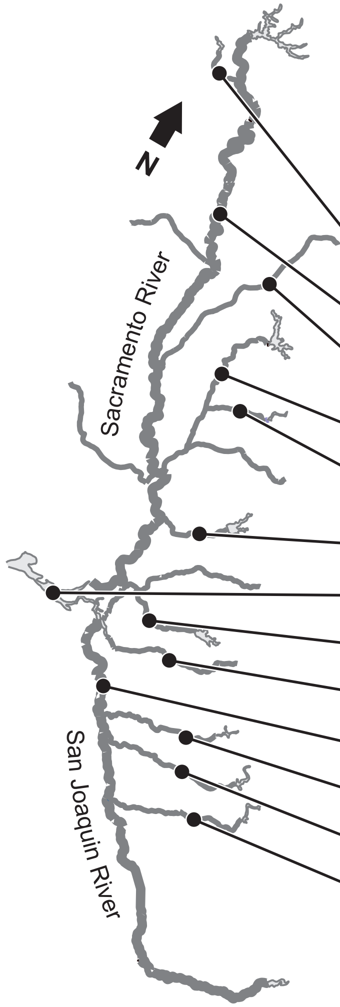
Watershed	Structure		Habitat Improvements			Flow			Species Interactions
	Fish Screens	Improved Passage	Instream	Riparian	Water Quality	Increased Flow	Reduced Fluctuation	Reduced Diversion	Predator Control
Clear Creek		☐	☐	☐	☐	☐	☐		
Sacramento R.	☐		☐	☐	☐	☐	☐		
*Minor Tributaries	☐	☐	☐	☐	☐	☐			
Feather R.	☐	☐	☐			☐			
Yuba River	☐	☐	☐	☐		☐	☐		
American R.	☐		☐	☐		☐	☐		
Bay-Delta	☐	■	☐	☐	☐	■		■	
Mokelumne R.	☐	☐	☐	☐	☐	☐	☐		
Calaveras R.	☐	☐				☐			
San Joaquin R.	☐	☐		☐	☐	☐			
Stanislaus R.	☐		☐	☐		☐			☐
Tuolumne R.	☐		☐	☐	☐	☐	☐		☐
Merced R.	☐	☐	☐	☐	☐	☐	☐		☐

■ = Actions in addition to those under Alternative 3
☐ = Action implemented under Alternatives 1, 2, and 3
No Symbol = No action implemented

*Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-40

CVPIA ACTIONS IMPLEMENTED TO BENEFIT FISH AND AQUATIC RESOURCES UNDER ALTERNATIVE 4



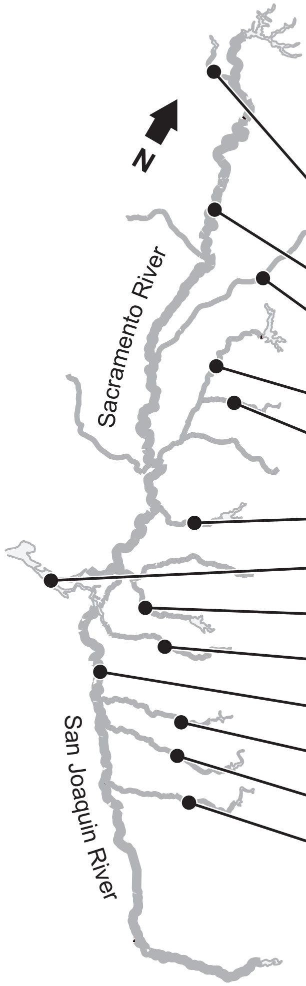
Watershed	River Water Temperature	Diversion	River Surface Level Changes	Pollutants	Predation	Movement	Habitat Quality and Quantity	Food Web Support
Clear Creek	✓	✓	✓			✓	✓	✓
Sacramento R.		✓	✓	✓	✓	✕	✓	✓
*Minor Tributaries	✓	✓			✓	✓	✓	✓
Feather R.		✓					✓	✓
Yuba River	✓	✓	✓		✓	✓	✓	✓
American R.	✕	✓	✓			✓	✓	✓
Bay-Delta		★		✓	✓	★	★	★
Mokelumne R.	✓	✓	✓	✓	✓	✓	✓	✓
Calaveras R.	✓	✓					✓	✓
San Joaquin R.		✓		✓	✓	✓	✓	✓
Stanislaus R.	✓	✓			✓	✓	✓	✓
Tuolumne R.	✓	✓	✓	✓	✓	✓	✓	✓
Merced R.	✓	✓	✓	✓	✓	✓	✓	✓

★ = Greater benefit compared to Alternative 3
✔ = New benefit compared to Alternative 3
✓ = Equivalent to benefit shown for Alternative 3
No Symbol = No change
✕ = Adverse change compared to the No-Action Alternative, but not greater than under Alternative 3

* Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-41

CHANGES IN ENVIRONMENTAL CONDITIONS AFFECTING FISH POPULATIONS UNDER ALTERNATIVE 4 COMPARED TO THE NO-ACTION ALTERNATIVE AND ALTERNATIVE 3



Watershed	Chinook Salmon	Steelhead Trout	Sacramento Splittail	Sturgeon	Striped Bass	American Shad	Delta Smelt	Longfin Smelt
Clear Creek	✓	✓	--	--	--	--	--	--
Sacramento R.	✓	✓	✓	✓	✗	✗	--	--
*Minor Tributaries	✓	✓	--	--	--	--	--	--
Feather R.	✓	✓	--	--	--	✓	--	--
Yuba River	✓	✓	--	--	--	✓	--	--
American R.	✓	✗	--	--	--	✗	--	--
Bay-Delta	★	★	★	★	★	★	★	★
Mokelumne R.	✓	--	--	--	--	--	--	--
Calaveras R.	✓	--	--	--	--	--	--	--
San Joaquin R.	✓	--	✓	--	--	--	--	--
Stanislaus R.	✓	--	--	--	--	--	--	--
Tuolumne R.	✓	--	--	--	--	--	--	--
Merced R.	✓	--	--	--	--	--	--	--

★ = Greater benefit compared to Alternative 3
✔ = New benefit compared to Alternative 3
✓ = Equivalent to benefit shown for Alternative 3
✗ = Adverse change compared to the No-Action Alternative, but not greater than Alternative 3
-- = Species does not occur or occurrence is minor

* Minor tributaries include Elder, Thomes, Cottonwood, Paynes, Mill, Deer, Big Chico, Cow, Butte, Battle, and Antelope creeks and Bear River

FIGURE IV-42

BENEFICIAL AND ADVERSE CHANGES TO FISH SPECIES UNDER ALTERNATIVE 4 COMPARED TO THE NO-ACTION ALTERNATIVE AND ALTERNATIVE 3

Diversion

Alternative 4 would include all actions affecting diversions described for Alternatives 1, 2, and 3. In the Delta, diversions would be reduced compared with diversions under the No-Action Alternative and Alternatives 1, 2, and 3 (Figure IV-40). Compared with the other alternatives and to the No-Action Alternative, reduced diversions under Alternative 4 would improve conditions affected by diversions in the Delta (Figure IV-41). All representative species would benefit (Figure IV-42).

In addition to the direct benefits of reduced diversions, more water would flow through and out of the Delta under Alternative 4 compared with conditions under the No-Action Alternative and Alternatives 1, 2, and 3. Increased outflow would shift the distribution of Delta species downstream, away from the influence of Delta diversions.

Changes in Water Surface Level

Alternative 4 would incorporate all actions addressing surface level fluctuations from Alternatives 1, 2, and 3 (Figure IV-40) and would provide similar benefits (Figure IV-41).

Pollution

Alternative 4 would incorporate all actions described for Alternatives 1, 2, and 3 that address conditions affected by pollutants (Figure IV-40) and would provide similar benefits (Figure IV-41).

Predation

Alternative 4 would implement all actions affecting predation that have been described for Alternatives 1, 2, and 3 and would have similar benefits (Figures IV-40 and IV-41).

Movement

Conditions that support both passive and active movement essential to organism survival, growth, and reproduction in streams and rivers upstream of the Delta would be the same under Alternative 4 as those discussed for Alternative 3 (Figure IV-40). In the Delta, reduced diversions of inflow to the Delta would increase net channel flows toward Suisun Bay (Figure IV-4-0), which are assumed to provide cues that increase the movement of organisms out of the central Delta. In addition, the DCC would be closed more frequently than under the No-Action Alternative or under conditions described for Alternatives 1, 2, and 3, providing additional benefits.

Under Alternative 4, the proportion of Sacramento River flow entering the DCC would be similar to that described for the previous alternatives for most months. From November through January, the DCC would be closed and proportionately less Sacramento River water would enter the central Delta than under the No-Action Alternative. Closure of the DCC would facilitate movement of juvenile late fall-, winter-, and spring-run chinook salmon and steelhead trout down the Sacramento River and reduce their movement into the central Delta. Organisms moving down the Sacramento River, rather than into the central Delta, would benefit from reduced exposure to Delta diversions, reduced predation, and possibly other factors that affect survival during movement through the central Delta.

As indicated by increased QWEST compared with QWEST under the No-Action Alternative, increased net flows from February through September under Alternative 4 may increase movement of larval and juvenile striped bass, delta smelt, and longfin smelt and juvenile chinook salmon and steelhead trout out of the central and southern Delta and toward Suisun Bay. Movement out of the central Delta would increase survival because of reduced diversion effects and increased food web support in Suisun Bay.

Habitat Quantity and Quality

Alternative 4 would include all actions affecting habitat discussed for Alternatives 1, 2, and 3 (Figure IV-40). Habitat effects upstream of the Delta would be the same as those described for Alternative 3 (Figure IV-41). Delta outflow would increase during all months and would shift estuarine salinity downstream, which would increase habitat availability for Sacramento splittail, delta smelt, longfin smelt, and striped bass compared with conditions under the No-Action Alternative and Alternatives 1, 2, and 3 (Figure IV-41).

Food Web Support

The response of fish species to other aspects of Alternative 4 (as described in the preceding sections) generally applies to food web organisms as well. Alternative 4 would include all actions affecting food web support discussed for Alternatives 1, 2, and 3 (Figure IV-40). Effects on food web support upstream of the Delta would be the same as described for Alternative 3 (Figure IV-41).

In the Delta, food web support would increase under Alternative 4 (Figure IV-41). Reduced Delta diversions would reduce the entrainment of food web organisms, nutrients, and organic carbon. In addition, a downstream shift in estuarine salinity compared with conditions under the No-Action Alternative, in response to increased Delta outflow in all months, may increase production of prey and increase food web support for rearing life stages of all the representative species.

AGRICULTURAL ECONOMICS AND LAND USE

A number of CVPIA provisions can potentially affect agricultural economics and land use. These provisions include (b)(2) Water Management for fish and wildlife, water acquired for in-stream flow and refuges, tiered water pricing, restoration payments, conservation and water measurement provisions, land retirement, and water transfers. Assumptions used to assess potential impacts are summarized in Table IV-14.

TABLE IV-14

SUMMARY OF ASSUMPTIONS FOR AGRICULTURAL ECONOMICS AND LAND USE

Assumptions Common to All Alternatives and Supplemental Analyses	
For each Alternative or Supplemental Analysis, hydrology and water supplies are estimated in the corresponding analysis for Surface Water and Facilities Operations and Groundwater.	
Alternative or Supplemental Analysis	**Assumptions Specific to the Alternative or Supplemental Analysis**
No-Action Alternative	CVP water is priced at cost of service, subject to ability to pay limits. 2020 level of demand for crop production is assumed, based on DWR Bulletin 160-93 (1994). 45,000 acres of drainage-affected land are assumed to be retired, per Bulletin 160-93.
1	CVP water is priced using tiered rates, with cost of service for the first 80 percent of contract total, full cost rates for the last 10 percent tier, and the average of the two rates for the middle tier. Restoration charges and Friant surcharges are imposed. The ability to pay policy is maintained as applied to repayment of principal on capital and restoration charges. An additional 30,000 acres is assumed to be retired for drainage control.
1a	Assumptions are the same as Alternative 1.
1b	Assumptions are the same as Alternative 1.
1c	Assumptions are the same as Alternative 1, except that CVP water prices begin at the full cost rates for the first 80 percent of contract total, with delivery between 80 and 90 percent priced at 110 percent of full cost rates, and deliveries more than 90 percent priced at 120 percent of full cost rates.
1d	Assumptions are the same as Alternative 1.
1e	Assumptions are the same as Alternative 1, except that all CVP water is transferable subject to the charges and conditions specified in CVPIA.
1f	Assumptions are the same as Supplemental Analysis 1e, except an additional $50 per acre-foot fee is charged to any CVP water transferred.
1g	Assumptions are the same as Alternative 1, except that ability to pay is not used to limit CVP water prices.
1h	Assumptions are the same as Alternative 1.
1i	Assumptions are the same as Alternative 1.
2	Assumptions are the same as Alternative 1.
2a	Assumptions are the same as Alternative 1.
2b	Assumptions are the same as Supplemental Analysis 1e.
2c	Assumptions are the same as Supplemental Analysis 1f.

TABLE IV-14. CONTINUED

Alternative or Supplemental Analysis	Assumptions Specific to the Alternative or Supplemental Analysis
2d	Assumptions are the same as Supplemental Analysis 1c.
3	Assumptions are the same as Alternative 1.
3a	Assumptions are the same as Supplemental Analysis 1e.
4	Assumptions are the same as Alternative 1.
4a	Assumptions are the same as Supplemental Analysis 1e.

Geographic areas for the assessment of agricultural impacts are shown in Figure IV-43, and include three Central Valley regions and the San Felipe CVP delivery area. Agricultural economics and land use impacts are assessed primarily by comparing irrigated acres, value of production (or gross revenue), net revenue, and irrigation water use. All prices and costs are measured in real, 1992 dollars. Additional impacts including irrigation efficiency, land values, farm financing, and risk are also noted.

Two sets of analyses are presented. The first set of results is for the alternatives without water transfers considered. These are the No-Action Alternative and Alternatives 1 through 4. Following Alternative 1 are summaries of results for the two water pricing Supplemental Analyses, 1c and 1g. The second set of results is for alternatives with water transfers, including a No-Action Alternative with non-CVPIA transfers (also called the Base Transfer Scenario) and Alternatives 1e, 1f, 2b, 2c, 3a, and 4a. Results for Alternatives and Supplemental Analyses are summarized in Table IV-15. Results for Supplemental Analyses of water transfers are summarized in Table IV-16.

Results presented in this summary focus on average year conditions, with dry or wet year impacts described if they are notably greater or lesser than the average year conditions.

NO-ACTION ALTERNATIVE

The No-Action Alternative provides the basis for comparison for all of the other alternatives. Key assumptions used in this alternative include: 2020 level of demand for crop production, based on DWR's Bulletin 160-93 estimates; renewal of CVP water service contracts, with cost-of-service pricing of water; and the Bay-Delta Plan Accord.

Dominant crops in the Sacramento River Region include rice, deciduous orchards, grains, and other field crops. The San Joaquin River Region includes a broad mix of crops, with cotton, deciduous orchards, and grapes having the largest acreage. The largest acreages in the Tulare Lake Region include cotton, deciduous orchards, and grapes. Alfalfa hay and grains show significant acreage in all three regions. Dominant crops in the San Felipe Division are vegetables and orchards. Figure IV-44 shows the percent crop mix by region estimated for the No-Action Alternative in an average water condition. Table IV-17 presents the crop acres estimated for the No-Action Alternative in the average year water condition. In general, dry year conditions show reductions in field crops and other annual crops compared to average conditions.

Gross revenue (value of production) by region and crop is presented for the average and condition in Tables IV-18. Within the Central Valley, the Sacramento River Region accounts for just under 20 percent of the gross revenue, with Tulare Lake Region at about 38 percent and San Joaquin River Region at about 43 percent. Value of production shows the large influence of fruit and vegetable crops: truck crops, tomatoes, orchards, and vineyards especially. These crops account for over two thirds of the value of irrigated production valley-wide. Cotton and rice also produce significant revenue. Although the direct value of other crops such as hay and grains is relatively low, they support linked sectors such as dairies, other livestock, and food processing. San Felipe Division has a disproportionately large gross revenue due to the relatively high value of the predominant orchard and vegetable crops.

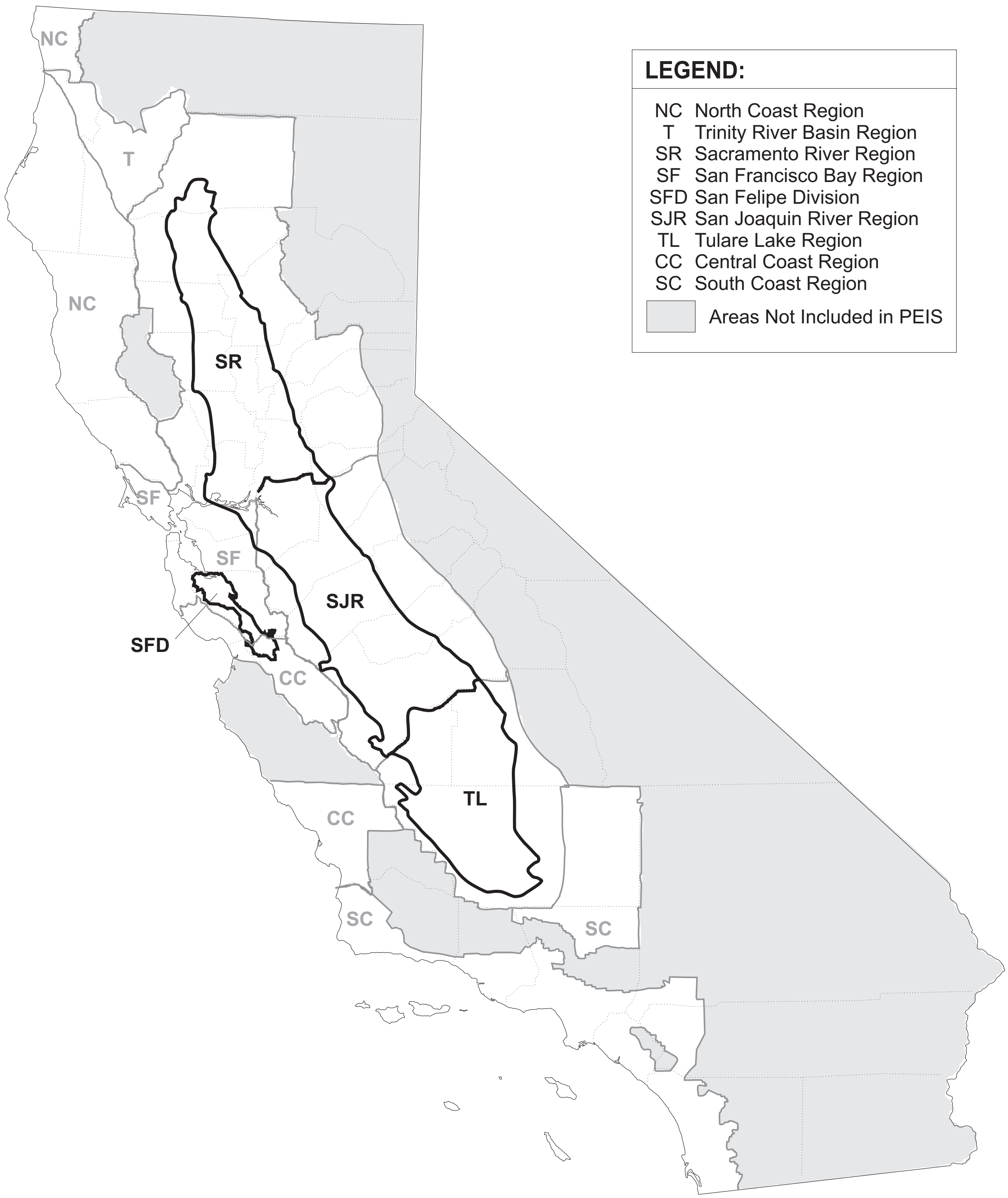


FIGURE IV-43

AGRICULTURAL ECONOMICS AND LAND USE STUDY AREA

TABLE IV-15

SUMMARY OF IMPACT ASSESSMENT FOR ALTERNATIVES WITHOUT WATER TRANSFERS AGRICULTURAL ECONOMICS AND LAND USE

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	6.6 million irrigated acres and $10.2 billion of gross revenue from irrigated acres in Central Valley and San Felipe Division.
	Changes Compared to the No-Action Alternative
1	Reduction of 50,000 acres of irrigated land and $76 million in annual gross revenue, due to Land Retirement Program and reduction in water delivery. Increase in annual CVP and groundwater cost of $46 million, due to water pricing changes and additional groundwater pumping. Increased financial risk due to reduced reliability of CVP water supply. Impacts are concentrated on CVP water service contractors, especially in the Delta export delivery areas.
	Changes Compared to Alternative 1
1a	Additional reduction in CVP water supply is replaced by additional 80,000 acre-feet of groundwater pumping in Central Valley, 2,000 acres of land fallowed in San Felipe Division, and about $4 million annual loss of agricultural net revenue.
1b	Conditions are similar to Alternative 1.
1c	Up to 570,000 acre-feet of CVP water could be unaffordable and not used. Impacts would include up to 56,000 acres of land out of production in Sacramento River Region, 337,000 acre-feet of additional groundwater pumped in the San Joaquin River and Tulare Lake regions, and a large aggregate increase in the cost of CVP water. All impacts would fall on CVP water service contractors.
1d	Reduced CVP delivery largely in the San Joaquin River Region, replaced by additional groundwater pumping.
1e	See summary of impacts of Alternatives with Water Transfers.
1f	See summary of impacts of Alternatives with Water Transfers.
1g	Up to 24,000 acre-feet of CVP water could be unaffordable and not used. Some land would go out of production in the Sacramento River Region but most of the water would be replaced with additional groundwater pumping.
1h	Conditions are similar to Alternative 1.
1i	Conditions are similar to Alternative 1.

TABLE IV-15. CONTINUED

	Changes Compared to the No-Action Alternative
2	Impacts to CVP delivery areas are similar to Alternative 1. An additional 40,000 acres of irrigated land could be idled due to the purchase of (b)(3) water for instream flow and Level 4 refuge supply. Revenue received for water augments the sellers' farm income.
	Changes Compared to Alternative 2
2a	Conditions are similar to Alternative 1.
2b	See summary of impacts for Alternatives with Water Transfers.
2c	See summary of impacts for Alternatives with Water Transfers.
2d	Changes are similar to those described under Supplemental Analysis 1c.
	Changes Compared to the No-Action Alternative
3	Impacts to CVP delivery areas are less than those described under Alternative 1, due to pumping and delivery of some (b)(3) water to CVP contractors. A total of about 172,000 acres of irrigated land could be idled due to a combination of the Land Retirement Program, reduction in CVP water delivery, and purchase of (b)(3) water for refuges and instream flow. Revenue received for water augments the sellers' farm income.
	Changes Compared to Alternative 3
3a	See summary of impacts for Alternatives with Water Transfers.
	Changes Compared to the No-Action Alternative
4	Impacts to CVP delivery areas are greater than those described under Alternative 1, due to the use of (b)(2) water for Delta restoration actions. A total of about 200,000 acres of irrigated land could be idled due to a combination of the Land Retirement Program, reduction in CVP water delivery, and purchase of (b)(3) water for refuges and instream flow. Revenue received for water augments the sellers' farm income.
	Changes Compared to Alternative 4
4a	See summary of impacts for Alternatives with Water Transfers.

TABLE IV-16

SUMMARY OF IMPACT ASSESSMENT FOR ALTERNATIVES WITH WATER TRANSFERS AGRICULTURAL ECONOMICS AND LAND USE

Alternative or Supplemental Analysis	Impact Assessment
Base Transfer Scenario	A No-Action Alternative with non-CVPIA transfers was evaluated to provide a basis for estimating the incremental impacts of CVPIA on the opportunities for water transfers. Assumptions for this analysis are the same as for the No-Action Alternative, except that water transfers between regions are explicitly allowed. CVP water service and Exchange contract water is assumed to be not transferable. Transfers are limited by available facilities capacity. Only consumptive use or irrecoverable loss is transferred. For purposes of analysis, water is assumed to be provided by fallowing irrigated land. Up to 150,000 acre-feet would be sold in an average year, primarily from the Tulare Lake Region. This would fallow about 40,000 acres and provide revenue to sellers of about $18 million. Under a dry condition, up to 1 million acre-feet could be transferred, with over half of this from the Sacramento River Region. Almost 300,000 acres would be fallowed, and sellers could receive up to $170 million in revenue.
	Changes Compared to the Base Transfer Scenario
1e	In an average year, quantities and locations of water sold are similar to the Base Transfer Scenario. The price of water, and the revenue to sellers, would decline slightly due to more CVP water available for transfer. In a dry condition, substantially less water would be sold from the Sacramento River Region and more from regions south of Delta, due to CVP water available for transfer. The price of water, and the revenue to sellers, would decline substantially due to the availability of CVP water for transfer.
1f	Results would be similar to 1e, except that non-CVP water would be purchased rather than CVP water, due to the additional $50 per acre-foot fee on CVP water transfers. In average condition, Restoration Fund revenues from transfers are lower than 1e. Local, within-region transfers of CVP water would likely be eliminated due to the $50 fee.
2b	Results are similar to those described under Supplemental Analysis 1e, except that (b)(3) water acquisition in the San Joaquin River Region would increase the price of water for transfer. Some water transfer purchases are shifted to Sacramento River and Tulare Lake Regions.
2c	Changes are similar to those described under Supplemental Analysis 1f.
3a	Changes are similar to those described under Supplemental Analysis 1e, except that water purchased is about 10 percent less than under Supplemental Analysis 1e. This occurs because higher CVP and SWP delivery in Alternative 3 results in a lower level of demand for transfers.
4a	Changes are similar to those described under Supplemental Analysis 1e, except that the price of water has been increased by the (b)(3) water acquisition and the greater demand for transfers due to the use of (b)(2) water in the Delta.

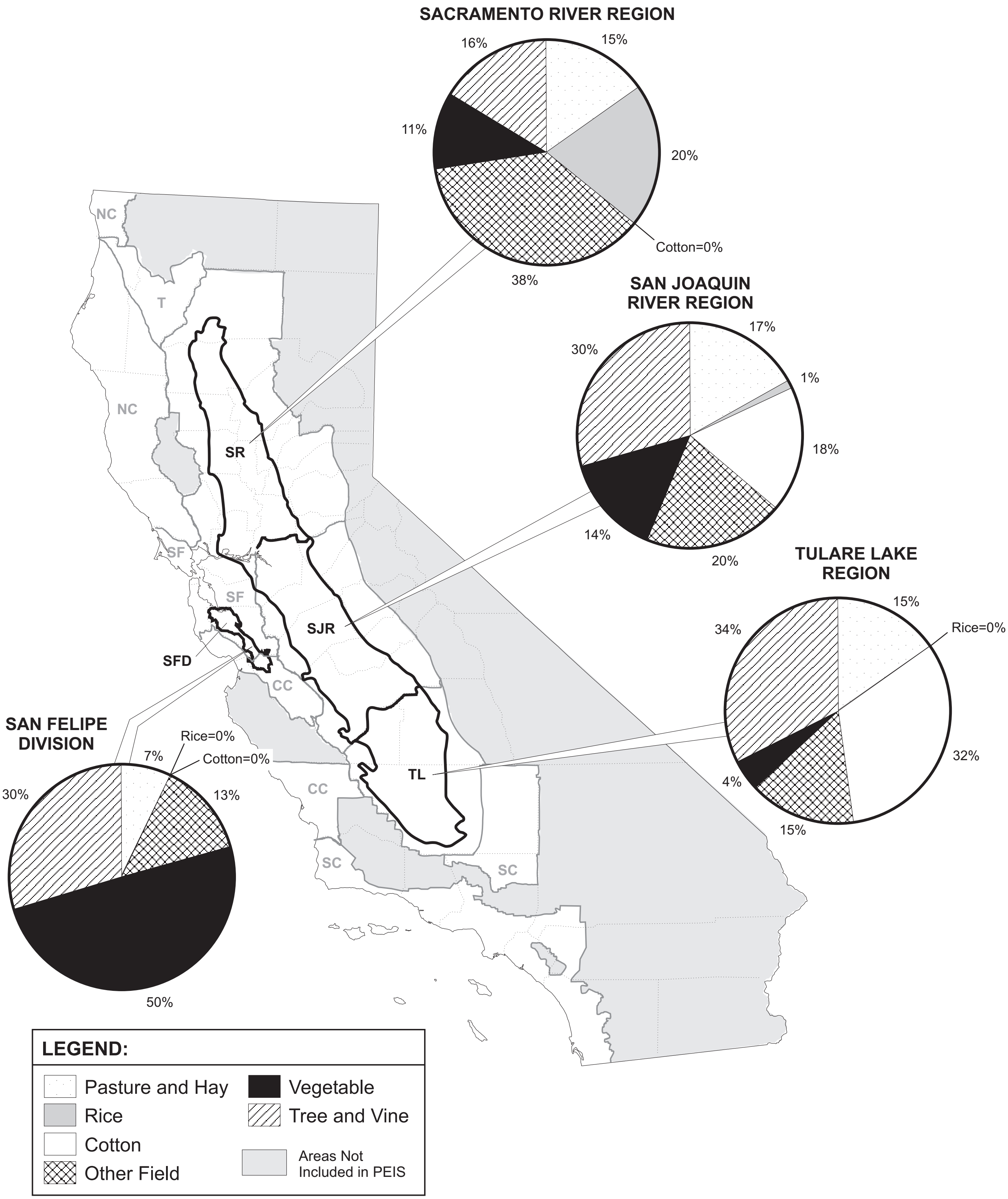


FIGURE IV-44

1990 AGRICULTURAL LAND USE IN THE CENTRAL VALLEY AND SAN FELIPE DIVISION

TABLE IV-17
IRRIGATED ACREAGE
AVERAGE 1922-1990 CONDITION

		Changes Compared to No-Action Alternative			
	No-Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
		Sacramento River Region			
Pasture and Hay	280	-0.3	0.3	-6.0	-5.6
Rice	473	-1.2	-4.3	-12.7	-12.6
Cotton	0.0	0.0	0.0	0.0	0.0
Other Field	615	-0.1	-1.8	-4.6	-4.6
Vegetable	250	0.0	-0.2	-0.2	-0.2
Tree and Vine	400	0.0	0.0	-0.3	-0.3
Subtotal	**2,020**	**-1.6**	**-6.0**	**-23.8**	**-23.3**
		San Joaquin River Region			
Pasture and Hay	338	-3.9	-22.3	-67.0	-73.5
Rice	14	-0.1	-0.9	-3.0	-3.2
Cotton	465	-18.7	-25.5	-27.7	-37.2
Other Field	479	-5.5	-12.2	-25.8	-27.2
Vegetable	462	-2.4	-3.0	-2.9	-3.9
Tree and Vine	800	-0.2	-1.0	-3.3	-3.4
Subtotal	**2,558**	**-30.9**	**-64.9**	**-129.7**	**-148.5**
		Tulare Lake River Region			
Pasture and Hay	191	-2.7	-2.4	-1.3	-3.6
Rice	0	0.0	0.0	0.0	0.0
Cotton	646	-9.7	-9.3	-9.2	-12.7
Other Field	304	-2.7	-1.9	-2.4	-1.9
Vegetable	211	-0.3	-0.3	-0.3	-0.2
Tree and Vine	657	-0.2	-0.2	-0.2	-0.3
Subtotal	**2,009**	**-15.6**	**-14.1**	**-13.4**	**-18.8**
		San Felipe Division			
Pasture and Hay	2	-0.7	-0.7	-0.4	-0.7
Rice	0	0.0	0.0	0.0	0.0
Cotton	0	0.0	0.0	0.0	0.0
Other Field	3	-1.2	-1.2	-0.7	-1.3
Vegetable	12	-4.4	-4.4	-2.4	-4.9
Tree and Vine	8	-2.7	-2.7	-1.5	-2.9
Subtotal	**25**	**-9.0**	**-9.0**	**-5.0**	**-9.8**
Total	**6,611**	**-57.1**	**-94.0**	**-171.9**	**-200.3**

NOTE:
All values in thousands of acres.

TABLE IV-18

GROSS REVENUE
AVERAGE 1922-1990 CONDITION

		Changes Compared to No-Action Alternative			
	No-Action Alternative	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Sacramento River Region					
Pasture and Hay	89	0.3	0.9	1.2	1.7
Rice	401	-1.0	-3.6	-10.4	-10.3
Cotton	0	0.0	0.0	0.0	0.0
Other Field	269	0.0	-0.7	-1.9	-1.9
Vegetable	615	0.4	0.2	0.0	0.2
Tree and Vine	455	0.0	0.1	0.1	0.2
Subtotal	**1,828**	**-0.3**	**-3.0**	**-10.9**	**-10.0**
San Joaquin River Region					
Pasture and Hay	145	-1.5	-7.4	-19.6	-22.3
Rice	12	-0.1	-0.7	-2.4	-2.6
Cotton	503	-20.5	-27.2	-29.3	-39.2
Other Field	276	-3.2	-7.4	-15.7	-16.8
Vegetable	2,095	-5.8	-7.2	-6.9	-8.5
Tree and Vine	1,405	-0.2	-1.1	-3.7	-3.8
Subtotal	**4,436**	**-31.3**	**-51.1**	**-77.6**	**-93.2**
Tulare Lake River Region					
Pasture and Hay	114	-1.2	-0.5	0.8	-0.2
Rice	0	0.0	0.0	0.0	0.0
Cotton	713	-9.6	-9.0	-8.8	-12.2
Other Field	186	-1.7	-1.2	-1.5	-1.2
Vegetable	1,265	-1.8	-1.6	-1.8	-1.0
Tree and Vine	1,616	-0.3	0.0	0.8	0.7
Subtotal	**3,893**	**-14.5**	**-12.4**	**-10.4**	**-13.9**
San Felipe Division					
Pasture and Hay	0	-0.1	-0.1	-0.1	-0.2
Rice	0	0.0	0.0	0.0	0.0
Cotton	0	0.0	0.0	0.0	0.0
Other Field	2	-0.7	-0.7	-0.4	-0.8
Vegetable	75	-26.6	-26.6	-14.6	-29.3
Tree and Vine	11	-3.8	-3.8	-2.1	-4.2
Subtotal	**88**	**-31.2**	**-31.2**	**-17.1**	**-34.4**
Total	**10,245**	**-77.3**	**-97.7**	**-116.1**	**-151.5**

NOTE:
All values in millions of 1992 dollars per year.

Estimates of net revenues associated with the irrigated crops are shown in Table IV-19. Sacramento River Region with about 30 percent of acreage produces less than 20 percent of valley-wide net income due to the crop mix, yields, and prices received. San Joaquin River and Tulare Lake Regions each produce about 40 percent of net income. San Felipe Division has a high, per-acre gross and net revenue due to the crop mix, but total acreage is small in comparison to the Central Valley regions. Water use estimates for the No-Action Alternative are presented in Table IV-20 for the average water condition.

ALTERNATIVE 1

Provisions of CVPIA implemented in Alternative 1 that most affect crop production are the dedication of (b)(2) water, restoration payments, tiered water prices, and land retirement.

Irrigated Acres

Changes in irrigated acres from the No-Action Alternative are summarized by crop in Table IV-17, and summarized in Figure IV-45. The changes are largely determined by the assumed location of land included in the Land Retirement Program and by the location of water service areas most affected by the reallocation of project water. The San Joaquin River Region shows the largest estimated decline, about 1.2 percent of irrigated land, due to a combination of the Land Retirement Program and additional fallowing due to reduced CVP delivery. The predominance of cotton as the crop most affected is largely a result of the areas targeted for retirement and those losing CVP delivery: both of these occur in areas where cotton is the predominant field crop. A decline of 28,400 acres represents about 2.5 percent of Central Valley cotton acreage in the No-Action Alternative. Irrigated acreage in the Tulare Lake Region declines by about 0.8 percent due to the Land Retirement Program. Irrigated acreage in the Sacramento River Region would decline about 1,500 acres. Most of the decline is in rice, but is much less than 1 percent of total rice acreage. Total reduction in the Central Valley is about 48,000 acres, less than 1 percent of irrigated acreage.

Irrigated acres in the San Felipe Division are estimated to decline about 9,000 acres due to reductions in CVP water deliveries.

Impacts of CVPIA are not expected to result in significant idling or conversion of prime or unique farmlands. The Land Retirement Program specifically targets land with an existing salinity or drainage problem. Growers facing water reductions are likely to try to keep the most productive lands in irrigation and fallow the less productive lands.

Gross and Net Revenue

Central Valley gross revenue from irrigated farming declines about $46 million in an average water supply year. This estimate accounts for crop price increases expected to occur because production has declined. Without this price increase the value of production would decline another $3.9 million per year as compared to the No-Action Alternative. Most of the decline is in cotton, consistent with the change in acreage. The total decline in value represents less than one half of one percent of the No-Action Alternative value. Similar values are estimated for dry and wet conditions. Table IV-18 shows estimated changes in gross revenue by region and crop,

TABLE IV-19

CHANGE IN NET REVENUE
AVERAGE 1922-1990 CONDITION

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Felipe Division	Total
NO-ACTION ALTERNATIVE					
No-Action Alternative Net Revenue	268	558	522	8	1356
ALTERNATIVE 1 COMPARED TO NO-ACTION ALTERNATIVE					
Fallowed Land	0.6	-1.9	-0.4	-3.0	-4.8
Groundwater Pumping	-1.4	-18	2.1	0.0	-17.4
Irrigation Cost	-0.3	-3.8	-0.8	0.0	-4.8
CVP Water Cost	-0.3	-11.9	-16.5	-0.3	-29
Total Reduction	-1.4	-35.6	-15.6	-3.3	-56
Increase From Higher Crop Prices	1.1	1.6	1.2	0.0	3.9
Increase From Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase From Water Sales	0.0	0.0	0.0	0.0	0.0
Combined Net Revenue Change	-0.3	-33.1	-13.4	-3.3	-50.1
ALTERNATIVE 2 COMPARED TO NO-ACTION ALTERNATIVE					
Fallowed Land	-0.7	-7.2	-1.8	-3.0	-12.7
Groundwater Pumping	-1.8	-20	0.5	0.0	-21.3
Irrigation Cost	-0.3	-3.7	-0.8	0.0	-4.7
CVP Water Cost	-0.3	-12.5	-16.5	-0.3	-29.6
Total Reduction	-3.1	-43.4	-18.6	-3.3	-68.4
Increase From Higher Crop Prices	1.7	3.1	2.4	0.0	7.2
Increase From Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase From Water Sales	1.2	13.7	2.6	0.0	17.5
Combined Net Revenue Change	-0.2	-25.7	-12.5	-3.3	-41.7
ALTERNATIVE 3 COMPARED TO NO-ACTION ALTERNATIVE					
Fallowed Land	-2.4	-13.4	-1.6	-1.6	-19
Groundwater Pumping	-3.2	-14.2	3.8	0.0	-13.6
Irrigation Cost	-0.3	-3.7	-0.7	0.0	-4.7
CVP Water Cost	-0.3	-12.9	-16.5	-0.4	-30
Total Reduction	-6.2	-44.1	-15.0	-2.0	-67.4
Increase From Higher Crop Prices	4.0	5.7	4.1	0.0	13.7
Increase From Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase From Water Sales	8.7	57.6	1.6	-2.0	67.9
Combined Net Revenue Change	6.5	20.1	-8.3	0.0	16.3
ALTERNATIVE 4 COMPARED TO NO-ACTION ALTERNATIVE					
Fallowed Land	-2.4	-15.6	-2.3	-3.3	-23.2
Groundwater Pumping	-3.9	-22.5	-2.0	0.0	-28.4
Irrigation Cost	-0.3	-3.7	-0.7	0.0	-4.7
CVP Water Cost	-0.3	-11.4	-16.3	-0.3	-28.3
Total Reduction	-6.8	-53.1	-21.3	-3.6	-84.6
Increase From Higher Crop Prices	4.5	6.5	4.9	0.0	15.9
Increase From Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase From Water Sales	8.8	58.5	1.7	0.0	68.9
Combined Net Revenue Change	6.5	12.7	-13.6	-3.6	2.0

NOTE:
All values in millions of 1992 dollars per year.

TABLE IV-20

IRRIGATION WATER APPLIED AVERAGE 1922-1990 CONDITION

Source	No-Action Alternative	Change Compared to No-Action Alternative			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Sacramento River					
Surface Water	4,524	-39	-72	-195	-194
Groundwater	2,603	25	38	80	82
Total Applied	7,127	-14	-34	-115	-112
San Joaquin River					
Surface Water	4,453	-302	-480	-697	-854
Groundwater	3,427	134	182	124	213
Total Applied	7,880	-168	-298	-573	-641
Tulare Lake					
Surface Water	2,761	-22	-39	26	-69
Groundwater	3,297	-44	-23	-83	-9
Total Applied	6,058	-66	-62	-57	-78
Total Central Valley					
Surface Water	11,738	-363	-591	-866	-1,117
Groundwater	9,327	115	197	121	286
Total Applied	21,065	-248	-394	-745	-831
San Felipe Division(1)					
CVP Water	71	-18	-18	-10	-20

Notes:
All volumes in thousands of acre-feet.
(1) Non-CVP supplies not estimated.

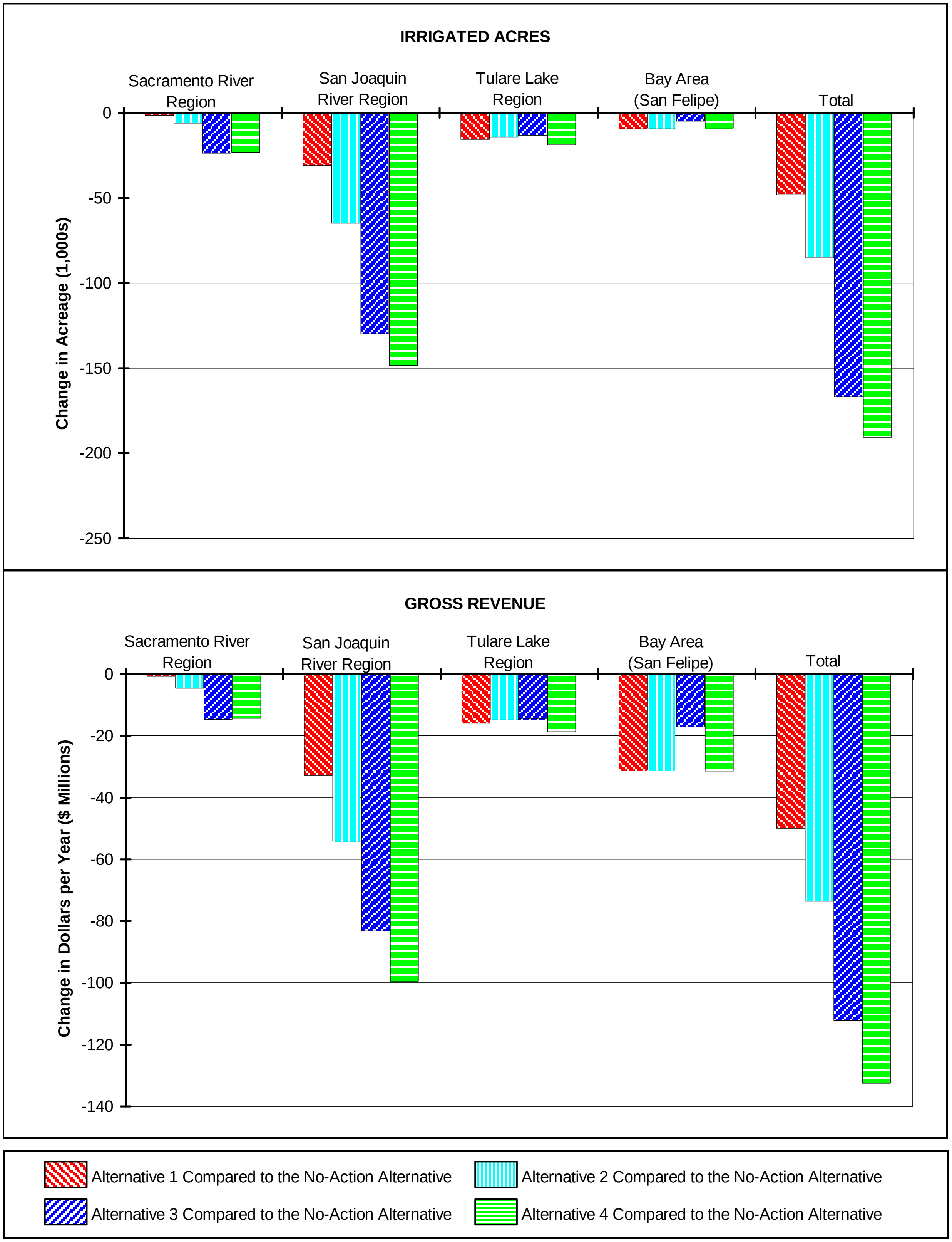


FIGURE IV-45
CHANGE IN IRRIGATED ACREAGE AND GROSS REVENUE FOR ALTERNATIVES 1 THROUGH 4 AS COMPARED TO THE NO-ACTION ALTERNATIVE

and Figure IV-45 summarizes the change from the No-Action Alternative. Loss in gross revenue in the San Felipe Division is estimated at about $31 million in an average water supply year, or about 7.5 percent of production revenue in San Benito, Santa Clara, and Santa Cruz Counties.

Net farm income, or net revenue, changes are shown in Table IV-19. Reductions in net income fall into four categories: loss of net income from fallowed or retired land; increased cost of CVP water due to tiered pricing and restoration payments; increased cost of groundwater pumping; and increased cost of irrigation systems or management. Over half of the change is a result of increased CVP water cost. Another third is caused by the increased cost of groundwater pumping, and the remainder is split about evenly between net revenue loss from fallow or retired land and the cost of changes in irrigation methods. Approximately $2 million per year is received in payment for land retirement, split between the San Joaquin River and Tulare Lake Regions.

Water Use and Efficiency

The net reduction in Central Valley surface water delivered to the field of 363,000 acre-feet includes an overall decline in CVP water application of about 385,000 acre-feet and an increase of about 21,000 acre-feet in SWP agricultural delivery in Tulare Lake Region. Of the net 363,000 acre-feet loss of surface water, about 155,000 acre-feet comes from 48,000 acres of fallowed or retired lands; about 115,000 acre-feet is replaced from new groundwater pumping; and the remainder (about 93,000 acre-feet) comes from reduced irrigation losses including tailwater and deep percolation. In the San Felipe Division, about 18,000 acre-feet less CVP water would be delivered under Alternative 1. Table IV-20 shows the changes in water use for the four regions.

Estimated irrigation efficiency changes induced by Alternative 1 would be modest, with an increase of about 0.6 percentage points in the San Joaquin River Region and essentially no change estimated in the other regions.

Impacts on Consumers and Farm Programs

Other economic impacts associated with Alternative 1 include losses to consumers of irrigated farm products. These losses are estimated at about $3.9 million per year, which measures only the surplus, or benefit, loss to direct consumers of irrigated farm commodities. Alternative 1 would decrease agricultural revenues from U.S. Department of Agriculture (USDA) farm programs by about $3.8 million per year because retired land would lose eligibility for farm program payments. These payments are counted as part of the gross and net revenue impacts to farmers, but also can be viewed as an expense to the federal government. Reductions in program payments are therefore savings to the federal treasury.

Water Supply Reliability and Risk

The CVPIA may affect economic costs to water users through effects on the reliability of water supplies. Variable surface water supplies can be a substantial economic problem in irrigated agriculture. Farmers often must make important investment, planting, and marketing decisions before knowing their water supply. Water supply variability adds to other risks imposed by crop price, yield, and production cost variability. The cost of additional groundwater pumping capacity provides one way to measure the cost of less reliable surface water supply. Using this approach, Sacramento River Region costs would be $0.6-0.7 million per year. San Joaquin River Region has by far the largest cost, $4-4.5 million annually. Tulare Lake Region is less than $0.5 million per year. These costs would occur every year to finance the investment, even though the additional capacity would only be used occasionally. This does not include the power and other variable costs of pumping the water.

Land Value

Value of irrigated land depends significantly upon the quantity and variability of the water supply available, and on the profitability of farming. The San Joaquin River Region has the largest potential reduction in land value. Its reduction in annual net income is estimated at $33.1 million per year spread over about 2.6 million acres, for a reduction in net income per acre of about $12.7 per year. A simple estimate of land value is to calculate the present value of the stream of profit earned on the land. Therefore, capitalizing this region's stream of lost income using a real 4 percent interest rate, the average reduction in land value is about $320 per acre. The actual reduction could be greater in local areas most affected by higher water cost and reduced delivery, and land values could potentially increase in regions unaffected by reduced delivery or higher costs as a result of higher crop prices.

Credit and Financing

Availability of credit for farming depends largely on the expected profitability of production, the risk or variability of profitability, and the collateral available to secure the lender's money. Changes in conditions that reduce profit, increase risk, or reduce the value of land have been documented as reducing lenders' willingness to lend money or to increase the interest rate they charge (Archibald, 1992). Although quantitative estimates are not available, it is probable that similar impacts would occur due to Alternative 1 implementation.

Water Conservation and Measurement

Conservation and measurement costs may occur both at the farm and the district level. On-farm conservation costs are reflected in the irrigation cost estimates discussed above. District costs may result from either mandatory conservation requirements or discretionary conservation guidelines. For districts that do not currently measure delivery to each customer, the cost of achieving an acceptable accuracy of measurement could be significant. The estimated annual cost of the measurement hardware is $123 per turnout. The entire measurement program cost per turnout would be $470 to $670 per year. Depending on the acres served per turnout (typical areas are 20 to 200 acres), the cost per acre could range from $4 to $33 per year.

Localized Impacts

Impacts aggregated or averaged over large regions can mask more pronounced impacts in smaller areas. The largest economic impacts of CVPIA provisions in Alternative 1 focus on CVP water service contractors. For example, the entire $28 million loss due to higher water costs fall on CVP contractors, and none on other agricultural water users.

Water Pricing Supplemental Analyses

Supplemental Analysis 1c evaluates the additional impact of charging higher tiered water rates as described in Table IV-14. Changes from the main Alternative 1 are shown in Table IV-21. The imposition of full-cost-plus pricing is estimated to reduce total CVP water purchases by about 570,000 acre-feet on average. Reductions are mostly in the Sacramento River and San Joaquin River Regions. Some CVP water service contractors that receive water from the Tehama-Colusa, Delta-Mendota, and Friant-Kern Canals and the New Melones Reservoir may be unable to afford some or all of their CVP water. Sacramento River Region reductions would be mainly met through land fallowing, while those in the San Joaquin River Region would be mostly from a shift to groundwater. San Joaquin River Region agriculture would experience a net revenue reduction of about 10 percent, due to higher groundwater pumping costs. Additional water cost in the San Felipe Division is large. The full-cost CVP water rate for much of the San Felipe delivery is over $190 per acre-foot. Assuming the water would still be purchased, then implementing full-cost-plus pricing would increase the cost of CVP water to San Felipe growers by almost $5 million in an average water year.

Ability-to-pay is a long-standing Reclamation policy that provides relief of all or part of capital repayment responsibility for CVP irrigation water users in cases where estimated farm income is insufficient to cover normal CVP irrigation water costs after allowance for returns to farm investment, production costs, and management. The CVPIA also provides relief for Restoration Charges if the same conditions are met. Supplemental Analysis 1g provides an analysis of the potential impact of eliminating the ability-to-pay relief. Results for average water year conditions are presented in Table IV-21. The table shows a direct comparison of the supplemental analysis results with the main Alternative 1.

Reductions in total demand for CVP water resulting from removal of the ability-to-pay policy are estimated to be about 25,000 acre-feet per year. These reductions would occur primarily in areas served by the Tehama-Colusa, Delta-Mendota, and Madera Canals and New Melones Reservoir. Demand reductions in the Sacramento River Region would result in increased groundwater pumping and land fallowing, while those in the San Joaquin River Region would result primarily in increased groundwater pumping. Water costs to some agricultural water users, especially in the Sacramento River Region, would be substantially increased. Based on the regional estimates of payment capacity available, the Tulare Lake Region would not receive price relief from the ability-to-pay policy, and therefore its removal in this scenario has no impact. The cropping pattern in the San Felipe Division also indicates that its contractors are not constrained by payment capacity. The large increase in CVP water cost in the Sacramento River Region results in a $6 million per year decline in net revenue. Another $1 million reduction is estimated in the San Joaquin River Region, from a combination of higher CVP and groundwater cost.

TABLE IV-21

SUMMARY OF AGRICULTURAL ECONOMIC IMPACTS WATER PRICING SUPPLEMENTAL ANALYSES

Item/ Region	No-Action Alternative	Alternative 1	Change Compared to Alternative 1	
			1c	1g
Surface Water Use (taf)				
Sacramento	4,524	4,485	-199	-11.1
San Joaquin	4,453	4,151	-354	-13.3
Tulare Lake	2,761	2,739	-17	0.0
San Felipe	71	53	0	0.0
Total	11,809	11,428	-570	-24.4
Groundwater Use (taf)				
Sacramento	2,603	2,628	0	1.2
San Joaquin	3,427	3,561	320	12.8
Tulare Lake	3,297	3,253	17	0.0
San Felipe	na	na	na	na
Total	9,327	9,442	337	14.0
Irrigated Acreage (1,000 acres)				
Sacramento	2,020	2,018	-56	-1.8
San Joaquin	2,558	2,527	-6	0.0
Tulare Lake	2,009	1,993	0	0.0
San Felipe	25	16	0	0.0
Total	6,611	6,554	-62	-1.8
Gross Revenue ($ Million)				
Sacramento	1,828	1,828	-28	-0.2
San Joaquin	4,436	4,405	-2	0.0
Tulare Lake	3,893	3,878	0	0.0
San Felipe	88	57	0	0.0
Total	10,245	10,168	-30	-0.2
Net Revenue ($ Million)				
Sacramento	268	267	-3	-6.0
San Joaquin	558	525	-25	-1.0
Tulare Lake	522	509	-10	0.0
San Felipe	8	5	-4	0.0
Total	1,356	1,306	-42	-7.0

Notes:
Non-CVP supplies not estimated for San Felipe Division.

ALTERNATIVE 2

Provisions of CVPIA implemented in Alternative 2 include all features of Alternative 1 plus the acquisition of water for in-stream flow and wildlife refuges. By assumption, water is acquired from willing agricultural sellers who would reduce acreage to provide water for sale.

Irrigated Acres

Changes in irrigated acreage from the No-Action Alternative are shown by crop and region in Table IV-17, and summarized in Figure IV-45. The changes are largely determined by the assumed location of land identified for the Land Retirement Program, by the location of water contractors most affected by the reallocation of project water, and by the areas identified for water acquisition. The San Joaquin River Region shows the largest estimated decline, about 65,000 acres in an average year (2.5 percent of irrigated land), followed by the Tulare Lake Region which declines about 14,000 acres (0.7 percent) due to the Land Retirement Program. Sacramento River Region shows a decline of about 6,000 acres (0.3 percent). Most of the decline is in rice, but is much less than 1 percent of rice acreage. Total reduction in the Central Valley would be about 85,000 acres, or about 1.3 percent of the No-Action Alternative's Central Valley irrigated acreage.

San Felipe Division impacts are similar to those described under Alternative 1.

Impacts of CVPIA are not expected to result in significant idling or conversion of prime or unique farmlands. The Land Retirement Program specifically targets land with an existing salinity or drainage problem. Growers facing water reductions are likely to try to keep the most productive lands in irrigation and fallow the less productive lands. Similarly, growers selling water to the (b) (3) acquisition program can be expected to fallow less productive land and continue farming the best land.

Gross and Net Revenue

Central Valley gross revenue from irrigated farming is estimated to decline about $66.5 million in an average water supply year. This estimate accounts for crop price increases expected to occur because of declines in production. Without this price increase the value of production would decline another $7.2 million per year. Most of the decline is in cotton, consistent with the change in acreage. The total decline in value represents less than one percent of the No-Action Alternative value. Similar reductions are estimated for dry conditions. Table IV-18 shows estimated changes in gross revenue by region and crop, and Figure IV-45 summarizes the change from the No-Action Alternative.

Net farm income, or net revenue, changes are shown in Table IV-19. Reductions in net income fall into four categories: loss of net income from fallowed or retired land; increased cost of CVP water due to tiered pricing and restoration payments; increased cost of groundwater pumping; and increased cost of irrigation systems or management. Increases in farm income offset some of these losses. Approximately $2 million per year is received in payment for land retirement, split between the San Joaquin River and Tulare Lake Regions. Sale of water to the acquisition program adds another $17.5 million to income in an average water year.

Losses in gross and net revenue in the San Felipe Division are similar to Alternative 1.

Water Use and Efficiency

Water use in non-acquisition areas is similar to conditions discussed in Alternative 1. Groundwater use increases somewhat more than in Alternative 1. This occurs because of a shift of acreage from the areas selling water for restoration, where groundwater substitution is not allowed, to areas not selling water, where Interior has no means to prevent additional groundwater pumping. Table IV-20 shows the estimated changes in water use for the four regions. Irrigation efficiency changes induced by Alternative 2 are similar to those described under Alternative 1. Water supply and use in the San Felipe Division are similar to those described under Alternative 1.

Impacts on Consumers and Farm Programs

Other economic impacts associated with Alternative 2 include losses to consumers of irrigated farm products. These losses are estimated at about $7.2 million per year, which measures only the surplus, or benefit, loss to direct consumers of irrigated farm commodities. Alternative 2 would decrease agricultural revenues from U.S. Department of Agriculture (USDA) farm programs by about $6 million per year because retired land would lose eligibility for farm program payments. These payments are counted as part of the gross and net revenue impacts to farmers, but also can be viewed as an expense to the federal government. Reductions in program payments are therefore savings to the federal treasury.

Water Supply Reliability and Risk

Most of the impacts to water supply reliability and risk are similar to those described under Alternative 1. Additional risk or uncertainty might occur due to water acquisition because land fallowing concentrated in a small area could threaten the infrastructure of suppliers, workers, and processors available to the remaining producers. Changes in the timing of streamflows and availability of irrigation return flows could also affect some growers' pattern or costs of diversion.

Growers who sell water may be able to reduce financial risk. A steady income from water sales can combine with more variable crop revenues to provide a more stable overall income stream. Revenue from water sold can also be used to finance other production costs that otherwise would be funded through borrowing.

Land Value

Land values in areas of higher water costs or losses of supply would be affected as in Alternative 1. Land values in areas selling water could increase if the right to sell the water is attached, or allocated, to the land.

Credit and Financing

Availability of credit for farming depends largely on the expected profitability of production, the risk or variability of profitability, and the collateral available to secure the lender's money. The same potential increases in risk and reduction in profit discussed in Alternative 1 also apply in

Alternative 2. Growers able to sell water for restoration can potentially increase net income and reduce risk, which would increase credit worthiness.

Water Conservation and Measurement

Conservation and measurement costs would be similar to those discussed under Alternative 1.

Localized Impacts

Impacts on areas most affected by water cost increases or loss of supply are similar to those in Alternative 1.

Water Pricing Supplemental Analyses

The impacts of higher tiered water prices were also assessed relative to Alternative 2. Results are similar to those discussed for Supplemental Analysis 1c.

ALTERNATIVE 3

Provisions of CVPIA implemented in Alternative 3 include all features of Alternative 1 plus the acquisition of water for in-stream flow and wildlife refuges. More water is acquired, and on more streams, than in Alternative 2. By assumption, water is acquired from willing agricultural sellers who would reduce acreage to provide water for sale. In addition, Alternative 3 allows both (b)(2) and acquired water to be exported from the Delta for use by water contractors, subject to water quality and fishery constraints.

Irrigated Acres

Changes in irrigated acreage from the No-Action Alternative are shown by crop and region in Table IV-17, and summarized in Figure IV-45. The regional pattern of impacts is largely determined by the assumed location of land identified for the Land Retirement Program, by the location of water contractors most affected by the reallocation of project water, and by the areas identified for water acquisition. The San Joaquin River Region shows the largest estimated decline, about 130,000 acres in an average year (5 percent of irrigated land), followed by Sacramento River Region, which declines about 24,000 acres (1.2 percent), and Tulare Lake Region which declines 13,400 acres (0.7 percent). Total reduction in the Central Valley would be about 167,000 acres, or about 2.5 percent of the No-Action Alternative irrigated acreage. San Felipe Division acreage would decline about 5,000 acres.

Impacts of CVPIA are not expected to result in significant idling or conversion of prime or unique farmlands. The Land Retirement Program specifically targets land with an existing salinity or drainage problem. Growers facing water reductions are likely to try to keep the most productive lands in irrigation and fallow the less productive lands. Similarly, growers selling water to the (b) (3) acquisition program can be expected to fallow less productive land and continue farming the best land.

Gross and Net Revenue

Central Valley gross revenue from irrigated farming is estimated to decline about $99 million in an average water supply year. This estimate accounts for crop price increases expected to occur because of declines in production. Without this price increase the value of production would decline another $13.2 million per year. Most of the decline is in the field crop categories, consistent with the change in acreage. The reduction in value produced from fruit and vegetable crops in the San Joaquin River Region is also notable even though the acreage decline is fairly small. The total decline in value represents less than one percent of the No-Action Alternative value. Similar reductions are estimated for dry conditions. Table IV-18 shows estimated changes in gross revenue by region and crop, and Figure IV-45 summarizes the change from the No-Action Alternative.

Estimated net revenue changes are shown in Table IV-19. Increased CVP water cost is the largest category of net income loss, followed by fallowed land. Increases in farm income would offset these losses over the entire study area, but gains and losses are not evenly distributed. In general, losses would occur in CVP service areas and are similar to Alternative 1 losses. Gains would occur primarily in the areas selling water for restoration purposes. Sale of water to the water acquisition program would add another $68 million to income in an average water year. Approximately $2 million per year is received in payment for land retirement, split between the San Joaquin River and Tulare Lake Regions.

Losses in gross and net revenue in the San Felipe Division are smaller than in Alternatives 1 and 2 due to the additional CVP water exported and delivered to the region About $17 million in gross revenue and $2 million in net revenue is estimated to be lost compared to the No-Action Alternative.

Water Use and Efficiency

Water use estimates represent the net effect of reductions in CVP delivery, increases in SWP delivery in Tulare Lake Region, reductions due to water acquisition, and changes in groundwater use. The most important difference from Alternative 1 is the acquisition of water for restoration. Some water is acquired in all three regions for Level 4 refuge water supply, and additional water is purchased for instream flow in the Sacramento River and San Joaquin River Regions. Because Alternative 3 allows expenditure for water acquisition beyond what is currently authorized in the Restoration Fund, substantially more water is acquired than in Alternative 2.

Groundwater use would increase slightly more in Alternative 3 than in Alternative 1 (122,000 acre-feet vs. 115,000 acre-feet). This occurs because of a shift of acreage from the areas selling water for restoration, where groundwater substitution is not allowed, to areas not selling water, where Interior has no means to prevent additional groundwater pumping. In the aggregate numbers reported, a portion of that shift is offset by the delta export of additional water, as allowed by Alternative 3 assumptions. This additional surface water exported to the westside and southern San Joaquin Valley displaces some groundwater pumping. Table IV-20 shows the estimated changes in water use for the four regions. Irrigation efficiency changes induced by Alternative 3 are similar to those described in Alternative 1.

Less surface water would be lost in the San Felipe Division than in Alternative 1 (about 10,000 acre-feet in an average water year vs. 18,000 acre-feet) because Alternative 3 allows delta export of acquired water.

Impacts on Consumers and Farm Programs

Other economic impacts associated with Alternative 3 include losses to consumers of irrigated farm products. These losses are estimated at about $13.6 million per year, which measures only the surplus, or benefit, loss to direct consumers of irrigated farm commodities. Alternative 3 would decrease agricultural revenues from U.S. Department of Agriculture (USDA) farm programs by about $10.2 million per year because retired land would lose eligibility for farm program payments. These payments are counted as part of the gross and net revenue impacts to farmers, but also can be viewed as an expense to the federal government. Reductions in program payments are therefore savings to the federal treasury.

Water Supply Reliability and Risk

Most of the impacts to water supply reliability and risk are similar to Alternative 1. Additional risk or uncertainty might occur due to water acquisition because land fallowing concentrated in a small area could threaten the infrastructure of suppliers, workers, and processors available to the remaining producers. Changes in the timing of stream flows and availability of irrigation return flows could also affect some growers' pattern or costs of diversion.

Growers who sell water may be able to reduce financial risk. A steady income from water sales can combine with more variable crop revenues to provide a more stable overall income stream. Revenue from water sales can also be used to finance other production costs that otherwise would be funded through borrowing.

Land Value

Land values in areas of higher water costs or losses of supply would be affected as in Alternative 1. Land values in areas selling water could increase if the right to sell the water is attached, or allocated, to the land.

Credit and Financing

Availability of credit for farming depends largely on the expected profitability of production, the risk or variability of profitability, and the collateral available to secure the lender's money. The same potential increases in risk and reduction in profit discussed in Alternative 1 also apply in Alternative 3. Growers able to sell water for restoration can potentially increase net income and reduce risk, which would increase credit worthiness.

Water Conservation and Measurement

Conservation and measurement costs would be similar to those discussed under Alternative 1.

Localized Impacts

Impacts on areas most affected by water cost increases or loss of supply are similar to those in Alternative 1.

ALTERNATIVE 4

Provisions of CVPIA implemented in Alternative 4 include all features of Alternative 1 plus the acquisition of water for in-stream flow and wildlife refuges. The same amount of water is acquired as in Alternative 3. By assumption, water is acquired from willing agricultural sellers who would reduce acreage to provide water for sale. In contrast to Alternative 3, Alternative 4 includes actions that use a portion of the (b)(2) water in the Delta, and does not allow acquired water to be exported from the Delta for use by water contractors.

Irrigated Acres

Changes in irrigated acres from the No-Action Alternative are shown by crop and region in Table IV-17, and summarized in Figure IV-45. The regional pattern of impacts is largely determined by the assumed location of land identified for the Land Retirement Program, by the location of water contractors most affected by the reallocation of project water, and by the areas identified for water acquisition. The San Joaquin River Region shows the largest estimated decline, about 149,000 acres in an average year (5.8 percent of irrigated land), followed by Sacramento River Region, which declines about 23,000 acres (1.2 percent), and Tulare Lake Region which declines 19,000 acres (0.9 percent). Total reduction in the Central Valley would be about 191,000 acres, or about 3 percent of the No-Action Alternative irrigated acreage. San Felipe Division acreage would decline about 10,000 acres in an average water year. Dry condition changes would be similar to those described for the average condition.

Impacts of CVPIA are not expected to result in significant idling or conversion of prime or unique farmlands. The Land Retirement Program specifically targets land with an existing salinity or drainage problem. Growers facing water reductions are likely to try to keep the most productive lands in irrigation and fallow the less productive lands. Similarly, growers selling water to the (b)(3) acquisition program can be expected to fallow less productive land and continue farming the best land.

Gross and Net Revenue

Central Valley gross revenue from irrigated farming is estimated to decline about $117 million in an average water supply year. This estimate accounts for crop price increases expected to occur because of declines in production. Without this price increase the value of production would decline another $15.4 million per year. Most of the decline is in the field crop categories, consistent with the change in acreage. The reduction in value produced from fruit and vegetable crops in the San Joaquin River Region is also notable even though the acreage decline is fairly small. The total decline in value represents less than one percent of the No-Action Alternative value. Similar reductions are estimated for dry conditions. Table IV-18 shows estimated changes in gross revenue by region and crop, and Figure IV-45 summarizes the change from the No-Action Alternative.

Net revenue changes are shown in Table IV-19. Increased CVP water cost is the largest category of net income loss, followed by fallowed land. Increases in farm income offset these losses over the entire study area, but gains and losses are not evenly distributed. In general, losses occur in CVP service areas and are similar to Alternative 1 losses. Gains are primarily in the areas selling water for the acquired water program. Sale of water to the acquisition program would add another $68 million to income in an average water year. Approximately $2 million per year would be received in payment for land retirement, split between the San Joaquin River and Tulare Lake Regions.

Losses in gross and net revenue in the San Felipe Division would be larger than in Alternatives 1, 2, and 3. About $34 million in gross revenue and $3.3 million in net revenue is estimated to be lost compared to the No-Action Alternative.

Water Use and Efficiency

Water use estimates represent the net effect of reductions in CVP delivery, increases in SWP delivery in Tulare Lake Region, reductions due to water acquisition, and changes in groundwater use. Some water is acquired in all three regions for Level 4 refuge water supply, and additional water is purchased for instream flow in the Sacramento River and San Joaquin River Regions. Acquisition quantities and sources are the same as those in Alternative 3.

Groundwater use in the Central Valley would increase substantially more in Alternative 4 than in Alternative 1 (286,000 acre-feet vs. 115,000 acre-feet). This occurs largely as replacement of additional losses of project water delivered south of the Delta, and to a smaller extent because of a shift of acreage from the areas selling water for restoration, as in Alternative 3. Table IV-20 shows the estimated changes in water use for the four regions. Irrigation efficiency changes induced by Alternative 4 would be similar to described in Alternative 1.

More surface water would be lost in the San Felipe Division than in Alternative 1 (about 20,000 acre-feet in an average water year vs. 18,000 acre-feet) because of additional export limitations in Alternative 4.

Impacts on Consumers and Farm Programs

Other economic impacts associated with Alternative 4 include losses to consumers of irrigated farm products. These losses are estimated at about $15.6 million per year, which measures only the surplus, or benefit, loss to direct consumers of irrigated farm commodities. Alternative 4 would decrease agricultural revenues from U.S. Department of Agriculture (USDA) farm programs by about $11.6 million per year because retired land would lose eligibility for farm program payments. These payments are counted as part of the gross and net revenue impacts to farmers, but also can be viewed as an expense to the federal government. Reductions in program payments are therefore savings to the federal treasury.

Water Supply Reliability and Risk

Most of the impacts to water supply reliability and risk would be similar to those described under Alternative 1. Additional risk or uncertainty might occur due to water acquisition because land fallowing concentrated in a small area could threaten the infrastructure of suppliers, workers, and processors available to the remaining producers. Changes in the timing of streamflows and availability of irrigation return flows could also affect some growers' pattern or costs of diversion.

Growers who sell water may be able to reduce financial risk. A steady income from water sales can combine with more variable crop revenues to provide a more stable overall income stream. Revenue from water sales can also be used to finance other production costs that otherwise would be funded through borrowing.

Land Value

Land values in areas of higher water costs or losses of supply would be affected as in Alternative 1. Land values in areas selling water could increase if the right to sell the water is attached, or allocated, to the land.

Credit and Financing

Availability of credit for farming depends largely on the expected profitability of production, the risk or variability of profitability, and the collateral available to secure the lender's money. The same potential increases in risk and reduction in profit discussed in Alternative 1 also apply in Alternative 4. Growers able to sell water for restoration can potentially increase net income and reduce risk, which would increase credit worthiness.

Water Conservation and Measurement

Conservation and measurement costs would be similar to those discussed under Alternative 1.

Localized Impacts

Impacts on areas most affected by water cost increases or loss of supply are similar to those in Alternative 1.

ALTERNATIVES WITH WATER TRANSFERS

The potential impacts of CVPIA water transfers were assessed by implementing transfers as additional actions beyond the Base Alternatives without transfers. The reasons for this approach were: transfers are voluntary between buyer and seller, and therefore cannot be assumed to occur; the hypothetical nature of any assessment of impacts from transfers would potentially obscure the more directly assessed impacts of other CVPIA actions; and the quantitative analysis of hydrologic, water operations, and other impacts cannot be assessed at the same level of detail as the Base Alternatives without knowing the specific circumstances and locations of buyers and sellers.

Therefore, the analysis of water transfers should more properly be viewed as an analysis of the opportunities for water transfers and how implementation of CVPIA may affect those opportunities. None of the specific volumes of water sold that are displayed in this analysis should be viewed as predictions. They should be considered as reasonable representations of the potential water transfer market for purposes of describing impacts of CVPIA water transfers. In most cases, the estimated water volumes transferred are limited by market demand and supply rather than by physical or regulatory constraints, though regulatory requirements can increase the cost of transferring water.

Base Transfer Scenario (No-Action Alternative with Non-CVPIA Transfers)

The market for water transfers is expected to develop over time with or without CVPIA. In order to assess the incremental impact of CVPIA on this market, a Base Transfer Scenario is included that represents the potential for water transfers in the absence of CVPIA. Alternatives with water transfers are assessed as changes from the Base Transfer Scenario.

Estimates of water transfer opportunities in the Base Transfer Analysis are shown for the average condition in Table IV-22 and for the dry condition in Table IV-23. Estimates of water sold are largely determined by future demands of urban regions, as described in the Municipal Water Cost analysis. In the average condition, most water is sold from the Tulare Lake Region because of its proximity to urban demand. Due to conveyance losses and the assumption that only consumptive use or irrecoverable loss can be transferred, the purchase of over 150,000 acre-feet results in a net of about 105,000 acre-feet received. Under dry conditions, the Tulare Lake Region is deficient in water supply, so almost all of the additional water transferred comes from the Sacramento River and San Joaquin River Regions. Due to higher conveyance losses and a Delta outflow requirement for transfers across the Delta, the purchase of over 1,000,000 acre-feet results in a net of about 525,000 acre-feet received by the buyer.

Supplemental Analysis 1e

Supplemental analysis 1e allows the transfer of CVP water service and exchange contract water, subject to the charges and conditions defined in CVPIA. Because it is a supplemental analysis of Alternative 1, it also imposes all other assumptions of Alternative 1, including management of (b)(2) water and Restoration Charges. Compared with the Base Transfer Scenario, average year transfers are slightly higher due to increased transfer demand by CVP contractors. Estimated dry year transfers, however, are about 100,000 acre-feet lower than those for the Base Transfer Scenario. This is a result of the availability of CVP water closer to the point of urban demand, which reduces conveyance losses and water contributed to Delta outflow. Estimated changes are summarized in Tables IV-22 and IV-23.

Land fallowing as a result of water transfers in an average year is estimated to be about the same as in the Base Transfer Scenario, and is less than 1 percent of irrigated acreage in the Central Valley. Higher demands for transferred water in dry years increases the land fallowing to about 255,000 acres, or about 4 percent. This is a reduction in land fallowed compared to the Base Transfer Scenario. In general, crop lands idled by transfers are pasture, hay, grain, field crops, rice, and cotton.

Anticipated change in net revenues to agricultural water users has been estimated by combining net revenue loss due to crop fallowing, the cost of the water, and the income from water sales. As expected for transactions among willing buyers and sellers, in all cases sellers would benefit

TABLE IV-22

SUMMARY OF AGRICULTURAL IMPACTS
SUPPLEMENTAL ANALYSES OF ALTERNATIVES WITH WATER TRANSFERS
1922-1990 AVERAGE CONDITION

	Base Transfer Scenario	Changes Compared to Base Transfer Scenario			
		Supplemental Analysis 1e	Supplemental Analysis 2b	Supplemental Analysis 3a	Supplemental Analysis 4a
Sacramento River Region					
Water Sold	0	5	7	5	5
Land Fallowed	0	1	1	1	1
Revenue Received	$0.0	$0.3	$0.3	$0.4	$0.4
San Joaquin River Region					
Water Sold	6	8	-32	-16	-35
Land Fallowed	2	2	-2	-2	-5
Revenue Received	$0.3	$0.7	-$2.3	-$0.9	-$2.5
Tulare Lake Region					
Water Sold	148	-8	29	1	36
Land Fallowed	42	-3	7	-1	10
Revenue Received	$17.5	-$2.0	$3.7	-$0.5	$4.9
Total Central Valley					
Water Sold	154	5	4	-10	6
Land Fallowed	44	0	6	-2	6
Revenue Received	$17.8	-$1.0	$1.7	-$1.0	$2.8

NOTES:
Water is in thousand acre-feet. Land is in thousand acres. Revenue is in million $.
All values are annual and measured at the seller's location.
The San Joaquin River Region is a net buyer of water for agriculture in some alternatives.

TABLE IV-23

SUMMARY OF AGRICULTURAL IMPACTS
SUPPLEMENTAL ANALYSES OF ALTERNATIVES WITH WATER TRANSFERS
1928-1934 DRY CONDITION

	Base Transfer Scenario	Changes Compared to Base Transfer Scenario			
		Supplemental Analysis 1e	Supplemental Analysis 2b	Supplemental Analysis 3a	Supplemental Analysis 4a
Sacramento River Region					
Water Sold	561	-293	-260	-336	-161
Land Fallowed	150	-88	-89	-101	-60
Revenue Received	$83.7	-$64.1	-$60.9	-$67.1	-$48.6
San Joaquin River Region					
Water Sold	276	27	-12	-63	-70
Land Fallowed	71	11	-1	-5	-13
Revenue Received	$54.5	-$16.4	-$19.0	-$21.5	-$25.7
Tulare Lake Region					
Water Sold	184	159	173	217	180
Land Fallowed	72	40	49	57	20
Revenue Received	$31.7	$27.8	$32.5	$42.0	$36.8
Total Central Valley					
Water Sold	1,021	-107	-99	-182	-51
Land Fallowed	293	-37	-41	-49	-53
Revenue Received	$169.9	-$52.7	-$47.4	-$46.6	-$37.5

NOTES:
Water is in thousand acre-feet. Land is in thousand acres. Revenue is in million $.
All values are annual and measured at the seller's location.
The San Joaquin River Region is a net buyer of water for agriculture in some alternatives.

from water transfers. Gains range from $10.7 million ($40-70 per acre-foot sold) in an average year to $90.7 million ($45-130 per acre-foot sold) in a dry year, when urban buyers would bid up water prices to make up for shortfalls in supplies from their normal water sources. These estimates are lower than in the Base Transfer Scenario because, with the provision for CVP water transfers, more water would be available for transfer, and more price competition would occur among sellers. The estimates of gains to sellers do not include any cost of tilling, weed control, etc. that may be needed for temporarily fallowed land. Significant variation in selling price and gains from sales can be expected within a region and between regions.

The estimates above focus on interregional transfers. Local transfers within a region are not counted in these estimates, but would not have the system-wide implications and impacts of interregional transfers.

Supplemental Analysis 1f

Supplemental Analysis 1f also evaluates the effect of CVP water transfers, but also assumes an additional $50 per acre-foot fee on CVP water transferred. The fee would be paid into the Restoration Fund.

Impacts of the fee on transfers to M&I buyers is primarily to discourage purchase of CVP water. In an average year, almost all purchases shift to non-CVP sources, resulting in up to a $1 million per year reduction in Restoration Fund revenue compared to Alternative 1e. The average unit cost of water purchased by M&I buyers is estimated to be about 5-10 percent higher than Alternative 1e due to more expensive alternative sources and the additional CVP transfer fee.

The impacts of the fee on agriculture are small as estimated by the water transfer analysis, because little water is purchased by agricultural users from other regions. However, the transfer analysis focuses on interregional transfers. Many transfers between agricultural buyers and sellers are likely to occur within a region, where transport and transactions costs are small. A $50 per acre-foot fee on these kinds of transactions would virtually eliminate them, because additional groundwater pumping or non-CVP surface water would be lower cost options for the potential buyers.

Supplemental Analysis 2b

The impacts of Supplemental Analysis 2b are presented in Tables IV-22 and IV-23. Total water transfers in an average year are similar to the Base Transfer Scenario, but the acquisition of water in the San Joaquin River Region for instream flow and refuges induces a shift in the location of water purchased for transfers. More water is purchased from the Tulare Lake Region, and agriculture in the San Joaquin River Region replaces some of the water sold for instream flow Changes in the dry condition are similar.

Total land fallowed as a result of water transfers in an average year is estimated to be similar to the Base Transfer Scenario, or less than 1 percent of the total irrigated acreage in the Central Valley. Higher demands for transferred water increases the land fallowing to about 250,000 acres, or 4 percent in dry years. In general, crop lands idled by transfers are pasture, hay, grain, field crops, rice, and cotton. Regional changes in land fallowing follow the same pattern described for water purchases.

Anticipated change in net revenues to agricultural water users has been estimated by combining net revenue loss due to crop reductions, the cost of any water purchased, and the income from water sales. In all cases sellers are expected to benefit from water transfers. Gains range from $14.7 million ($35-80 per acre-foot sold) in an average year to $94.9 million ($60-135 per acre-foot sold) in a dry year, when urban users bid up water prices to make up for shortfalls in supplies from their normal water sources. The average gains in Supplemental Analysis 2b are slightly higher than those reported in 1e because the acquisition of water would reduce the supply of water for sale and raise the price. The estimates of gains to sellers do not include any cost of tilling, weed control, etc. that may be needed for temporarily fallowed land. Significant variation in selling price and gains from sales can be expected within a region and between regions.

The estimates above focus on interregional transfers. Local transfers within a region are not counted in these estimates, but would not have the system-wide implications and impacts of interregional transfers.

Supplemental Analysis 2c

The impacts of Supplemental Analysis 2c would be similar to those discussed under Supplemental Analysis 1f.

Supplemental Analysis 3a

The impacts of Supplemental Analysis 3a would be similar to those discussed under Supplemental Analysis 2b, except that water purchased is about 10 percent less. This occurs because higher CVP and SWP delivery in Alternative 3 results in a lower level of demand for transfers. Impacts are summarized in Tables IV-22 and IV-23.

Supplemental Analysis 4a

The impacts of Supplemental Analysis 4a would be similar to those discussed under Supplemental Analysis 2b, except that the price of water has been driven up by the (b)(3) water acquisition and the greater demand for transfers due to the use of (b)(2) water in the Delta. Impacts are summarized in Tables IV-22 and IV-23.

MUNICIPAL AND INDUSTRIAL LAND USE AND DEMOGRAPHICS

Projected Municipal and Industrial (M&I) land use areas for 1990 and 2020, are based on DWR projections, as shown on Table IV-24. As indicated on this table, M&I land use areas would be projected to increase between 25 percent in the San Francisco Bay Region, and 48 percent in the Tulare Lake Region as compared to the Affected Environment. The overall projected increase in M&I land use throughout the four regions is approximately 34 percent.

Projected changes in regional population from 1990 to 2020 are shown in Table IV-25. The 1990 population estimates were obtained from the 1990 Census, published by the department of Commerce. The 2020 projected population estimates were obtained from State of California official population projections, published in April 1993. These estimates were projected from a baseline developed from the 1990 Census. The 1990 level data presented in that report are adjusted for a census population in mid-year, rather than on April 1, as reported by the Department of Commerce. Therefore, the baseline used to develop 2020 projections was slightly different from the 1990 populations shown on Table IV-25.

TABLE IV-24

PROJECTED REGIONAL CHANGE IN M&I LAND USE IN THE NO-ACTION ALTERNATIVE

Year	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Francisco Bay Region
Total Area	17,254	10,208	10,573	2,816
M&I Area - 1990	396	138	229	656
M&I Area - 2020	616	234	440	871
Percent Increase	36	41	48	25
Percent of Total Area - 1990	2.3	1.4	2.2	23.3
Percent of Total Area - 2020	3.6	2.3	4.2	30.1

NOTES:
All areas in 1,000s of acres.
SOURCE:
DWR Bulletin 160-93.

TABLE IV-25

PROJECTED REGIONAL POPULATION

Year	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Francisco Bay Region
1990	2,583	1,880	957	5,184
2020	4,803	4,232	2,162	6,679

NOTES:
All population data shown in thousands.
Projections reflect the No-Action Alternative
SOURCE:
U.S. Department of Commerce, 1990 Census Report. California Department of Finance, 2020 Population Projections.

Under Alternatives 1, 2, 3, 4 and all associated Supplemental Analyses deficiencies in deliveries of CVP water supplies to M&I users in the Central Valley and San Francisco Bay Regions would periodically occur, as presented in the Surface Water Supplies and Facility Operations Technical Appendix. The extent of the deficiencies would not be greater than historically encountered. It is anticipated that conservation efforts that would be implemented during years with CVP deficiencies under the No-Action Alternative would also be implemented during years of similar water contract deficiency under all alternatives. Therefore, M&I land uses and population conditions under all the alternatives would not change as compared to the No-Action Alternative.

VEGETATION AND WILDLIFE RESOURCES

This section describes projected conditions for vegetation and wildlife resources under the No-Action Alternative, followed by a comparison of the impacts of Alternatives 1 through 4 with the No-Action Alternative. Implementation of the CVPIA may result in changes in land uses, agricultural practices, and operation of CVP facilities and other water delivery systems. These changes could affect vegetation and wildlife. The impact analysis focused on changes in habitat rather than changes in population sizes of individual species. Population sizes were not evaluated because they can be affected by factors beyond the control of CVP (such as the condition of waterfowl breeding habitat in Canada) because the CVPIA actions are often defined too generally to be able to determine specific effects, and because consistent population models were not available for all species in all affected areas. A summary of the assumptions associated with each of the alternatives is presented in Table IV-26

Impact mechanisms and assumptions are described for natural and terrestrial agricultural habitats, riparian and wetland habitats, river and reservoir habitats, waterfowl and shorebirds, and special-status species. Detailed, site-specific cause-and-effect relationships were not evaluated. Rather, data from existing models were used to evaluate general relationships and trends. A summary of the impact assessment for each alternative is presented in Table IV-27.

NO-ACTION ALTERNATIVE

Under the No-Action Alternative, approximately 1.75 million acres of land would be in agricultural production, 2.07 million acres would be non-irrigated land, and 498,300 acres would be developed for urban uses in the Sacramento River Region. In the Delta Region, approximately 422,600 acres of land would be in agricultural production, 301,100 acres would be non-irrigated lands, and 70,500 acres would be developed for urban uses. In the San Joaquin River Region, approximately 2.4 million acres of land would be in agricultural production, 1.60 million acres would be non-irrigated lands, and 477,000 acres would be developed for urban uses. In the Tulare Lake Region, approximately 2.01 million acres of land would be in agricultural production, 1.56 million acres would be non-irrigated lands, and 244,000 acres of urban development would occur.

Under the No-Action Alternative, approximately 45,000 acres of irrigated agricultural land would be retired to improve water quality and acquire water. Approximately 21,600 acres would be in the San Joaquin River Region, and approximately 23,400 acres would be in the Tulare Lake Region.

Under the No-Action Alternative, the upper and middle reaches of the Sacramento River support 14,800 acres of riparian habitat. On the lower reach of the Sacramento River (Colusa to the Delta), the acreage of riparian vegetation and abundance of common wildlife species are not expected to change by 2020. The extent and density of riparian communities along the Feather River may increase slightly by 2020. For the lower American River at Natoma, lower water levels in summer may result in a somewhat smaller extent of riparian vegetation, which may have a minimal effect on common riparian plant species and wildlife species using riparian habitats. In the Delta Region, the extent of riparian vegetation is expected to remain approximately 7,000

TABLE IV-26

SUMMARY OF ASSUMPTIONS FOR VEGETATION AND WILDLIFE RESOURCES

Assumptions Common to All Alternatives and Supplemental Analyses	
Land use per DWR Bulletin 160-93.	
Reservoir operations, river flows, and refuge deliveries based on Surface Water and Facilities Operations analysis. Acres of land fallowed based on Agricultural Land Use and Economics analysis.	
Alternative or Supplemental Analysis	**Assumption Specific to the Alternative or Supplement Analysis**
No-Action Alternative	Conservation Program implemented.
1	Retirement of up to 30,000 acres of lands with drainage problems, limited revegetation for erosion control. No conservation easements purchased on fallowed land. CVP provides Level 2 water supply to refuges, with maximum 25% shortages per Shasta Index. Implementation of AFRP physical habitat restoration actions. Approximately 80,000 acres of seasonal field flooding in winter. (b)(1) “other” program is implemented.
1a	Same assumptions as Alternative 1.
1b	Same assumptions as Alternative 1.
1c	Same assumptions as Alternative 1.
1d	Same assumptions as Alternative 1.
1e	Same assumptions as Alternative 1.
1f	Same assumptions as Alternative 1.
1g	Same assumptions as Alternative 1.
1h	Same as Alternative 1 plus Retired land is restored to native habitats.
1i	Same assumptions as Alternative 1.

TABLE IV-26. CONTINUED

Alternative or Supplemental Analysis	Assumption Specific to the Alternative or Supplement Analysis
2	Same as Alternative 1 plus Level 4 water supply for refuges acquired from willing sellers with shortages per water source
2a	Same assumptions as Alternative 2.
2b	Same assumptions as Alternative 2.
2c	Same assumptions as Alternative 2.
2d	Same assumptions as Alternative 2.
3	Same as Alternative 2 plus Conservation easements may be purchased on up to 15% of land fallowed due to water acquisitions in the San Joaquin River Region. The value of 15% was selected because it appeared that about 15% of the fallowed land under this alternative would be adjacent to wetlands or refuge areas.
3a	Same assumptions as Alternative 3.
4	Same as Alternative 3 plus Conservation easements may be purchased on up to 15% of land fallowed due to water acquisitions in the San Joaquin River Region. The value of 15% was selected because it appeared that about 15% of the fallowed land under this alternative would be adjacent to wetlands or refuge areas.
4a	Same assumptions as Alternative 4.

TABLE IV-27

SUMMARY OF IMPACT ASSESSMENT FOR VEGETATION AND WILDLIFE RESOURCES

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	Conservation Program implemented, and will improve conditions for federally listed, proposed, and candidate species.
	Changes Compared to the No-Action Alternative
1	There are benefits for species through habitat acquisition, management, restoration, and studies in (b)(1) "other" program. 30,000 acres of retired agricultural land provide potential habitat for special-status species and other species associated with those sites. 18,000 acres of fallowed land provide potential habitat for some special-status species and other species. Riparian restoration on the Sacramento and San Joaquin rivers and their tributaries improves habitat for dependent special-status species and other species. Improved fisheries provide additional prey for fish-eating predators. Level 2 water deliveries improve wetland management for water birds and shorebirds but do not allow for optimal management. Up to 80,000 acres of agricultural fields are flooded to provide additional wetland habitat for migratory water birds and other wetland species.
	Changes Compared to Alternative 1
1a	Conditions are similar to Alternative 1.
1b	Conditions are similar to Alternative 1.
1c	Impacts could range from those similar to Alternative 1, to additional benefits for riparian vegetation and wildlife habitat near reservoirs and/or rivers in the Sacramento River, San Joaquin River, and Sacramento-San Joaquin Delta regions.
1d	Conditions are the same as Alternative 1, except for additional habitat provided for water birds during dry years at federal and state refuges, and at the Grasslands Resource Conservation District.
1e	Conditions are similar to Alternative 1.
1f	Conditions are similar to Alternative 1.
1g	Conditions are the same as Alternative 1.

TABLE IV-27. CONTINUED

	Changes Compared to Alternative 1
1h	Conditions are the same as Alternative 1, except for the restoration of some fallowed lands to natural habitats would benefit 27 special-status species and other species.
1i	Conditions are the same as Alternative 1.
	Changes Compared to the No-Action Alternative
2	Conditions are the same as Alternative 1, except 55,000 acres of fallowed land provide potential habitat for some special-status species and other species. Increased spring flows on the tributaries to the San Joaquin River improve riparian habitat along the San Joaquin River near Vernalis. Further improvements in fisheries provide additional prey for fish-eating predators. Level 4 water deliveries allow optimal wetland habitat management.
	Changes Compared to Alternative 2
2a	Conditions are similar to Alternative 2.
2b	Conditions are similar to Alternative 2.
2c	Conditions are similar to Supplemental Analysis 2b.
2d	Conditions are similar to Supplemental Analysis 1c.
	Changes Compared to the No-Action Alternative
3	Conditions are the same as Alternative 2, except 137,000 acres could be fallowed land provide potential habitat for some special-status species and other species. Conservation easements could be acquired on 15% of fallowed land in the San Joaquin River Region. Increased spring flows on the tributaries to the San Joaquin River improve riparian habitat along the San Joaquin River from the Merced River to Vernalis. Further improvements in fisheries provide additional prey for fish-eating predators.
3a	Conditions are similar to Alternative 3.
	Changes Compared to the No-Action Alternative
4	Conditions are the same as Alternative 3, except 160,000 acres could be fallowed land provide potential habitat for some special-status species and other species. Conservation easements could be acquired on 15% of fallowed land in the San Joaquin River Region. Further improvements in fisheries provide additional prey for fish-eating predators.
4a	Conditions are similar to Alternative 4.

acres. The extent of the riparian vegetation along the upper San Joaquin River is expected to be similar to or somewhat below the extent under Existing Conditions. For the San Joaquin River at Vernalis the abundance of common riparian plants and wildlife that use riparian habitats is not expected to change. The estimated 14,000 acres of riparian vegetation in the Tulare Lake Region along the Kings, Kaweah, Tule, and Kern rivers under the No-Action Alternative would be similar to existing conditions.

Under the No-Action Alternative, acreages of wetland communities in the Sacramento River, Delta, San Joaquin River, and Tulare Lake regions are expected to be the same or very similar to acreages under existing conditions. Salinity values on the southwestern end of the Delta at Chipps Island are projected to fall within the range associated with freshwater marsh habitat.

The availability of fish as prey for belted kingfishers, river otter, and other wildlife associated with riverine habitats is not expected to change in any of the study regions.

Under the No-Action Alternative, water deliveries to the boundaries of refuges in the Sacramento River Region, including Sacramento, Delevan, and Colusa NWRs, would total approximately 128,000 acre-feet; deliveries to Delta Region refuges would be the same as described for existing conditions; refuges in the San Joaquin River Region and private wetlands would receive approximately 143,570 acre-feet of CVP water in normal and wet years; and refuges in the Tulare Lake Region (including Mendota WMA, Kern NWR, and Pixley NWR) would receive approximately 28,450 acre-feet of CVP water in normal and wet years. This level of water deliveries reflects the general conditions on the refuges prior to the implementation of the CVPIA in 1992. Water supplies available to many of these refuges under the No-Action Alternative would limit the flexibility of refuge managers to use adaptive management techniques to adjust the timing and location of water deliveries to wetland habitats to maximize benefits to wildlife.

The area of evaporation ponds in the San Joaquin River and Tulare Lake regions is projected to remain at current levels under the No-Action Alternative even with the retirement of some farmland.

ALTERNATIVE 1

Under Alternative 1, it was assumed that no new agricultural lands would be put into production, so no impacts on natural and terrestrial habitats would occur as a result of this mechanism. Similarly, no additional urban development would occur under Alternative 1 compared with the No-Action Alternative, so no impacts on vegetation and wildlife would occur as a result of urban development.

Subsidence would increase along the west side of the San Joaquin River Region. Localized flooding associated with subsidence may adversely affect several special-status species by inundating burrows. Implementation of the b(1) “other” Program would reduce this impact. Subsidence in the Tulare Lake Region would decrease compared to the No-Action Alternative. More detailed information concerning special status species are presented in the Vegetation and Wildlife Technical Appendix.

Approximately 18,000 acres more of agricultural land would be fallowed in the study area under Alternative 1 than under the No-Action Alternative. Approximately 1,600 acres would be in the Sacramento River Region, 10,000 acres would be fallowed in the San Joaquin River Region and 6,400 acres would be fallowed in the Tulare Lake Region. For this analysis, it was assumed that these fallowed lands would be in small, isolated parcels distributed throughout each region and would provide low-quality habitat for vegetation and wildlife, including special-status plant species.

The scattered, isolated patches of ruderal and annual grass could provide low-quality habitat for Swainson's hawk in the Sacramento and San Joaquin River regions and habitat for San Joaquin kit fox, San Joaquin antelope squirrel, giant kangaroo rat, and blunt-nosed leopard lizard in the San Joaquin River and Tulare Lake regions. Similarly, these patches would provide habitat for common wildlife species such as the house mouse, deer mouse, savannah sparrow, and western fence lizard.

An additional 30,000 acres of irrigated agricultural land would be retired under Alternative 1; 14,400 would be in the San Joaquin River Region and 15,600 in the Tulare Lake Region. If retired lands were allowed to be used for unirrigated grazing, populations of special-status plants occurring near retired lands could colonize the grazed areas, though colonization would be sporadic and would occur over a long time. If retired lands were restored to provide grassland and alkali desert scrub habitats, these areas would provide high-quality habitat for several common special-status species and may be used to implement conservation objectives for regional habitat conservation plans.

The fallowing and retirement of agricultural land under Alternative 1 would reduce the use of herbicides and pesticides and provide a small benefit to various common and one special status species.

Changes in river flows would have little effect on riparian habitat and would not adversely affect habitat used by common or special-status species.

Restoration of riparian habitat along Clear, Cow, Cottonwood, Mill, Deer, and Big Chico creeks and the Sacramento, Yuba, lower American, Mokelumne, Stanislaus, Tuolumne, Merced, and San Joaquin rivers would all have locally beneficial effects on the extent and condition of riparian habitat. Several common and special-status species would benefit from these actions.

No substantial changes in riparian vegetation extent or condition would occur as a result of reservoir drawdown at Folsom Lake under Alternative 1. Similar conclusions are anticipated for other reservoirs.

Changes in the extent and condition of wetland communities as a result of changes in hydrology would be minor and would not adversely affect habitat used by common and special-status species.

Freshwater, brackish water, and salt marshes in the Delta would not be affected by salinity changes and no effects on common or special-status species associated with these habitats would occur.

Reservoir aquatic habitat quality would not change in the Sacramento River or San Joaquin River regions; nesting or wintering bald eagles would not be affected. However, increases in the availability of fish in the Sacramento and San Joaquin rivers and many of their tributaries would improve riverine habitat quality and benefit common waterbirds and bald eagles.

Full Level 2 water deliveries to refuges would result in an 18-percent increase in normal and wet years deliveries to Sacramento River Region refuges, a 65-percent increase to San Joaquin River Region refuges, and a 36-percent increase to Tulare Lake Region refuges. Relative indices indicate that the number of use-days for ducks, geese and other waterbirds could be 18 percent higher than under the No-Action Alternative at refuges in the Sacramento River Region, 65 percent higher at refuges in the San Joaquin River Region, and 36 percent higher at refuges in the Tulare Lake Region. Although these deliveries would result in increases in the acreage of wetland at refuges, and would represent a substantial benefit to migratory waterfowl and other waterbirds, inadequate water supplies would exist under this alternative for optimal wetland management.

Alternative 1 would result in approximately 80,000 acres of field flooding in the Sacramento River, Sacramento-San Joaquin Delta, and San Joaquin River regions. These new seasonal wetlands would offer major benefits for migratory waterfowl, shorebirds, and wading birds, including bother common and special-status species.

The area of evaporation ponds in the San Joaquin River and Tulare Lake regions is projected to remain the same under Alternative 1 as under the No-Action Alternative. Impacts on waterfowl and shorebirds would continue to occur. The magnitude of the impacts would depend on the design of individual evaporation ponds and the availability of alternative wetlands that would provide suitable waterfowl and shorebird habitat.

ALTERNATIVE 2

The impacts and benefits of Alternative 2 on vegetation and wildlife resources would be the same as those described under Alternative 1, with the following exceptions.

Approximately 55,000 acres more of agricultural land would be fallowed in the study area under Alternative 2 than under the No-Action Alternative. Approximately 6,100 acres would be in the Sacramento River Region, 300 acres would be fallowed in the Sacramento-San Joaquin Delta Region, 43,800 acres would be fallowed in the San Joaquin River Region and 4,800 acres would be fallowed in the Tulare Lake Region. For this analysis, it was assumed that these fallowed lands would be in small, isolated parcels distributed throughout each region and would provide habitat for common species but would not provide high-quality habitat for special-status plant species.

Reductions in pesticide use would result from land retirement and fallowing. The amount of reduction would be slightly greater under Alternative 2 than under Alternative 1.

Higher spring flows under Alternative 2, compared with spring flows under the No-Action Alternative, would result in a higher level of reproduction of riparian species, especially during dry years on the Merced and San Joaquin rivers. The magnitude of this effect cannot be determined; however, this would beneficially affect several common and special-status plant and wildlife species. Similarly, changes in river flows on the San Joaquin River and some of its tributaries would improve wetland habitat in the riparian zones of these rivers and benefit common and several special-status plant and wildlife species.

Under Alternative 2, the restoration of riparian habitat and spawning gravel in rivers and streams in the Sacramento River, Delta, and San Joaquin River regions could increase populations of salmonid fish in these rivers and streams. The availability of additional fish would benefit the wildlife species that feed on fish.

Alternative 2 would deliver Level 4 water supplies to all affected refuges. This would result in the delivery of about 179,000 acre-feet of water to refuges in the Sacramento River Region, representing a 40 percent increase in normal and wet years compared with deliveries under the No-Action Alternative. Approximately 316,360 acre-feet of water would be delivered to refuges in the San Joaquin River Region, representing a 120-percent increase in normal and wet years compared with deliveries under the No-Action Alternative. Approximately 60,650 acre-feet of water would be delivered to refuges in the Tulare Lake Region, representing an increase of 113 percent in normal and wet years compared with deliveries under the No-Action Alternative.

These increased water deliveries to refuges would permit optimal management (Level 4) of existing and new wetlands to benefit migratory and breeding waterfowl and other waterbirds and wildlife. Relative indices indicate that the number of use-days for ducks, geese, and other waterbirds at refuges in the Sacramento River Region could be 35 percent higher under Alternative 2 than under the No-Action Alternative. At refuges in the San Joaquin River Region the number of use-days for ducks, geese, and other waterbirds could be more than 100 percent higher, and at refuges in the Tulare Lake Region the number of use-days could be more than 65 percent higher.

ALTERNATIVE 3

The impacts and benefits of Alternative 3 on vegetation and wildlife resources would be the same as those described under Alternative 1, with the following exceptions.

The level of subsidence in the western San Joaquin River Region would be greater under Alternative 3, than under Alternative 1.

Approximately 137,000 acres more of agricultural land would be fallowed in the study area under Alternative 3 than under the No-Action Alternative. Approximately 23,100 acres would be in the Sacramento River Region, 1,500 acres would be fallowed in the Sacramento-San Joaquin Delta Region, 108,100 acres would be fallowed in the San Joaquin River Region and 4,100 acres would be in the Tulare Lake Region. It is assumed that approximately 15 percent of the land (18,375 acres) would be adjacent to wildlife refuges or SNAs, or that individual parcels would be large enough to provide potentially high-quality habitat. Where these lands are near existing wildlife refuges and SNAs, federal conservation easements could be used to benefit common and special-status plants. Conservation easements could be acquired, and these parcels could be managed in ways that included vegetation and wildlife objectives. Many common and special-status species could benefit from habitat enhancement, including plant species in grassland, alkali desert scrub, and valley foothill hardwood habitats that are federally listed or proposed for listing.

Reductions in pesticide use would result from land retirement and fallowing. The amount of reduction would be greater under Alternative 3 than under Alternative 1.

Under Alternative 3, increased spring stages would increase habitat for common and special-status species supported by riparian and wetland habitats in the San Joaquin River and Sacramento-San Joaquin Delta regions. This would beneficially affect many common and special-status plant and wildlife species.

Under Alternative 3, the restoration of riparian habitat and spawning gravel in rivers and streams in the Sacramento River, Delta, and San Joaquin River regions could increase populations of salmonid fish in these rivers and streams. The availability of additional fish would benefit the wildlife species that feed on fish.

Alternative 3 would deliver Level 4 water supplies to all affected refuges. This would result in the delivery of about 179,000 acre-feet of water to refuges in the Sacramento River Region, representing a 40 percent increase in normal and wet years compared with deliveries under the No-Action Alternative. Approximately 316,360 acre-feet of water would be delivered to refuges in the San Joaquin River Region, representing a 120-percent increase in normal and wet years compared with deliveries under the No-Action Alternative. Approximately 60,650 acre-feet of water would be delivered to refuges in the Tulare Lake Region, representing an increase of 113 percent in normal and wet years compared with deliveries under the No-Action Alternative.

These increased water deliveries to refuges would permit optimal management (Level 4) of existing and new wetlands to benefit migratory and breeding waterfowl and other waterbirds and wildlife. Relative indices indicate that the number of use-days for ducks, geese, and other waterbirds at refuges in the Sacramento River Region could be 35 percent higher under Alternative 3 than under the No-Action Alternative. At refuges in the San Joaquin River Region the number of use-days for ducks, geese, and other waterbirds could be more than 100 percent higher, and at refuges in the Tulare Lake Region the number of use-days could be more than 65 percent higher.

ALTERNATIVE 4

The impacts and benefits of Alternative 4 on vegetation and wildlife resources would be the same as those described under Alternative 1, with the following exceptions.

The level of subsidence in the western San Joaquin River Region would be greater under Alternative 4, than under Alternative 1.

Approximately 160,000 acres more of agricultural land would be fallowed in the study area under Alternative 4 than under the No-Action Alternative. Approximately 22,6300 acres would be in the Sacramento River Region, 1,600 acres would be fallowed in the Sacramento-San Joaquin Delta Region, 125,600 acres would be fallowed in the San Joaquin River Region and 10,600 acres in the Tulare Lake Region. It is assumed that approximately 15 percent of the land (18,375 acres) would be adjacent to wildlife refuges or SNAs, or that individual parcels would be large enough to provide potentially high-quality habitat. Where these lands are near existing wildlife refuges and SNAs, federal conservation easements could be used to benefit common and special-status plants. Conservation easements could be acquired, and these parcels could be managed in ways that included vegetation and wildlife objectives. Many common and special-status species could benefit from habitat enhancement, including plant species in grassland, alkali desert scrub, and valley foothill hardwood habitats that are federally listed or proposed for listing.

Reductions in pesticide use would result from land retirement and fallowing. The amount of reduction would be greater under Alternative 4 than under Alternative 1.

Under Alternative 4, increased spring stages would increase habitat for special status-species supported by riparian habitat and associated wetlands in the San Joaquin River and Sacramento-San Joaquin Delta regions. This would beneficially affect several common and special-status plant and wildlife species. Similarly, changes in river flows would improve wetland habitat and benefit many common and special-status plant and wildlife species.

Under Alternative 4, the restoration of riparian habitat and spawning gravel in rivers and streams in the Sacramento River, Delta, and San Joaquin River regions could increase populations of salmonid fish in these rivers and streams. The availability of additional fish would benefit the wildlife species that feed on fish.

Alternative 4 would deliver Level 4 water supplies to all affected refuges. This would result in the delivery of about 179,000 acre-feet of water to refuges in the Sacramento River Region, representing a 40 percent increase in normal and wet years compared with deliveries under the No-Action Alternative. Approximately 316,360 acre-feet of water would be delivered to refuges in the San Joaquin River Region, representing a 120-percent increase over deliveries under the No-Action Alternative. Approximately 60,650 acre-feet of water would be delivered to refuges in the Tulare Lake Region, representing a 113 percent increase over deliveries under the No-Action Alternative.

These increased water deliveries to refuges would permit optimal management (Level 4) of existing and new wetlands to benefit migratory and breeding waterfowl and other waterbirds and wildlife. Relative indices indicate that the number of use-days for ducks, geese, and other waterbirds at refuges in the Sacramento River Region could be 35 percent higher under Alternative 4 than under the No-Action Alternative. At refuges in the San Joaquin River Region the number of use-days for ducks, geese, and other waterbirds could be more than 100 percent higher, and at refuges in the Tulare Lake Region the number of use-days could be more than 65 percent higher.

CENTRAL VALLEY PROJECT POWER RESOURCES

Currently, CVP power is marketed under Contract 2948A, as described in the Affected Environment. This contract provides for the integrated operation of the CVP generation with the PG&E system. The contract expires the end of 2004 and is not expected to be renewed. While the CVP has historically been operated, to the extent possible, to meet the requirements of this contract and to receive the benefits thereof, it is not expected to continue to be operated in a similar manner after contract termination in 2004. For the purposes of this study, it has been assumed that the CVP will be operated to meet authorized project purposes which include providing water deliveries to water users, meeting fish and wildlife purposes, and power generation. Within given operating constraints, the CVP will be operated to maximize meeting load requirements of the CVP Project Use and Preference Customers.

A summary of the assumptions associated with the alternatives for power resources is presented in Table IV-28. Table IV-29 provides a summary of the impact assessment for each of the alternatives.

TABLE IV-28

SUMMARY OF ASSUMPTIONS FOR CVP POWER RESOURCES

Assumptions Common to All Alternatives or Supplemental Analyses
CVP Generation Contract 2948A with PG&E would not be renewed. Shasta Temperature Control Device in operation. CVP power generation incidental to water operations. **CVP Project Use** Project Use load met at all times. On and off-peak definitions per 2948A. **CVP Market Value of Power** Energy available for sale based on long term (1922 - 1990) average. Capacity available for sale based on 90 percent exceedence synthetic dry year. Reservoir operation and project use based on Surface Water Supplies and Facilities Operations analyses.

IMPACT ASSESSMENT METHODOLOGY

The impacts associated with each alternative were viewed from the perspective of the change in available CVP power production. The difference in power generation as well as the difference in monthly on- and off-peak Project Use capacity and energy, between the alternatives and the No-Action Alternative, was evaluated in order to estimate the impacts associated with each alternative.

CVP OPERATIONS

The Project Simulation Model (PROSIM) and San Joaquin Area Simulation Model (SANJASM) were used to simulate monthly CVP water facility operations. The model simulations were carried out for the period 1922 through 1990, using historical hydrology adjusted for a projected 2022 level of development. The power module of the PROSIM model was used to calculate monthly CVP generation, available capacity, and CVP Project Use energy and capacity. The simulation of CVP water facilities was conducted on a monthly time step using generalized reservoir operating rules and system criteria. The power information computed for each of the alternatives should only be interpreted in a comparative manner, and is only intended to provide an indication of the potential changes to CVP power generation, available capacity, and Project Use that would result from the implementation of the alternative considered in the PEIS.

TABLE IV-29

SUMMARY OF IMPACT ASSESSMENT FOR POWER RESOURCES

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	**CVP Generation** Average annual: 4935 GWh/yr. Average annual dry period (1929-1934): 2764 GWh/yr. Average monthly available capacity: 1597 MW. Average monthly dry period (1929-1934) capacity: 1380 MW. **CVP Project Use** Average annual: 1425 GWh/yr. Average annual dry period (1929-1934): 974 GWh/yr. Average monthly on-peak capacity: 184 MW. Average monthly dry period (1929-1934) on-peak capacity: 142 MW. **Market Value of Power** Average energy available for sale: 3511 GWh/yr. Average monthly capacity with energy for sale: 756 MW, based on 90 percent exceedence synthetic dry year. Average monthly capacity without energy for sale: 708 MW, based on 90 percent exceedence synthetic dry year. Total average annual market value: $125,800,000.
	Changes Compared to the No-Action Alternative
1	**CVP Generation** Average annual reduction of 5.4 percent. Average annual dry period (1929-1934) reduction of 5.0 percent. Average monthly capacity reduction of 1.4 percent. Average monthly dry period (1929-1934) capacity reduction of 4.7 percent. **CVP Project Use** Average annual reduction of 10.3 percent. Average annual dry period (1929-1934) reduction of 10.7 percent. Average monthly on-peak capacity reduction of 8.1 percent. Average monthly dry period (1929-1934) on-peak capacity reduction of 8.9 percent. **Market Value of Power** Reduction in average annual energy available for sale of 3.4 percent. Increase in average monthly capacity with energy for sale of 6.0 percent, based on 90 percent exceedence synthetic dry year. Reduction in average monthly capacity without energy for sale of 12.1 percent, based on 90 percent exceedence synthetic dry year. Increase in total average annual market value of 0.1 percent.
	Changes Compared to Alternative 1
1a	CVP power generation would be similar to Alternative 1. CVP Project Use would be reduced due to the decrease in CVP deliveries and Tracy Pumping Plant exports.
1b	Conditions are similar to Alternative 1.

TABLE IV-29. CONTINUED

	Changes Compared to Alternative 1
1c	Changes in power resources will depend of revised surface water operations. Use of non-delivered CVP water not determined at this time.
1d	Conditions are similar to Alternative 1.
1e	Conditions are similar to Alternative 1, except in dry years when site specific transfers may affect power operations. Further site specific analyses will be required.
1f	Conditions are similar to Supplemental Analysis 1e.
1g	Conditions are similar to Alternative 1.
1h	Conditions are the same as Alternative 1.
1i	Conditions are the same as Alternative 1.
	Changes Compared to the No-Action Alternative
2	**CVP Generation** Average annual reduction of 5.2 percent. Average annual dry period (1929-1934) reduction of 4.7 percent. Average monthly capacity reduction of 1.4 percent. Average monthly dry period (1929-1934) capacity reduction of 4.8 percent. **CVP Project Use** Average annual reduction of 10.2 percent. Average annual dry period (1929-1934) reduction of 10.6 percent. Average monthly on-peak capacity reduction of 7.9 percent. Average monthly dry period (1929-1934) on-peak capacity reduction of 9.3 percent. **Market Value of Power** Reduction in average annual energy available for sale of 3.2 percent. Increase in average monthly capacity with energy for sale of 2.8 percent, based on 90 percent exceedence synthetic dry year. Reduction in average monthly capacity without energy for sale of 8.4 percent, based on 90 percent exceedence synthetic dry year. Reduction in total average annual market value of 0.9 percent.
	Changes Compared to Alternative 2
2a	Conditions are similar to Alternative 2.
2b	Conditions are similar to Alternative 2, except in dry years when site specific transfers may affect power operations. Further site specific analyses will be required.
2c	Conditions are similar to Supplemental Analysis 2b.
2d	Changes in power resources will depend of revised surface water operations. Use of non-delivered CVP water not determined at this time.

TABLE IV-29. CONTINUED

	Changes Compared to the No-Action Alternative
3	**CVP Generation** Average annual reduction of 5.3 percent. Average annual dry period (1929-1934) reduction of 5.3 percent. Average monthly capacity reduction of 1.3 percent. Average monthly dry period (1929-1934) capacity reduction of 4.9 percent. **CVP Project Use** Average annual reduction of 4.0 percent. Average annual dry period (1929-1934) reduction of 1.6 percent. Average monthly on-peak capacity reduction of 2.8 percent. Average monthly dry period (1929-1934) on-peak capacity increase of 0.2 percent. **Market Value of Power** Reduction in average annual energy available for sale of 5.8 percent. Increase in average monthly capacity with energy for sale of 3.2 percent, based on 90 percent exceedence synthetic dry year. Reduction in average monthly capacity without energy for sale of 13.7 percent, based on 90 percent exceedence synthetic dry year. Reduction in total average annual market value of 2.2 percent.
3a	Conditions are similar to Alternative 3, except in dry years when site specific transfers may affect power operations. Further site specific analyses will be required.
	Changes Compared to the No-Action Alternative
4	**CVP Generation** Average annual reduction of 5.1 percent. Average annual dry period (1929-1934) reduction of 4.9 percent. Average monthly capacity reduction of 1.6 percent. Average monthly dry period (1929-1934) capacity reduction of 4.8 percent. **CVP Project Use** Average annual reduction of 11.3 percent. Average annual dry period (1929-1934) reduction of 11.5 percent. Average monthly on-peak capacity reduction of 10.0 percent. Average monthly dry period (1929-1934) on-peak capacity reduction of 9.9 percent. **Market Value of Power** Reduction in average annual energy available for sale of 2.6 percent. Increase in average monthly capacity with energy for sale of 2.6 percent, based on 90 percent exceedence synthetic dry year. Reduction in average monthly capacity without energy for sale of 15.9 percent, based on 90 percent exceedence synthetic dry year. Reduction in total average annual market value of 1.4 percent.
4a	Conditions are similar to Alternative 4, except in dry years when site specific transfers may affect power operations. Further site specific analyses will be required.

MARKET VALUE OF POWER

The electric production cost model, PROSYM, used the output from the hydrologic model, PROSIM, and the PROSIM power module to develop an estimate of the annual change in the market value of CVP power production for each alternative, as compared to the No-Action Alternative.

Generation in an average year was based on a monthly average of the generation at each power plant over the 69 years of simulation from the PROSIM model. The value of energy produced by the CVP was estimated based on a marginal heat rate approach. To the extent the CVP power output is increased or decreased in a particular time period, an opposite change will occur in the output of the marginal unit which is operating at the same time. The marginal heat rates for Northern California, Pacific Northwest, Southwest, and southern California from which power may be transmitted and purchased were reviewed. It was then assumed that, given industry restructuring, it would be possible to access the source of energy having the lowest delivered cost. This resulted in the alternative energy source varying monthly and by time of day (on-peak versus off-peak). The energy values used in this analysis ranged from $11.67 per megawatt-hour to $22.54 per megawatt-hour (1992 dollars).

The value of capacity available for sale was determined based on the monthly maximum level of load-carrying capability (capacity supported with energy) available under adverse hydrologic conditions. Dry year energy and capacity was chosen such that the CVP capacity would be available at least 90 percent of the time for any given month (barring equipment failure). Thus, a 90 percent hydrologic exceedence level was utilized (i.e., the level of energy assumed to be produced in any month will be exceeded 90 percent of the time). The resulting twelve months of energy levels developed for the PEIS alternative analysis comprise a set of synthetic years that do not resemble any specific operating or chronological year within the 69 year simulation period. This synthetic year does not necessarily represent a worst case generation year or worst case of net available power for marketing, but is for use in comparison of alternatives to the No-Action Alternative. The value of capacity supported with energy was estimated to be $6.28 per kilowatt-month. In addition, capacity without energy (available capacity less capacity supported with energy) was also valued based on its ability to provide certain ancillary services (primarily spinning and installed reserves). This capacity was valued at 20 percent of the value used for capacity supported with energy.

NO-ACTION ALTERNATIVE

Under the No-Action Alternative, the CVP power generation facilities are operated in a manner similar to the operations discussed under the Affected Environment. The primary differences between operations under the No-Action Alternative and Affected Environment are primarily related to changes due to the Bay-Delta Plan Accord, revised Stanislaus River operations, and the availability of the Shasta Temperature Control Device that eliminates the need for bypass of Shasta powerplant.

ALTERNATIVE 1

Average annual CVP power generation under this alternative is reduced at Trinity, Carr, and Spring Creek powerplants, as compared to the No-Action Alternative, due to increases in instream flows in the Trinity River and the decreased diversions from the Trinity River Basin in the spring and summer as well as increased CVP reservoir releases in the fall and spring months under the (b)(2) Water Management. Power generation is also slightly reduced at other CVP powerplants due to changes in reservoir operations under the (b)(2) Water Management. The simulated average annual generation for each powerplant is shown in Figure IV-46. The average annual generation and available capacity for the CVP system is shown in Table IV-30. The average annual CVP generation under long term (1922-1990) and under dry hydrologic conditions (1929-1934) is reduced as compared to the No-Action Alternative by 5.4 percent and 5.0 percent respectively. The average total CVP available generating capacity for the long term and dry period is reduced 1.4 percent and 4.7 percent respectively. Average monthly generation and available capacity are shown in Figures IV-47 and IV-48.

TABLE IV-30

CVP GENERATION

Alternative	Average Annual Generation (GWh)		Average Monthly Available Capacity (MW)	
	Long Term (1922-1990)	Dry Period (1929-1934)	Long Term (1922-1990)	Dry Period (1929-1934)
No-Action Alternative	4,935	2,764	1,597	1,380
1	4,667	2,626	1,575	1,315
2	4,678	2,633	1,575	1,314
3	4,674	2,618	1,576	1,312
4	4,682	2,630	1,571	1,313

Changes in CVP pumping plant operations result in differences in the CVP Project Use energy and capacity in Alternative 1, as compared to the No-Action Alternative. Increased fall and reduced summer Tracy Pumping Plant exports, and increased fall pumping to lift water into San Luis Reservoir shift the simulated average monthly Project Use energy and capacity. Project Use needs are reduced during the spring and summer and are increased in the fall and winter months. Average Project Use is shown in Table IV-31. The long term average annual Project Use energy is reduced 10.3 percent compared to the No-Action Alternative. Average monthly Project Use energy and capacity are shown in Figures IV-49 and 50.

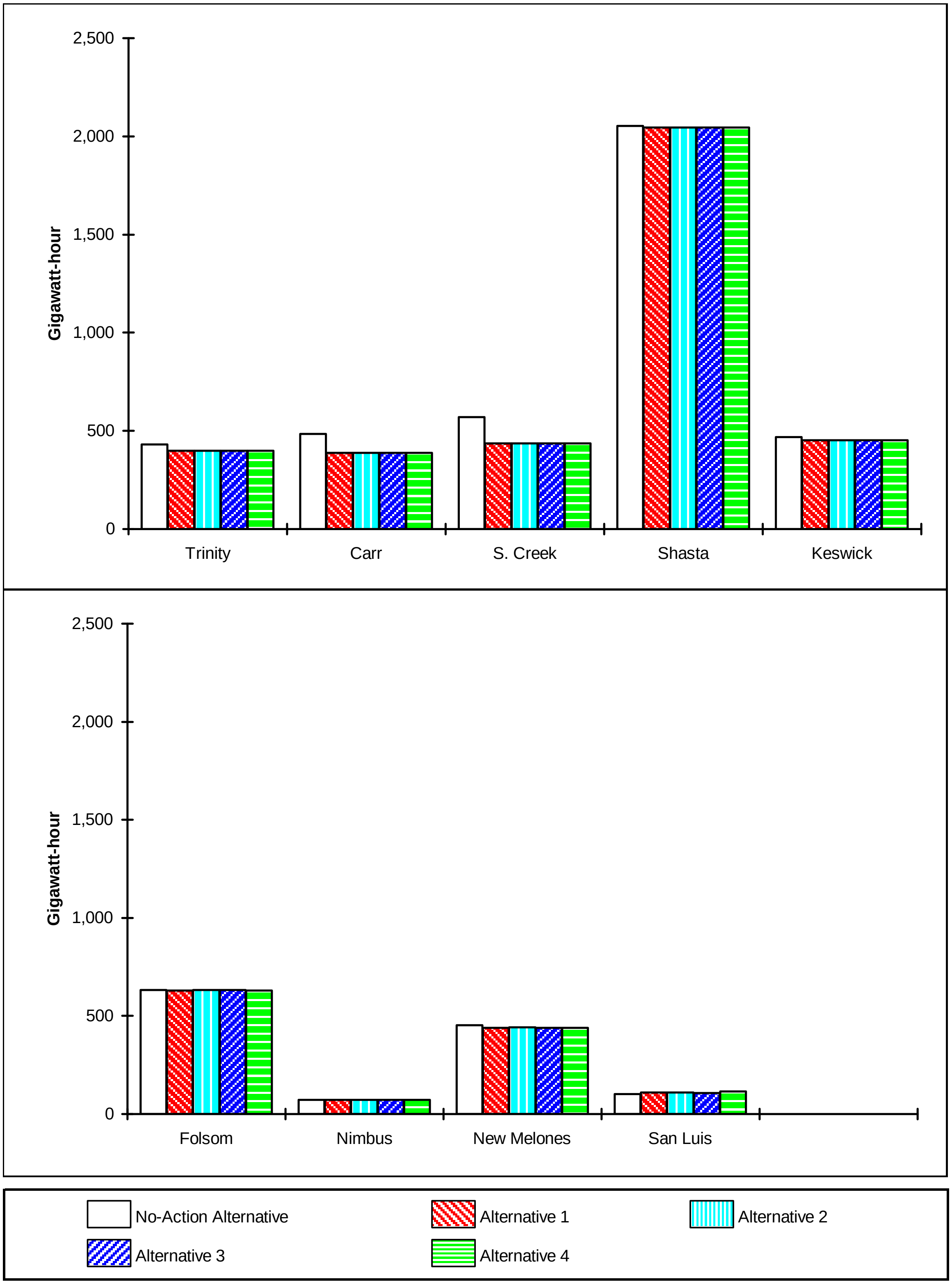


FIGURE IV-46

SIMULATED AVERAGE ANNUAL GENERATION AT CVP POWERPLANTS

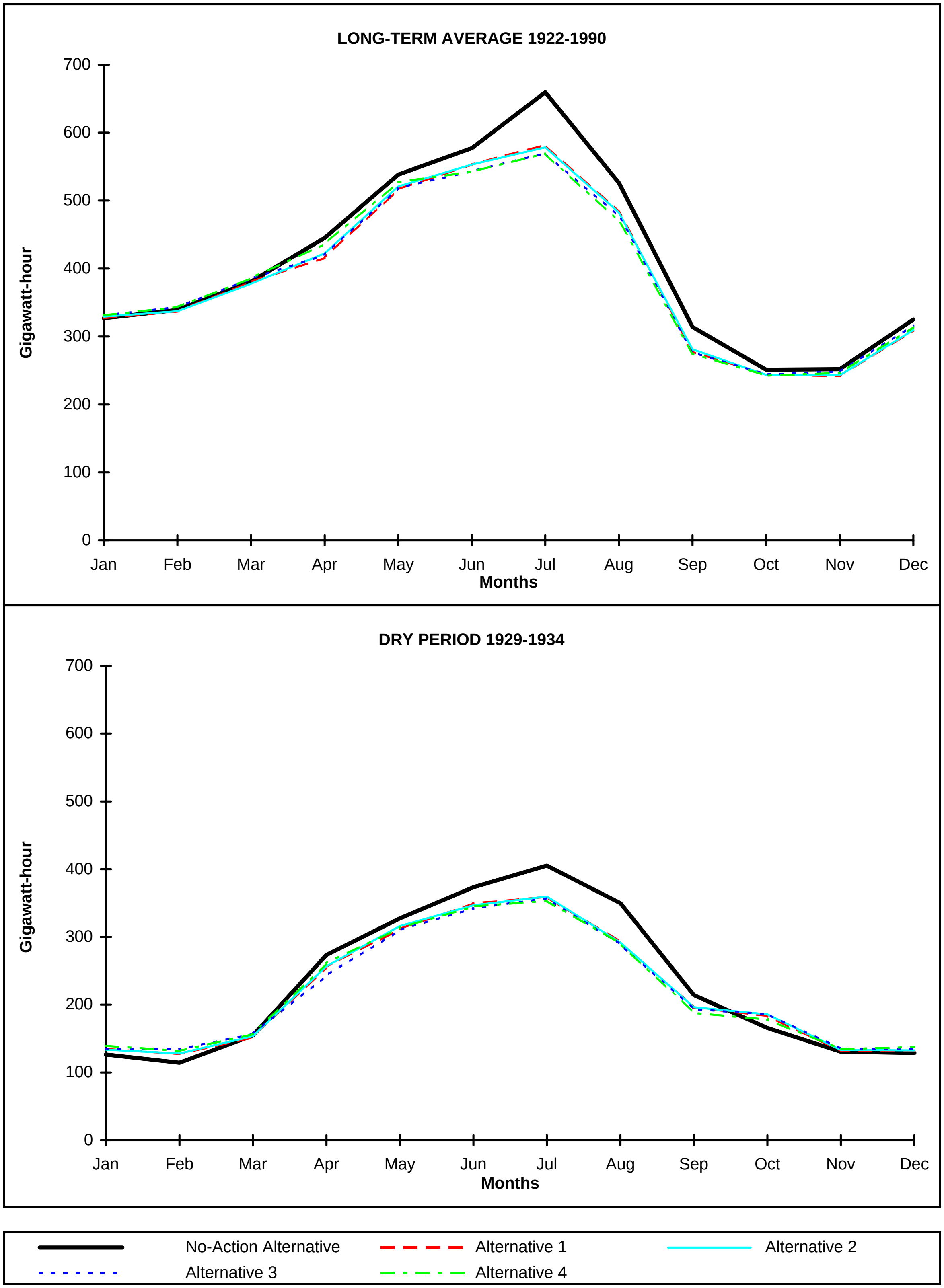


FIGURE IV-47

SIMULATED AVERAGE MONTHLY CVP GENERATION

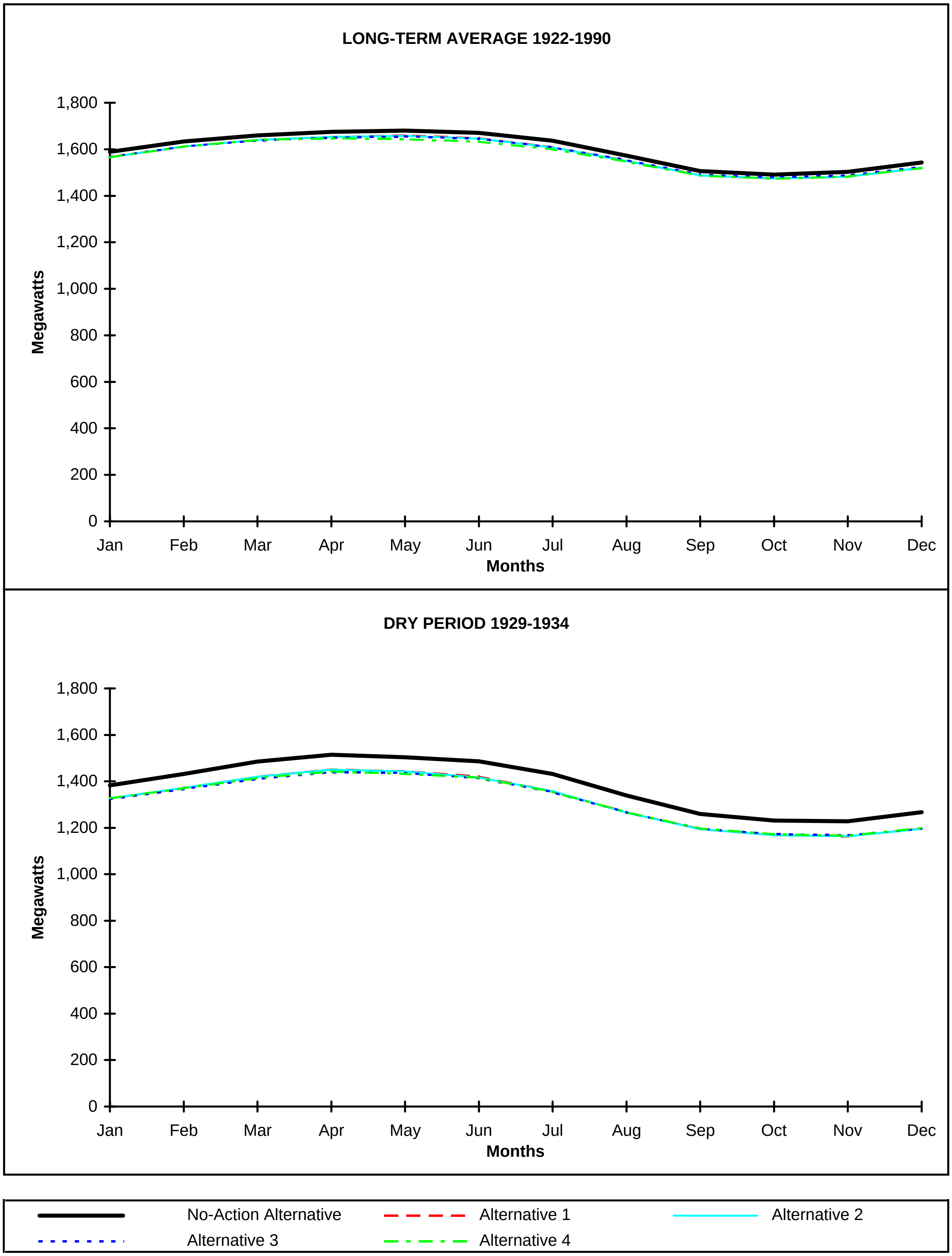


FIGURE IV-48

SIMULATED AVERAGE MONTHLY AVAILABLE CAPACITY

TABLE IV-31

AVERAGE CVP PROJECT USE

Alternative	Average Annual Project Use Energy (GWh)		Average Monthly On-Peak Project Use Capacity (MW)	
	Long Term (1922-1990)	Dry Period (1929-1934)	Long Term (1922-1990)	Dry Period (1929-1934)
No-Action Alternative	1,425	974	184	142
1	1,278	870	169	129
2	1,280	871	170	129
3	1,367	990	179	142
4	1,263	862	166	128

The long term average annual energy available for sale and capacity available for sale (based on the 90 percent exceedence synthetic year) are shown in Table IV-32. This information was prepared for the PEIS by Western Area Power Administration. The energy available for sale under average conditions decreases by 3.4 percent compared to the No-Action Alternative, resulting in a reduction in energy value. However, the energy available for sale under adverse conditions is greater than in the No-Action Alternative, resulting in high firm load carrying capability value (capacity with energy). This increase in capacity with energy for sale of 6.0 percent under adverse conditions offsets the reduction in value due to reduced average year energy. Capacity without energy for sale decreases by 12.1 percent. Based on the market value of power analysis, the net increase in the value of CVP power production under Alternative 1, as compared to the No-Action Alterative, is approximately $100,000 per year, an increase of 0.1 percent compared to the No-Action Alternative value of $125,800,000 (Western, 1997).

TABLE IV-32

CVP ENERGY AND CAPACITY AVAILABLE FOR SALE

Alternative	Average Annual Energy (GWh)	90 Percent Exceedence Synthetic Dry Year Average Monthly Capacity (MW)	
		With Energy	Without Energy
No-Action Alternative	3,511	756	708
1	3,391	801	622
2	3,401	777	649
3	3,308	780	611
4	3,420	776	595

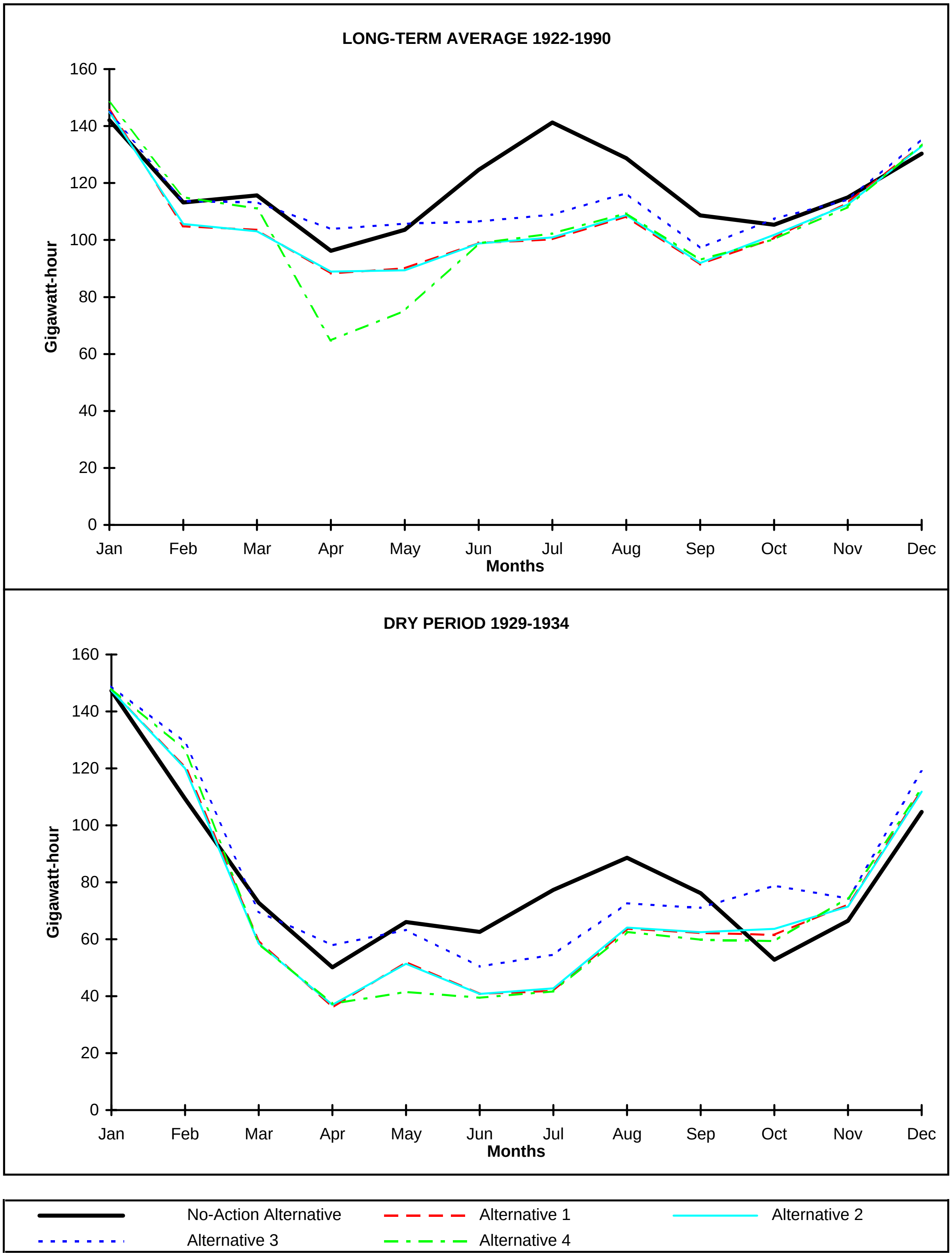


FIGURE IV-49

SIMULATED AVERAGE MONTHLY CVP PROJECT USE ENERGY

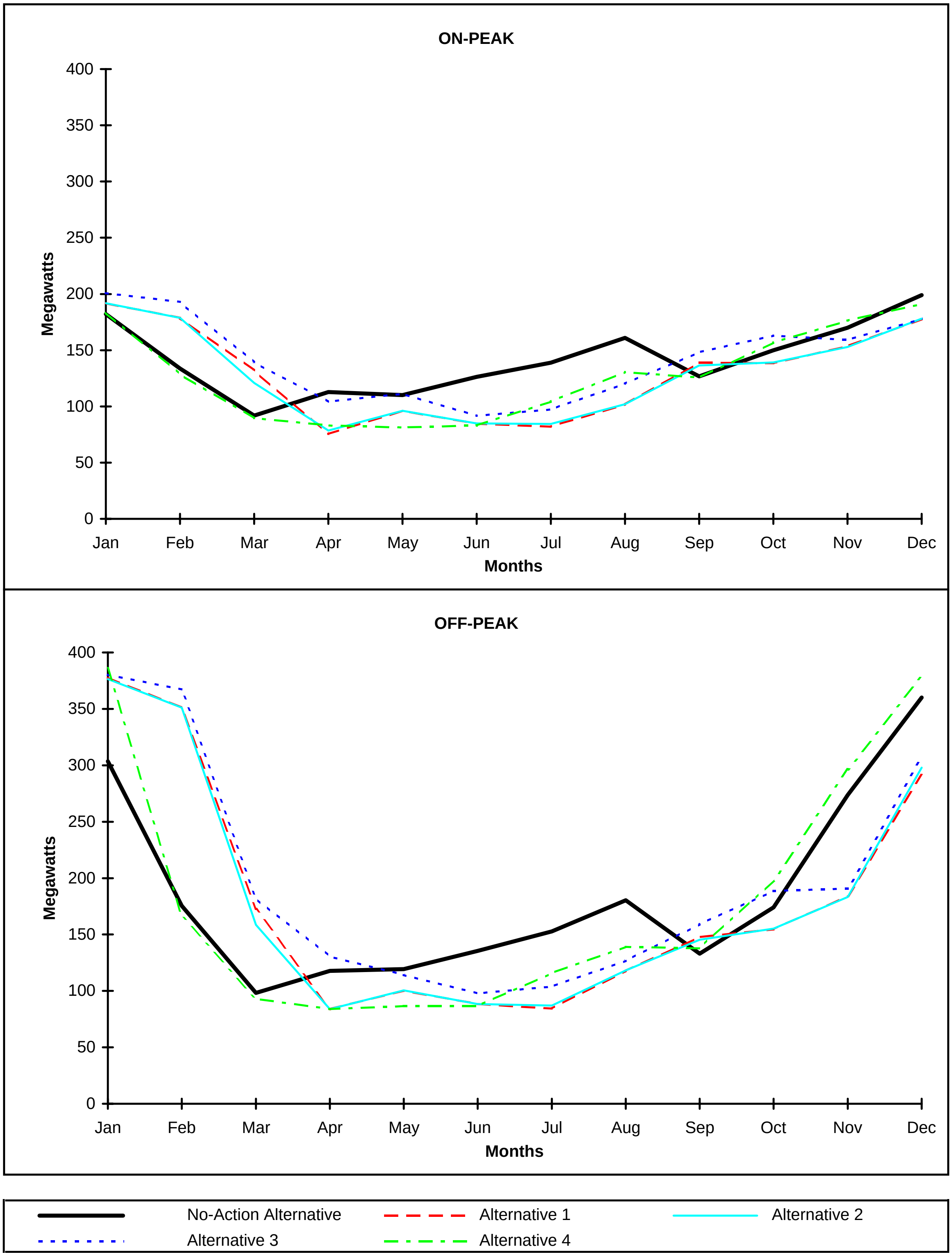


FIGURE IV-50
SIMULATED AVERAGE MONTHLY ON- AND OFF-PEAK CVP PROJECT USE CAPACITY DRY YEAR PERIOD 1929-1934

However, power production at hydropower facilities on Battle Creek could be reduced under Alternative 1 as compared to the No-Action Alternative, if restoration actions for fisheries are initiated on Battle Creek.

ALTERNATIVE 2

Changes in generation for Alternative 2 are similar to Alternative 1. Generation at New Melones powerplant is slightly reduced due to water acquisition on the Stanislaus River. The simulated average annual generation, for each powerplant is shown in Figure IV-46. The average annual generation and available capacity is shown in Table IV-30. The reduction in average annual CVP generation under average and dry hydrologic conditions, for Alternative 2 as compared to the No-Action Alternative is 5.2 percent and 4.7 percent respectively. The reduction in simulated average monthly total CVP available capacity for average and dry periods is 1.4 percent and 4.8 percent respectively. Monthly generation and available capacity are shown in Figures IV-47 and IV-48.

In Alternative 2, CVP pumping plant operations are similar to Alternative 1. Average Project use is shown in Table IV-31. Increased fall and reduced summer Tracy Pumping Plant exports, and increased fall pumping to lift water into San Luis Reservoir shift the simulated average monthly Project Use capacity and energy. These shifts in Project Use capacity and energy requirements are shown in Figures IV-49 and IV-50. Overall, the average annual Project Use energy is reduced 10.2 percent compared to the No-Action Alternative.

The long term average annual energy available for sale and capacity available for sale (based on the 90 percent exceedence synthetic year) are shown in Table IV-32. The energy available for sale under average conditions decreases by 3.2 percent compared to the No-Action Alternative, resulting in a reduction in energy value. However, the energy available for sale under adverse conditions is greater than in the No-Action Alternative, resulting in higher firm load carrying capability value. This increase in capacity with energy for sale of 2.8 percent under adverse conditions partially offsets the reduction in value due to reduced average year energy. Capacity without energy for sale decreased by 8.4 percent. Based on the market value of power analysis, the net decrease in the market value of CVP power production under Alternative 2, as compared to the No-Action Alternative, is approximately $1,000,000 per year, a decrease of approximately 0.8 percent. Decreases in the energy and capacity available for sale may result in an increase in the unit cost of CVP power which may make it more difficult to market CVP power in a competitive environment.

Power production at hydropower facilities on Battle Creek, and Tuolumne and Merced rivers would be reduced under Alternative 2 as compared to the No-Action Alternative due to water acquisition for the AFRP target flows.

ALTERNATIVE 3

Changes in generation for Alternative 3 are similar to Alternative 2. The simulated average annual generation for each powerplant is shown in Figure IV-46. The average annual generation and available capacity is shown in Table IV-30. The reduction in average annual CVP generation under average and dry hydrologic conditions, for Alternative 3 as compared to the No-Action Alternative is 5.3 percent for both average and dry conditions. The reduction in simulated average monthly total CVP available capacity for average and dry periods is 1.3 percent and 5.0 percent respectively. Monthly generation and available capacity are shown in Figure IV-47 and IV-48.

In Alternative 3, acquired water can be exported after it flows into the Delta as long as requirements of the Bay-Delta Accord are met. This results in increased Tracy Pumping Plant exports as compared to Alternatives 1 and 2. Average Project use is shown in Table IV-31. The average monthly CVP Project Use energy requirements also increase in the fall and decrease in the summer in Alternative 3, as compared to the No-Action Alternative. These shifts in Project Use capacity and energy requirements are shown in Figures IV-49 and IV-50. Overall, the average annual Project Use energy is reduced 4.0 percent compared to the No-Action Alternative.

The long term average annual energy available for sale and capacity available for sale (based on the 90 percent exceedence synthetic year) are shown in Table IV-32. The energy available for sale under average conditions decreases by 5.8 percent compared to the No-Action Alternative, resulting in a reduction in energy value. However, the energy available for sale under adverse conditions is greater than in the No-Action Alternative, resulting in higher firm load carrying capability value. This increase in capacity with energy for sale of 3.2 percent under adverse conditions partially offsets the reduction in value due to reduced average year energy. Capacity without energy for sale decreased by 13.7 percent. Based on the market value of power analysis, the net decrease in the market value of CVP power production under Alternative 3, as compared to the No-Action Alternative, is approximately $2,800,000 per year, a decrease of approximately 2 percent. Decreases in the energy and capacity available for sale may result in an increase in unit cost of CVP power which may make it more difficult to market CVP power in a competitive environment.

Power production at hydropower facilities on Battle Creek, Tuolumne, Merced, and Yuba rivers would be reduced under Alternative 3 as compared to the No-Action Alternative, due to water acquisition for the flow targets.

ALTERNATIVE 4

Changes in generation for Alternative 4 are similar to Alternatives 2 and 3. The simulated average annual generation, for each powerplant is shown in Figure IV-46. The average annual generation and available capacity is shown in Table IV-30. The reduction in average annual CVP generation under average and dry hydrologic conditions, for Alternative 4 as compared to the No-Action Alternative is 5.1 percent and 4.9 percent respectively. The reduction in simulated average monthly total CVP available capacity for average and dry periods is 1.6 percent and 4.9 percent respectively. Monthly generation and available capacity are shown in Figures IV-47 and IV-48.

In Alternative 4 the CVP would not export acquired water after it flows into the Delta, and Tracy Pumping Plant exports would be changed due to use of (b)(2) water in the Delta above the Bay-Delta Plan Accord. This results in decreased Tracy Pumping Plant energy needs as compared to the other Alternatives. Average Project use is shown in Table IV-31. Figures IV-490 and IV-50 show the reduction in average monthly Project Use energy and capacity in April and May, for Alternative 4 as compared to the No-Action Alternative. Overall, the average annual Project Use energy is reduced 11.3 percent compared to the No-Action Alternative.

The long term average annual energy available for sale and capacity available for sale (based on the 90 percent exceedence synthetic year) are shown in Table IV-32. The energy available for sale under average conditions decreases by 2.6 percent compared to the No-Action Alternative, resulting in a reduction in energy value. However, the energy available for sale under adverse conditions is greater than in the No-Action Alternative, resulting in higher firm load carrying capability value. This increase in capacity with energy for sale of 2.6 percent under adverse conditions partially offsets the reduction in value due to reduced average year energy. Capacity without energy for sale decreased by 15.9 percent. Based on the market value of power analysis, the net decrease in the market value of CVP power production under Alternative 4, as compared to the No-Action Alternative, is approximately $1,800,000 per year, a decrease of about 1.4 percent. Decreases in the energy and capacity available for sale may result in an increase in unit cost of CVP power which may make it more difficult to market CVP power in a competitive environment.

Power production at hydropower facilities on Battle Creek, Tuolumne, Merced, and Yuba rivers would be reduced under Alternative 4 as compared to the No-Action Alternative, due to water acquisition for the flow targets.

RESTORATION CHARGES TO CVP POWER USERS

Section 3407 of the CVPIA established the Central Valley Project Restoration Fund. Section 3407(d)(2)(A) defined the responsibilities of CVP water and power users for payment into this fund. Although this section did not include specific annual amounts for payments to the Restoration Fund by water and power users, it did indicate that " . . . The Secretary shall require the Central Valley Project water and power contractors to make such additional annual payments as are necessary . . . " and " . . . such additional payments shall not exceed $30,000,000 (October 1992 price levels) on a three year rolling average basis . . ." and " . . . taking into account all funds collected under this title, shall, to the greatest degree practicable, be assessed in the same proportion, measured over a ten-year rolling average, as water and power users' respective allocations for repayment of the Central Valley Project".

For the purpose of the PEIS, it was assumed that payments to the Restoration fund for CVP power users for years with average year water deliveries for Alternative 1 would be approximately $6,200,000, for Alternative 2, $6,3000,000, alternative 3, $5,300,000, and for Alternative 4, $6,500,000. This amount may be greater or lesser for any given year depending on restoration payments collected from water users for that year and the requirement to maintain the three year average of $30,000,000.

RECREATION

Impacts on recreation are assessed for major CVP and SWP reservoirs and those operated by other agencies, rivers below these reservoirs, and federal and state wildlife refuges receiving federal water. Major CVP reservoirs are Shasta Lake, Whiskeytown Lake, Folsom Lake, San Luis Reservoir (joint CVP and SWP facility), Millerton Lake, and New Melones Reservoir. The major SWP reservoir is Lake Oroville. Impacts on recreation at secondary CVP and SWP reservoirs and major reservoirs operated by other agencies, including Keswick, Lake Red Bluff, Lake Natoma, Thermalito Forebay and Afterbay, O'Neill Forebay, and Bethany, are assessed at a more general level of detail.

Major rivers below CVP and SWP reservoirs are the Sacramento, Feather, American, San Joaquin, and Stanislaus. Major rivers below reservoirs operated by other agencies are the Yuba, Tuolumne, Calaveras, Merced, and Mokelumne. Federal and state wildlife refuges located in the Sacramento River, San Joaquin River, and Tulare Lake regions are also included in the impact assessment.

A summary of the assumptions associated with the alternatives for recreation is presented in Table IV-33. Table IV-34 provides a summary of the impact assessment for each of the alternatives.

TABLE IV-33

SUMMARY OF ASSUMPTIONS FOR RECREATION

Assumptions Common to All Alternatives and Supplemental Analyses
Recreational use at reservoirs will change with critical water levels which affect boat ramps, water skiing, and picnicking. Recreational use at refuges and on rivers will change with habitat quality. Reservoir operations, river flows, and refuge deliveries are estimated in the corresponding analysis for Surface Water and Facilities Operations analyses.

METHODOLOGY

Two types of changes related to recreation area are assessed in this section: changes in recreation opportunities and changes in recreation use. The assessment of recreation opportunities analyzes how changes in reservoir elevations, river flows, and water deliveries to wildlife refuges would affect the opportunities for water-related activities at these facilities. The analysis examines opportunities during the peak and off seasons (defined in the Recreation Technical Appendix).

The assessment of recreation use focuses on how the same changes studied in the opportunities analysis may affect annual rates of recreation use at these facilities. Because these changes in recreation use serve as the basis for estimating recreation-related economic impacts, changes in use are described but impacts are not cited.

TABLE IV-34

SUMMARY OF IMPACT ASSESSMENT FOR RECREATION

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	Conditions are similar to Affected Environment.
	Changes Compared to the No-Action Alternative
1	Lower surface elevations on Pitt River and Sacramento River arms of Shasta Lake constrain boating during the off season. Higher surface elevation at Lake Oroville reduces constraints on boating and shoreline activities during the peak and off-peak seasons. Higher surface elevation at Folsom Lake reduces constraints on boating and shoreline use during the peak and off-peak seasons. Flows are maintained within optimal range for boating more frequently on the upper Sacramento River during the peak season. Flows on the American River are more frequently below optimum level for swimming during the peak season. Opportunities are increased for wildlife observation, hunting, and fishing at wildlife refuges in the Sacramento River Region. Lower surface elevation at New Melones Reservoir constrains boating and increases the frequency when boat ramps are unusable. Lower surface elevation at New Melones Reservoir restricts shoreline recreation opportunities. Flows on the lower Stanislaus River are maintained above the minimum level for boating and swimming more frequently during the peak season. Opportunities are increased for wildlife observation, hunting, and fishing at wildlife refuges in the San Joaquin River Region.
	Changes Compared to Alternative 1
1a	Conditions are the same as Alternative 1.
1b	Conditions are the same as Alternative 1, except the barriers at Georgiana Slough and Old River could delay or restrict recreational boat access to portions of the Delta.
1c	Impacts could range from those similar to Alternative 1, to benefits for reservoir and/or river recreation in the Sacramento River and San Joaquin River regions.
1d	Conditions are similar to Alternative 1.

TABLE IV-24. CONTINUED

	Changes Compared to Alternative 1
1e	Conditions are similar to Alternative 1.
1f	Conditions are the same as Alternative 1.
1g	Conditions are the same as Alternative 1.
1h	Conditions are the same as Alternative 1.
1i	Conditions are the same as Alternative 1, except flatwater recreation is eliminated at Lake Red Bluff.
	Changes Compared to the No-Action Alternative
2	Conditions are the same as Alternative 1, except opportunities are increased over Alternative 1 for wildlife observation, hunting, and fishing at wildlife refuges in the San Joaquin River and Tulare Lake regions.
	Changes Compared to Alternative 2
2a	Average annual conditions are the same as Alternative 2, except the barriers at Georgiana Slough and Old River could delay or restrict recreational boat access to portions of the Delta.
2b	Conditions are similar to Alternative 2.
2c	Conditions are similar to Alternative 2.
2d	Conditions are similar to Alternative 2.
	Changes Compared to the No-Action Alternative
3	Conditions are the same as Alternative 3.
3a	Conditions are similar to Alternative 3.
	Changes Compared to the No-Action Alternative
4	Conditions are the same as Alternative 3.
4a	Conditions are similar to Alternative 4.

The effects of each alternative are compared to conditions under the No-Action Alternative to determine impacts on recreation. The results of this analysis are presented below, organized by alternative.

Changes in recreational activities in the Trinity River Region would be the same for all alternatives as compared to No-Action Alternative. The impacts associated with changes in the Trinity River Region are being evaluated in a separate environmental document.

NO-ACTION ALTERNATIVE

This section presents information on recreation opportunities and use at reservoirs, rivers, and wildlife refuges in the Sacramento River, San Joaquin River, and Tulare Lake regions under the No-Action Alternative. Changes in recreation opportunities and use under Alternatives 1, 2, 3, and 4 will be compared to those under the No-Action Alternative.

Reservoirs

Recreation opportunities at all major CVP and SWP reservoirs would be constrained under the No-Action Alternative. As shown in Table IV-35, boating opportunities would be constrained frequently on the Pit River and McCloud River arms of Shasta Lake during the peak and off seasons. At Folsom Lake and Lake Oroville, shoreline recreation opportunities (beach use,

camping, and picnicking) would be constrained frequently during the peak season, whereas boating would be constrained frequently during the off season. At San Luis Reservoir, Millerton Lake, and New Melones Reservoir, boating and shoreline recreation opportunities would be constrained only occasionally.

Recreation opportunities at secondary CVP and SWP reservoirs are expected to be the same as those under existing conditions because operation of these reservoirs is not expected to change under the No-Action Alternative.

Recreation opportunities at major reservoirs operated by other agencies are also sensitive to reservoir surface elevations. At some of the reservoirs located in the San Joaquin River Region, boating and shoreline recreation opportunities would be constrained frequently by low reservoir surface elevations during the peak season.

Annual use estimates for major CVP and SWP reservoirs are shown in Table IV-36. Under the No-Action Alternative, annual use is estimated to range from approximately 5.7 million visitors days at Shasta Lake to 184,000 visitor days at San Luis Reservoir. Combined annual recreation use at non-CVP and SWP reservoirs is estimated to total approximately 1.8 million visitor days.

TABLE IV-35

FREQUENCY WITH WHICH RECREATION THRESHOLDS ARE EXCEEDED AT MAJOR RESERVOIRS IN THE SACRAMENTO RIVER AND SAN JOAQUIN RIVER REGIONS UNDER THE NO-ACTION ALTERNATIVE

	Peak-Season Thresholds					Off-Season Thresholds	
Reservoir	**Boat-Ramp Availability**	**Limited Surface Area**	**Marinas Close**	**Beach Use Decline**	**Camping/ Picnicking Decline**	**Boat Ramp Availability**	**Limited Surface Area**
Shasta							
Main Area	0	5	0	--	--	0	6
Pit River Arm	5	24	--	--	<1	5	23
Sacramento River Arm	6	34	4	--	10	6	40
McCloud River Arm	6	10	--	--	8	6	10
Folsom	1	14	20	23	42	3	25
Oroville	7	15	--	39	6	10	23
San Luis	<1		--	--	--	0	4
Millerton	4	6	--	6	--	1	1
New Melones	>1	1	1	3	<1	1	1

NOTES:
Values are percentages of the total number of months over a 69-year hydrologic period.
Peak season is May through September (345 months) for Shasta Lake and San Luis Reservoir.
Peak season is April through September (414 months) for Folsom Lake, Lake Oroville, Millerton Lake, and New Melones Reservoir.

TABLE IV-36

ANNUAL VISITOR USE FOR RESERVOIRS IN THE SACRAMENTO RIVER AND SAN JOAQUIN RIVER REGIONS

Region and Reservoir	No-Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Sacramento River					
Shasta	5,740,000	5,650,000	5,670,000	5,670,000	5,650,000
Oroville	1,250,000	1,250,000	1,260,000	1,270,000	1,260,000
Folsom	910,000	930,000	930,000	930,000	930,000
San Joaquin River					
San Luis	184,000	184,000	184,000	184,000	182,000
Millerton	663,000	663,000	663,000	663,000	663,000
New Melones	800,000	788,000	788,000	785,000	785,000
Non- CVP and SWP	1,799,000	1,799,000	1,797,000	1,807,000	1,807,000

NOTES:
Use is reported in 12-hour visitor days.
Use is based on the 69-year hydrologic period.

Rivers

Recreation opportunities on major rivers below CVP and SWP reservoirs would be constrained under the No-Action Alternative. As shown in Table IV-37, boating opportunities on the upper Sacramento River are occasionally constrained during the peak season. On the American River, flows would frequently be above the minimum necessary to conduct boating activities, but would also frequently be outside the optimal range of flows for this activity. On the lower San Joaquin River, flows would frequently be within the optimal range for all boating activities, but would occasionally be below the minimum level for these activities. On the upper Stanislaus River, flows would never fall below the minimum necessary, and would frequently be within the optimum flow range, for all boating activities. Flows on the lower reach of the Stanislaus River, would frequently be below the minimum flows, and infrequently within the optimal range, needed for all boating activities.

Recreation opportunities on rivers below major reservoirs operated by other agencies are also sensitive to river flows. Flows on the Tuolumne, Mokelumne, and Merced rivers would frequently be outside the optimum range for conducting boating activities and would also frequently be below the minimum necessary for swimming activities.

TABLE IV-37

FREQUENCY WITH WHICH RECREATION THRESHOLDS ARE EXCEEDED DURING THE PEAK SEASON AT MAJOR RIVERS IN THE SACRAMENTO AND SAN JOAQUIN RIVER REGIONS UNDER THE NO-ACTION ALTERNATIVE

	Thresholds		
	Boating		Swimming
River	Within Optimal Flows	Below Minimum Flows	Below Minimum Flows
Sacramento	95	--	--
American	30	22	19
San Joaquin	70	--	5
Stanislaus			
Upper Reach	34	0	--
Lower Reach	7	37	--

NOTES:
Values are percentages of the total number of months over a 69-year hydrologic period.
Peak season is May through September (345 months) for all rivers.

Opportunities for river-related recreation on the Feather and Yuba rivers are expected to be similar to those under existing conditions.

Annual recreation use at rivers in the San Joaquin River Region is estimated to total approximately 1.2 million visitor days. Changes in recreation associated with rivers in the Sacramento River Region are not included because recreation use at these rivers would not be substantially affected by the flow changes projected for the alternatives. Information on recreation use occurring on these rivers is included in the Recreation Technical Appendix.

Wildlife Refuges

Under the No-Action Alternative, annual visitation to wildlife refuges in the Sacramento River Region is estimated to average 101,200 visitor days (Table IV-38). Nonconsumptive recreation, such as wildlife viewing and picnicking, would account for approximately 49 percent of total visitor days and consumptive recreation, such as hunting and fishing, would account for approximately 45 percent and 6 percent of total visitor days, respectively.

TABLE IV-38

ANNUAL VISITOR USE AT WILDLIFE REFUGES IN THE SACRAMENTO RIVER, SAN JOAQUIN RIVER, AND TULARE LAKE REGIONS

Region and Activity	No-Action Alternative	Alternative 1	Alternatives 2 - 4
Sacramento River			
Hunting	45,000	59,400	86,100
Fishing	6,500	7,700	9,100
Nonconsumptive	49,700	58,600	69,300
Total	101,200	125,700	164,500
San Joaquin River			
Hunting	32,500	48,800	70,100
Fishing	4,600	5,100	5,900
Nonconsumptive	35,800	39,300	45,000
Total	72,900	93,200	121,000
Tulare Lake Region			
Fishing	500	500	1,300
Nonconsumptive	3,900	3,900	9,700
Total	4,400	4,400	11,000

NOTES:
Use estimates are based on Level 2 water deliveries over a 69-year hydrologic period.
Use is reported in 5-hour visitor days.

At wildlife refuges in the San Joaquin River Region, annual visitation is estimated to average 72,900 visitor days (Table IV-38). Nonconsumptive recreation would account for approximately 49 percent of total visitor days. Consumptive recreation, such as hunting and fishing, would account for approximately 45 percent and 6 percent of total visitor days, respectively.

In the Tulare Lake Region, annual visitation to wildlife refuges is estimated to average 4,400 visitor days (Table IV-38). Nonconsumptive recreation would account for approximately 89 percent of total visitor days.

ALTERNATIVE 1

This section describes changes in recreation opportunities and use at reservoirs, rivers, and wildlife refuges in the Sacramento River, San Joaquin River, and Tulare Lake regions under Alternative 1 compared to conditions under the No-Action Alternative.

At some recreation sites in the three study regions, recreation opportunities would not change or would change only slightly under some of the alternatives compared to the No-Action Alternative. Table IV-39 shows which recreation sites are discussed under each alternative. For sites where no change would occur, no impacts on recreation opportunities are expected and these sites are not discussed further in this analysis. A detailed discussion of recreation opportunities at these sites under Alternatives 1, 2, 3, and 4 is provided in the Recreation Technical Appendix.

TABLE IV-39

RECREATION AREAS INCLUDED IN THE PEIS IMPACT ANALYSIS

Recreation Sites	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Reservoirs				
Shasta Lake	X	X	X	X
Whiskeytown Lake				
Lake Oroville	X	X	X	X
Folsom Lake	X	X	X	X
San Luis Reservoir			X	
Millerton Lake				
New Melones Reservoir	X	X	X	X
Rivers				
Sacramento	X	X	X	X
Feather				
American	X	X	X	X
San Joaquin				
Stanislaus	X	X	X	X
Wildlife Refuges				
Sacramento River Region	X	X	X	X
San Joaquin River Region	X	X	X	X
Tulare Lake Region		X	X	X

Reservoirs

Recreation opportunities at Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and reservoirs operated by other agencies could be affected under Alternative 1 (Table IV-40).

TABLE IV-40

CHANGES IN RECREATION OPPORTUNITIES AT IMPORTANT RECREATION SITES

	Comparison of Changes from No-Action Alternative			
Recreation Site (1)	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Major CVP/SWP Reservoirs				
Shasta Lake	Decreased boating	Decreased boating	Decreased boating	Decreased boating
Lake Oroville	Increase boating and shoreline uses	Increase boating and shoreline uses	Increase boating and shoreline uses	Increase boating and shoreline uses
Folsom Lake	Increase boating and shoreline uses	Increase boating and shoreline uses	Increase boating and shoreline uses	Increase boating and shoreline uses
New Melones Reservoir	Decrease boating and shoreline uses	Decrease boating and shoreline uses	Decrease boating and shoreline uses	Decrease boating and shoreline uses
San Luis Reservoir	No change	No change	Decrease boating and shoreline uses	No change
Non-CVP/SWP Reservoirs	No change	No change	Decrease shoreline uses	Decrease shoreline uses

At Shasta Lake during the off season, lake levels would be lower under Alternative 1 than they would be under the No-Action Alternative. These lower lake levels would constrain boating in the Pit River and Sacramento River arms more frequently under this alternative than under the No-Action Alternative. Boating and shoreline recreation opportunities during the peak season at Shasta Lake would be nearly the same under Alternative 1 and the No-Action Alternative. The lower lake levels during the off season would result in a potential impact on off-season boating opportunities at Shasta Lake.

At Lake Oroville during the peak season, lake levels would be higher under Alternative 1 than they would be under the No-Action Alternative. Because of these higher lake levels, usable surface area for boating would be constrained less frequently during the peak season under this alternative than under the No-Action Alternative. Shoreline recreation opportunities during the peak season and boating opportunities during the off season are expected to be similar under both alternatives. The higher lake levels during the peak season are expected to result in a potentially beneficial impact on peak-season boating opportunities.

At Folsom Lake during the peak season, lake levels would be higher under Alternative 1 than they would be under the No-Action Alternative. Because these higher levels would create more usable surface area, boating would be constrained less frequently, the lake's single marina would remain open substantially longer, and shoreline recreation opportunities would be available longer under this alternative than under the No-Action Alternative. Higher peak-season lake levels at Folsom Lake would result in a potentially beneficial impact on boating and shoreline recreation opportunities.

At New Melones Reservoir during the peak season, lake levels would be lower under Alternative 1 than they would be under the No-Action Alternative. This would result in boat ramps being unusable more frequently, boating being constrained by limited surface area more frequently, and the lakes' marinas being forced to close for longer periods under this alternative than under the No-Action Alternative. Further, the surface elevation of the reservoir would more frequently be below the level at which beach use declines. The lower lake levels at New Melones Reservoir would result in a potential impact on boating and shoreline recreation opportunities.

Recreation use estimates for reservoirs in the Sacramento River and San Joaquin River regions are shown in Table IV-36. Under Alternative 1, annual use would decrease by approximately 2 percent at Shasta Lake and by 1 percent at New Melones Reservoir. Annual use would increase by approximately 2 percent at Folsom Lake and by less than 1 percent at Lake Oroville. Annual use at San Luis Reservoir and non-CVP and SWP reservoirs in the San Joaquin Valley Region would be the same as under the No-Action Alternative.

Rivers

Recreation opportunities occurring on the Sacramento, American, and Stanislaus rivers could change under Alternative 1 (Table IV-40). No changes are expected on other study area rivers.

On the upper reach of the Sacramento River, river flows are expected to be within the optimal flow range for all boating activities more frequently under Alternative 1 than under the No-Action Alternative. On the lower reach, recreation opportunities are less sensitive to changes in river flows. Under this alternative, flows on the lower reach would be similar to those under the No-Action Alternative and recreation opportunities would not be expected to change. Frequent optimal flow ranges on the upper reach of the Sacramento River would result in a beneficial impact on boating during the peak season.

On the American River, river flows are expected to be within the optimal range for all boating activities much more frequently under Alternative 1 than under the No-Action Alternative; however, they would also be below the minimum flows needed much more frequently, offsetting the benefit. Further, river flows would be below the optimal levels for swimming much more frequently under Alternative 1 than under the No-Action Alternative. The frequency with which river flows fall below optimal levels would result in an impact on swimming opportunities.

On the upper reach of the Stanislaus River, river flows and associated recreation opportunities would be nearly the same under Alternative 1 and the No-Action Alternative. On the lower reach, river flows would be above the minimum level for all boating activities much more frequently and within the optimal range more frequently under Alternative 1 than under the No-

Action Alternative. The higher flows would result in a beneficial impact on boating opportunities.

Annual use at rivers in the San Joaquin River Region is estimated to be nearly the same under Alternative 1 as under the No-Action Alternative.

Wildlife Refuges

At Sacramento River Region wildlife refuges, increased water deliveries under Alternative 1 would support an additional 3,300 acres of wetlands. The additional wetlands are expected to result in an increase in both consumptive and nonconsumptive recreation opportunities. Annual visitation under Alternative 1 is expected to be 24 percent higher than annual use estimated for the No-Action Alternative. Waterfowl hunting would increase by 32 percent; both fishing and wildlife observation would increase by 18 percent.

At San Joaquin River Region wildlife refuges, increased water deliveries under Alternative 1 would support an additional 25,700 acres of wetlands. The additional wetlands are expected to result in an increase in both consumptive and nonconsumptive recreation opportunities. Annual visitation under Alternative 1 is expected to be 28 percent higher than annual use estimated for the No-Action Alternative. Waterfowl hunting would increase by 50 percent, fishing by 11 percent, and wildlife observation by 10 percent.

Increased water deliveries to wildlife refuges in the Sacramento River and San Joaquin River regions are expected to result in a potential beneficial impact on consumptive and nonconsumptive recreation opportunities.

ALTERNATIVE 2

This section describes changes in recreation opportunities and use at reservoirs, rivers, and wildlife refuges in the Sacramento River, San Joaquin River, and Tulare Lake regions under Alternative 2. At some of these sites, recreation opportunities would be the same or nearly the same under Alternative 2 and the No-Action Alternative. These sites are indicated in Table IV-39 and are not included as part of the following alternatives analysis. No impacts on recreation opportunities are expected at the indicated sites. A detailed discussion of recreation opportunities occurring at these sites under Alternative 2 is included in the Recreation Technical Appendix.

Reservoirs

Recreation opportunities at Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir could be affected under Alternative 2 (Table IV-40).

At Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir, changes in peak-season and off-season reservoir surface elevations under Alternative 2 would be the same as those described under Alternative 1. Changes in surface elevations are expected to result in potential:

- impacts on off-season boating opportunities at Shasta Lake,

- beneficial impacts on peak-season boating opportunities at Lake Oroville,

- beneficial impacts on boating and shoreline recreation opportunities at Folsom Lake, and

- impacts on boating and shoreline recreation opportunities at New Melones Reservoir.

Annual use under Alternative 2 would decrease by approximately 1 percent at Shasta Lake and New Melones Reservoir (Table IV-36). Annual use would increase by approximately 2 percent at Folsom Lake and by less than 1 percent at Lake Oroville, and decrease by less than 1 percent at non-CVP and SWP reservoirs in the San Joaquin River Region. Annual use at San Luis Reservoir would be the same under Alternative 2 and the No-Action Alternative.

Rivers

Recreation opportunities occurring on the Sacramento, American, Stanislaus, and other non-CVP and SWP rivers in the San Joaquin River Region could be affected under Alternative 2 (Table IV-40).

On the Sacramento and American rivers, changes in flows under Alternative 2 would be nearly the same as those described under Alternative 1. These changes in flows are expected to result in:

- potential beneficial impacts on boating opportunities occurring on the upper reach of the Sacramento River and

- potential impacts on swimming opportunities occurring on the American River.

On the upper reach of the Stanislaus River, river flows and associated recreation opportunities would be nearly the same under Alternative 2 as under the No-Action Alternative. On the lower reach, flows would be above the minimum level for all boating activities much more frequently and within the optimal range for all boating activities more frequently under this alternative than under the No-Action Alternative. The higher flows would result in a beneficial impact on boating opportunities under Alternative 2 compared to those under the No-Action Alternative.

For non-CVP and SWP rivers in the San Joaquin River Region, flows on the Tuolumne and Merced rivers would be above the flows necessary for boating activities and within the optimal range for swimming much more frequently under Alternative 2 than under the No-Action Alternative. Flows in other San Joaquin River Region rivers are expected to be the same or nearly the same under this alternative as under the No-Action Alternative. Increased flows in the Tuolumne and Merced rivers would result in a potential beneficial impact on boating and swimming opportunities.

Under Alternative 2, annual use at rivers in the San Joaquin River Region is estimated to increase by less than 1 percent.

Wildlife Refuges

At Sacramento River Region wildlife refuges, increased water deliveries under Alternative 2 would support 5,100 more acres of wetlands than under the No-Action Alternative. The additional wetlands are expected to result in an increase in consumptive and nonconsumptive recreation opportunities. Annual visitation under Alternative 2 is estimated to be 63 percent higher than annual use estimated for the No-Action Alternative. Waterfowl hunting would increase by 91 percent, fishing by 40 percent, and wildlife observation by 39 percent.

At San Joaquin River Region wildlife refuges, increased water deliveries under Alternative 2 would support an additional 25,700 acres of wetlands. The additional wetlands are expected to result in an increase in consumptive and nonconsumptive recreation opportunities. Annual visitation under Alternative 2 is estimated to be 65 percent higher than annual use estimated for the No-Action Alternative. Waterfowl hunting would increase by 116 percent, fishing by 28 percent, and wildlife observation by 26 percent.

At Tulare Lake Region wildlife refuges, increased water deliveries under Alternative 2 would support an additional 12,400 acres of wetlands. The additional wetlands are expected to result in an increase in consumptive and nonconsumptive recreation opportunities. Annual visitation under Alternative 2 is estimated to be 150 percent higher than annual use estimated for the No-Action Alternative. Wildlife observation would increase by 149 percent and fishing would increase by 160 percent.

Increased water deliveries to wildlife refuges in the Sacramento River, San Joaquin River, and Tulare Lake regions are expected to result in a potential beneficial impact on consumptive and nonconsumptive recreation opportunities.

ALTERNATIVE 3

This section describes changes in recreation opportunities and use at reservoirs, rivers, and wildlife refuges in the Sacramento River, San Joaquin River, and Tulare Lake regions under Alternative 3. At some of these sites, recreation opportunities would be the same or nearly the same as those described under the No-Action Alternative. These sites are indicated in Table IV-39 and are not included as part of the following alternatives analysis. No impacts on recreation opportunities are expected at the indicated sites. A detailed discussion of recreation opportunities occurring at these sites under Alternatives 3 is included in the Recreation Technical Appendix.

Reservoirs

Recreation opportunities at Shasta Lake, Lake Oroville, Folsom Lake, San Luis Reservoir, New Melones Reservoir, and non-CVP and SWP reservoirs in the San Joaquin River Region could be affected under Alternative 3 (Table IV-40).

At Shasta Lake, Lake Oroville, Folsom Lake, and New Melones Reservoir, changes in peak-season and off-season reservoir surface elevations would be the same under Alternative 3 as those described under Alternative 1. Changes in surface elevations are expected to result in:

- potential impacts on off-season boating opportunities at Shasta Lake,
- potential beneficial impacts on peak-season boating opportunities at Lake Oroville,
- potential beneficial impacts on boating and shoreline recreation opportunities at Folsom Lake, and
- potential impacts on boating and shoreline recreation opportunities at New Melones Reservoir.

In addition, at San Luis Reservoir, lake levels would be lower under Alternative 3 than under the No-Action Alternative. This would limit surface area and constrain boating opportunities. Camping and picnicking activities are constrained when reservoir surface elevations fall below specific levels. The surface elevation of the reservoir would also more frequently be at or below these levels. The lower lake levels at San Luis Reservoir would result in a potential impact on boating and shoreline recreation opportunities.

Lower lake levels could result in changes in recreation opportunities at some non-CVP and SWP reservoirs in the San Joaquin River Region. Shoreline recreation activities are constrained when the surface elevation of lakes falls below specific levels. The surface elevation of New Don Pedro Reservoir and New Hogan Lake could fall below these levels more frequently under Alternative 3 than under the No-Action Alternative.

Annual use under Alternative 3 would decrease by 2 percent at New Melones Reservoir and by 1 percent at Shasta Lake (Table IV-36). Annual use would increase by approximately 2 percent at Folsom Lake and Lake Oroville, by approximately 1 percent at Shasta Lake, and by less than 1 percent at non-CVP and SWP reservoirs in the San Joaquin Valley Region. Annual use at San Luis Reservoir would be the same under both Alternative 3 and the No-Action Alternative.

Rivers

Recreation opportunities on the Sacramento, American, Stanislaus, and other non-CVP and SWP rivers in the San Joaquin River Region could be affected under Alternative 3 (Table IV-40).

On the Sacramento and American rivers and on non-CVP and SWP rivers in the San Joaquin River Region, changes in flows under Alternative 3 would be nearly the same as those described under Alternative 1. These changes in flows are expected to result in:

- potential beneficial impacts on boating opportunities on the upper reach of Sacramento River,
- potential impacts on swimming opportunities on the American River, and
- potential beneficial impacts on boating and swimming opportunities on the Tuolumne and Merced rivers.

On the lower reach of the Stanislaus River, flows under Alternative 3 would be above the minimum level for all boating activities much more frequently, but would be within the optimal range slightly less frequently than under the No-Action Alternative. On the upper reach of the Stanislaus River, flows under Alternative 3 would be within the optimal range for all boating activities much more frequently than under the No-Action Alternative. These higher flows would result in a beneficial impact on boating opportunities on the Stanislaus River under Alternative 3 compared to those under the No-Action Alternative.

Under Alternative 3, annual use at rivers in the San Joaquin River Region is estimated to increase by approximately 3 percent.

Wildlife Refuges

Changes in recreation opportunities and use of wildlife refuges in the Sacramento River, San Joaquin River, and Tulare Lake regions under Alternative 3 would be same as those described under Alternative 2. Water deliveries made to these refuges under Alternative 3 would result in a potential beneficial impact on consumptive and nonconsumptive recreation opportunities.

ALTERNATIVE 4

This section describes changes in recreation opportunities and use at reservoirs, rivers, and wildlife refuges in the Sacramento River, San Joaquin River, and Tulare Lake regions under Alternative 4. At some of these sites, recreation opportunities would be the same or nearly the same this alternative as those described under the No-Action Alternative. These sites are indicated in Table IV-39 and are not included as part of the following alternatives analysis. No impacts on recreation opportunities are expected at the indicated sites. A detailed discussion of recreation opportunities occurring at these sites under Alternative 4 is included in the Recreation Technical Appendix.

Reservoirs

Recreation opportunities at Shasta Lake, Lake Oroville, Folsom Lake, New Melones Reservoir, and non-CVP and SWP reservoirs in the San Joaquin River could be affected under Alternative 4 (Table IV-40).

At Shasta Lake, Lake Oroville, and Folsom Lake, changes in peak-season and off-season reservoir surface elevations under Alternative 4 would be the same as those described under Alternative 1. Changes in surface elevations are expected to result in:

- potential impacts on off-season boating opportunities at Shasta Lake,
- potential beneficial impacts on peak-season boating opportunities at Lake Oroville, and
- potential beneficial impacts on boating and shoreline recreation opportunities at Folsom Lake.

At New Melones Reservoir and at non-CVP and SWP reservoirs in the San Joaquin River Region, changes in peak-season reservoir surface elevations under Alternative 4 would be the same as those described under Alternative 3. Changes in reservoir surface elevations are expected to result in:

- ♦ potential impacts on boating and shoreline recreation opportunities at New Melones Reservoir and
- ♦ changes in shoreline recreation opportunities at New Don Pedro Reservoir and New Hogan Lake.

Annual use under Alternative 4 would decrease by approximately 2 percent at Shasta Lake and New Melones Reservoir and by 1 percent at San Luis Reservoir (Table IV-36). Annual use would increase by approximately 2 percent at Folsom Lake and by less than 1 percent at Lake Oroville and non-CVP and SWP reservoirs in the San Joaquin Valley Region.

Rivers

Recreation opportunities occurring on the Sacramento, American, and Stanislaus rivers, and at non-CVP and SWP rivers in the San Joaquin River Region could be affected under Alternative 4 (Table IV-40).

On the Sacramento and American rivers, changes in flows under Alternative 4 would be nearly the same as those described under Alternative 1. These changes in flows are expected to result in:

- ♦ potential beneficial impacts on boating opportunities occurring on the upper reach of the Sacramento River and
- ♦ potential impacts on swimming opportunities occurring on the American River.

On the Stanislaus and on non-CVP and SWP rivers in the San Joaquin River Region, changes in flows under Alternative 4 would be nearly the same as those described under Alternative 3. These changes in flows are expected to result in:

- ♦ potential beneficial impacts on boating opportunities on the Stanislaus River and
- ♦ potential beneficial changes in boating and swimming opportunities on the Tuolumne and Merced rivers.

Under Alternative 4, annual use at rivers in the San Joaquin River Region is estimated to increase by approximately 3 percent.

Wildlife Refuges

Changes in recreation opportunities and use of wildlife refuges in the Sacramento River, San Joaquin River, and Tulare Lake regions under Alternative 4 would be same as those described under Alternative 2. Water deliveries made to these refuges under Alternative 4 would result in a potential beneficial impact on consumptive and nonconsumptive recreation opportunities.

FISH, WILDLIFE, AND RECREATION ECONOMICS

The analysis of recreation economics focuses on changes in recreation related expenditures, recreation trip-related spending, and recreation benefits. The evaluation depends on predicted changes in recreation use, which would occur at reservoirs operated by the CVP, SWP, and other water agencies; rivers and streams; federal and state wildlife refuges; and private hunting clubs. Table IV-41 provides a summary of the assumptions used for the analysis.

TABLE IV-41

SUMMARY OF ASSUMPTIONS FOR FISH, WILDLIFE, AND RECREATION ECONOMICS

Assumptions Common to All Alternatives and Supplemental Analyses
For each Alternative or Supplemental Analysis, stream flow, reservoir levels, and refuge supplies are estimated in the corresponding analysis for Surface Water Supplies and Facilities Operations analyses. Existing relationships among recreational use, expenditure, and benefit are assumed to apply.

In this analysis, changes in recreation-related expenditures relate only to the expenditures of recreationists that are made within the region of interest. For estimating changes in recreation trip-related spending, spending profiles were developed and applied to changes in recreation use at each affected recreation area. This procedure resulted in estimates of spending by recreationists associated with predicted visitation at each site. Recreation benefits measure recreationists' additional willingness to pay for recreation. Because these benefits are not actual expenditures (and thus not tied to a geographic location), all of these benefits are reported.

Tables IV-42 and IV-43 summarize the direct economic impacts associated with changes in the fishery and recreational resources.

NO-ACTION ALTERNATIVE

Projected annual recreation trip-related spending levels at affected reservoirs and wildlife refuges in the Sacramento River Region under the No-Action Alternative are shown in Table IV-44. Projected spending includes recreation-related purchases made within the Sacramento River Region by residents of the region and by people visiting regional recreation areas who live in other regions. It excludes recreation-related purchases made outside the region by visitors in preparation for their trips or en route to regional recreation areas.

TABLE IV-42

SUMMARY OF IMPACT ASSESSMENT FOR ALTERNATIVES WITHOUT WATER TRANSFERS FISH, WILDLIFE, AND RECREATION ECONOMICS

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	$145 million per year in recreation-related expenditure at reservoirs and refuges in the Sacramento River Region, and about $85 million per year in the San Joaquin River and Tulare Lake Region combined. Additional, unquantified expenditure and benefits to river recreation in the Sacramento River Region, and to ocean recreation related to Central Valley anadromous fisheries.
	Changes Compared to the No-Action Alternative
1	Small increase in recreation-related expenditures (less than 3%) at reservoirs and rivers. About 25% increase in expenditure at refuges resulting from greater use. Additional, unquantified expenditure and benefit to fisheries and recreational use.
	Changes Compared to Alternative 1
1a	Conditions are similar to Alternative 1.
1b	Conditions are similar to Alternative 1.
1c	Potential reallocation of water for other uses could change quantity and timing of releases from reservoirs and flow in streams, with potential impacts on fisheries, recreational use, and benefits.
1d	Conditions are similar to Alternative 1.
1e	See summary of impacts of Alternatives with Water Transfers.
1f	See summary of impacts of Alternatives with Water Transfers.
1g	Conditions are similar to Alternative 1.
1h	Conditions are similar to Alternative 1.
1i	Conditions are similar to Alternative 1, but recreational expenditures and benefits associated with Lake Red Bluff would be substantially reduced. Some of this expenditure could shift to other uses or sites within the region. Fisheries may benefit.
	Changes Compared to the No-Action Alternative
2	Impacts in CVP streams and reservoirs are similar to Alternative 1. Estimated increases of 70% in expenditure and benefits to refuge wildlife recreation occur due to Level 4 water deliveries. The purchase of (b)(3) water for instream flow provides potential increases in benefits related to streamflow and fisheries.

TABLE IV-42. CONTINUED

	Changes Compared to Alternative 2
2a	Conditions are similar to Alternative 2.
2b	See summary of impacts for Alternatives with Water Transfers.
2c	See summary of impacts for Alternatives with Water Transfers.
2d	Changes are similar to those described under Supplemental Analysis 1c.
	Changes Compared to the No-Action Alternative
3	Impacts are similar to those described for Alternative 2. The purchase of additional (b)(3) water for instream flow provides potential increases in benefits related to streamflow and fisheries.
	Changes Compared to Alternative 3
3a	See summary of impacts for Alternatives with Water Transfers.
	Changes Compared to the No-Action Alternative
4	Impacts are similar to those described for Alternative 3.
	Changes Compared to Alternative 4
4a	See summary of impacts for Alternatives with Water Transfers.

TABLE IV-43

SUMMARY OF IMPACT ASSESSMENT FOR ALTERNATIVES WITH WATER TRANSFERS FISH, WILDLIFE, AND RECREATION ECONOMICS

Alternative or Supplemental Analysis	Impact Assessment
Base Transfer Scenario	Impacts of water transfers on fish, wildlife, and recreation benefits depends on the timing and location of flows affected by water transfers. Negative impacts could occur if flow is reduced in a stream during a period of high recreational use. These would be offset to some extent by increased flows during other periods. Overall impact is uncertain.
	Changes Compared to the Base Transfer Scenario
1e	Potential impacts are similar to those described under the Base Transfer Scenario.
1f	Potential impacts are similar to those described under the Base Transfer Scenario.
2b	Potential impacts are similar to those described under the Base Transfer Scenario.
2c	Potential impacts are similar to those described under the Base Transfer Scenario.
3a	Potential impacts are similar to those described under the Base Transfer Scenario.
4a	Potential impacts are similar to those described under the Base Transfer Scenario.

TABLE IV-44

RECREATION TRIP-RELATED EXPENDITURES AT KEY RECREATION AREAS IN THE SACRAMENTO RIVER REGION

		Changes Compared to No-Action Alternative			
Recreation Area	No-Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Lakes					
Shasta	101,821	0*	0*	0*	0*
Oroville	19,492	0*	0*	0*	0*
Folsom	19,727	0*	0*	0*	0*
Subtotal	141,040	0*	0*	0*	0*
Wildlife Refuges	3,434	848	2,206	2,206	2,206
Total	144,474	848	2,206	2,206	2,206

NOTES:
All values are expressed in thousands of 1992 dollars.

The term “0*” denotes a change of less than 3 percent compared to the value associated with the No-Action Alternative. These changes are considered within the margin of error of the models and consequently are treated as zeros.

Total spending associated with use of affected reservoirs in the Sacramento River Region in 2020 under the No-Action Alternative is projected to be approximately $141 million. Shasta Lake is the predominant recreation area in the Sacramento River Region, accounting for 72 percent of the total spending associated with use of regional reservoirs. Folsom Lake and Lake Oroville are the second and third leading areas in the region, each accounting for about 14 percent of spending at affected regional reservoirs.

Recreation use of Sacramento River Region wildlife refuges would result in annual expenditures of approximately $3.4 million.

Economic activity associated with affected rivers in the Sacramento River Region is not shown because recreation uses of these rivers would not be substantially affected by the estimated flow changes in the alternatives.

Table IV-45 shows levels of recreation-related spending only by visitors at affected facilities in each affected study area region. Visitors are defined as users of recreation areas who reside outside the region in which the area is located. Under the No-Action Alternative, recreation-related spending by visitors to the Sacramento River Region is estimated at approximately $54 million.

TABLE IV-45

REGIONAL RECREATION-RELATED EXPENDITURES OF VISITORS BY ALTERNATIVE

Region	No-Action Alternative	Changes Compared to No-Action Alternative			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Sacramento River	54,238	312	838	838	838
San Joaquin River	22,909	294	688	1,050	1,050
Tulare Lake	34	0	52	52	52

NOTES:
All values are expressed in thousands of 1992 dollars.
Visitors are defined as users of recreation areas who reside outside the region in which the recreation area is located.

The benefits of recreation activity at affected reservoirs, lakes, and wildlife refuges in the Sacramento River Region are estimated to average approximately $211 million annually under the No-Action Alternative, as shown in Table IV-46. Seventy-three percent of this value is associated with recreation activity at Shasta Lake.

TABLE IV-46

RECREATION BENEFITS AT KEY RECREATION AREAS IN THE SACRAMENTO RIVER REGION

Recreation Area	No-Action Alternative	Changes Compared to No-Action Alternative			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Lakes					
Shasta	154,472	0*	0*	0*	0*
Oroville	17,981	0*	0*	0*	0*
Folsom	36,667	0*	0*	0*	0*
Subtotal	209,120	0	0	0	0
Wildlife Refuges	2,092	527	1,386	1,386	1,386
Total	211,212	527	1,386	1,386	1,386

NOTES:
All values are expressed in thousands of 1992 dollars.

The term “0*” denotes a change of less than 3 percent compared to the value associated with the No-Action Alternative. These changes are considered within the margin of error of the models and consequently are treated as zeros.

Under the No-Action Alternative, total spending associated with use of recreation areas in the San Joaquin River Region is projected to be approximately $84 million, as shown in Table IV-47. Reservoir activities account for 65 percent of the total regional recreation spending. Recreation use at rivers and wildlife refuges accounts for about 35 percent of the total spending.

The benefits of recreation activity at affected reservoirs and lakes in the San Joaquin River Region are estimated to average approximately $33 million annually under the No-Action Alternative, as shown in Table IV-48. Total recreation benefits at affected facilities in the San Joaquin River Region are estimated to average approximately $56 million annually, with affected reservoirs accounting for about 59 percent of this value.

Study area recreation sites in the Tulare Lake Region include Kern and Pixley National Wildlife Refuges (NWRs). Total recreation-related expenditures associated with use of these refuges are projected to be $77,000 under the No-Action Alternative. Recreation benefits associated with use of these refuges are estimated to be about $79,000.

TABLE IV-47

ANNUAL RECREATION TRIP-RELATED EXPENDITURES AT KEY RECREATION AREAS IN THE SAN JOAQUIN RIVER REGION

Recreation Area	No-Action Alternative	Changes Compared to the No-Action Alternative			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Reservoirs and Lakes					
San Luis	4,142	0*	0*	0*	0*
Millerton	10,454	0*	0*	0*	0*
New Melones	12,306	0*	0*	0*	0*
Non-CVP reservoirs (1)	28,254	0*	0*	0*	0*
Subtotal	**55,156**	**0**	**0**	**0**	**0**
Rivers (2)					
San Joaquin	11,712	0*	0*	0*	0*
Stanislaus	6,646	0*	0*	447	447
Non-CVP rivers (3)	9,089	0*	0*	379	379
Subtotal	**27,447**	**0**	**0**	**826**	**826**
Wildlife Refuges	1,891	662	1,547	1,547	1,547
Total	**84,494**	**662**	**1,547**	**2,373**	**2,373**

NOTES:
All values are expressed in thousands of 1992 dollars.

The term "0*" denotes a change of less than 3 percent compared to the value associated with the No-Action Alternative. These changes are considered within the margin of error of the models and consequently are treated as zeros.

Because of model limitations, wildlife refuge values should be interpreted as indicators of potential changes.

(1) Includes Lake McClure, New Don Pedro Reservoir, New Hogan Lake, and Camanche Reservoir.

(2) Includes fishing, boating, swimming, and wildlife viewing activities only.

(3) Includes the Merced and Tuolumne rivers.

TABLE IV-48

RECREATION BENEFITS AT KEY RECREATION AREAS IN THE SAN JOAQUIN RIVER REGION

		Changes Compared to No-Action Alternative			
Recreation Area	**No-Action Alternative**	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Reservoirs and Lakes					
San Luis	1,768	0*	0*	0*	0*
Millerton	6,361	0*	0*	0*	0*
New Melones	7,676	0*	0*	0*	0*
Non-CVP reservoirs (1)	17,274	0*	0*	0*	0*
Subtotal	33,079	0	0	0	0
Rivers (2)					
San Joaquin	9,362	0*	0*	0*	0*
Stanislaus	5,100	0*	0*	337	337
Non-CVP rivers (3)	7,009	0*	0*	288	288
Subtotal	21,471	0	0	625	625
Wildlife Refuges	1,507	463	1,091	1,091	1,091
Total	56,057	463	1,091	1,716	1,716

NOTES:

All values are expressed in thousands of 1992 dollars.

The term "0*" denotes a change of less than 3 percent compared to the value associated with the No-Action Alternative. These changes are considered within the margin of error of the models and consequently are treated as zeros.

(1) Includes Lake McClure, New Don Pedro Reservoir, New Hogan Lake, and Camanche Reservoir.

(2) Includes fishing, boating, swimming, and wildlife viewing activities only.

(3) Includes the Merced and Tuolumne rivers.

ALTERNATIVE 1

Under Alternative 1, annual spending associated with use of Sacramento River Region reservoirs and lakes would not change relative to the No-Action Alternative. Spending associated with use of Sacramento River Region wildlife refuges would increase by $848,000. Total recreation-related spending by visitors to the region is projected to increase by $312,000 under Alternative 1.

The annual benefits of recreation activity at affected reservoirs and lakes in the Sacramento River Region are not expected to change under Alternative 1 compared to the No-Action Alternative.

Spending on recreation activity at state and federal wildlife refuges in the Sacramento River Region are estimated to increase by approximately $848,000 per year under Alternative 1, or about 25 percent compared to the No-Action Alternative. Associated benefits would increase about $527,000 per year.

Under Alternative 1, spending associated with use of reservoirs in the San Joaquin River Region would not be expected to change. Spending associated with regional wildlife refuge use would increase by $662,000. Spending associated with use at affected rivers in the San Joaquin River Region would not change appreciably relative to the No-Action Alternative. Benefits associated with use at regional wildlife refuges would increase by $463,000.

No change in spending and recreation benefits associated with use of Tulare Lake Region wildlife refuges is projected under Alternative 1.

Benefits associated with sport and commercial fishing in the San Francisco Bay and Pacific Coast Regions could increase as a result of improvements in habitat conditions. Due to uncertainties in the degree of improvement, these changes have not been quantified.

Recreation-related spending and benefits associated with waterfowl hunting on private lands, in all regions, are expected to be unchanged compared to the No-Action Alternative.

ALTERNATIVE 2

Under Alternative 2, recreation-related spending and benefits associated with use of Sacramento River Region reservoirs and lakes would not change. Spending associated with use at wildlife refuges would increase by $2.2 million. The benefits of recreation activity at state and federal wildlife refuges in the Sacramento River Region are estimated to increase by approximately $1.4 million under Alternative 2, or about 66 percent compared to the No-Action Alternative.

Under Alternative 2, recreation-related spending and benefits associated with use at affected reservoirs and rivers in the San Joaquin River Region would not be expected to change. Recreation-related spending would increase by approximately $1.5 million for the region's wildlife refuges. The benefits of recreation activity at state and federal wildlife refuges in the San Joaquin River Region are estimated to increase by approximately $1.1 million under Alternative 2, or about 72 percent compared to the No-Action Alternative.

Spending associated with use of the Tulare Lake Region's wildlife refuges would increase by $116,000 under Alternative 2. Recreation benefits are estimated to increase by $119,000. Total recreation-related spending by visitors to the region is projected to increase by $52,000 under Alternative 2.

Benefits associated with sport and commercial fishing in the San Francisco Bay and Pacific Coast Regions could increase as a result of improvements in habitat conditions. Due to uncertainties in the degree of improvement, these changes have not been quantified. Some additional improvement over Alternative 1 is possible due to (b)(3) water acquired for instream flow.

Recreation-related spending and benefits associated with waterfowl hunting on private lands, in all regions, are expected to be unchanged compared to the No-Action Alternative.

ALTERNATIVE 3

Under Alternative 3, spending and benefits associated with use of Sacramento River Region reservoirs would not change. Spending and benefits associated with use of regional wildlife refuges is projected to be similar to those described under Alternative 2.

Spending at affected reservoirs in the San Joaquin Region would not change compared to the No-Action Alternative. Spending related to recreation use at the Merced, Tuolumne, and Stanislaus rivers would increase by $826,000. The largest spending impact in the San Joaquin River Region under this alternative would consist of a $1.5 million increase for the wildlife refuges.

The annual benefits of recreation activity at affected reservoirs and lakes in the San Joaquin River Region are not expected to change compared to the No-Action Alternative. The annual benefits of recreation activity at affected rivers in the San Joaquin River Region are estimated to increase by approximately $625,000 under Alternative 3. This change represents a 5 percent increase in recreation benefits compared to the No-Action Alternative. The benefits of recreation activity at state and federal wildlife refuges in the San Joaquin River Region are estimated to increase by approximately $1.1 million under Alternative 3, or by about 72 percent compared to the No-Action Alternative. Annual recreation benefits at all affected recreation areas in the San Joaquin River Region are estimated to increase by $1.7 million.

Spending associated with use of Kern and Pixley NWRs would increase by $116,000. Recreation benefits are estimated to increase by $119,000.

Benefits associated with sport and commercial fishing in the San Francisco Bay and Pacific Coast Regions could increase as a result of improvements in habitat conditions. Due to uncertainties in the degree of improvement, these changes have not been quantified. Some additional improvement over Alternative 2 is possible due to increased (b)(3) water acquired for instream flow.

Spending and recreation benefits associated with waterfowl hunting opportunities on private lands, in all regions, are expected to be unchanged compared to the No-Action Alternative.

ALTERNATIVE 4

Impacts are similar to those described under Alternative 3. Some improvements in fishery habitat conditions beyond Alternative 3 are possible, and could provide additional benefits to recreational and commercial fishing, Due to uncertainties in the degree of improvement, these additional benefits have not been quantified.

REGIONAL ECONOMICS

The direct impacts considered in the regional economic analysis were agricultural production, recreation and municipal water costs. These direct impacts, estimated by the respective economic analysis tools, were input into the regional economics analysis as the change caused by each alternative as compared to the No-Action Alternative. Regional economic analysis was conducted for the average condition only. A summary of the assumptions associated with each of the alternatives is presented in Table IV-49.

TABLE IV-49

SUMMARY OF ASSUMPTIONS FOR REGIONAL ECONOMICS

Assumptions Common to All Alternatives and Supplemental Analyses
For purposes of impact assessment, the structure of the regional economy in the year 2020 is assumed to be similar to Recent Conditions. For each Alternative or Supplemental Analysis: changes in agricultural production, costs, and revenues are derived from the Agricultural Economics and Land Use analysis; changes in recreation use and expenditures are estimated in the Fish, Wildlife, and Recreation Economics analysis; changes in water costs to retail customers of municipal water providers are estimated in the Municipal Water Cost analysis.

Direct economic impacts of the alternatives have been measured for activities occurring throughout California, but the incidence of the direct impacts depends on the location of the affected industries and economies. To better reflect these locational differences, multi-county regions were identified for which boundaries were be determined in part by the expected location of direct economic impacts. Figure IV-51 shows the regional economic impacts regions.

Direct impacts, aside from employment, were expressed in dollar terms for all impacted sectors, and used in an input-output model to estimate total (including secondary) impacts to the regional economy. Direct agricultural impacts were measured as changes in gross and net revenues. Direct recreation-related impacts of the alternatives were estimated as changes in expenditures by recreation users, based on estimated changes in visitor days. Direct impacts to the municipal and industrial users were measured as changes in the cost of water. Summaries of the impact assessments for the alternatives, with and without water transfers are presented in Tables IV-50 and 51.

FIGURE IV-51

REGIONAL ECONOMICS STUDY AREA

TABLE IV-50

SUMMARY OF IMPACT ASSESSMENT FOR ALTERNATIVES WITH WATER TRANSFERS REGIONAL ECONOMICS

Alternative or Supplemental Analysis	Impact Assessment
Base Transfer Scenario	Impacts on the local economy of areas selling water would be similar in direction to those resulting from (b)(3) water acquisition: land fallowed to provide water for transfer would result in losses of jobs and income, offset by a (usually) smaller increase in economic activity generated by spending revenue received for selling water. Regions buying water generally have positive impacts. Water bought can support economic activity at a lower cost than developing or using more expensive alternative supplies.
	Changes Compared to the Base Transfer Scenario
1e	Conditions are similar to those described under the Base Transfer Scenario.
1f	Conditions are similar to those described under the Base Transfer Scenario.
2b	Conditions are similar to those described under the Base Transfer Scenario.
2c	Conditions are similar to those described under the Base Transfer Scenario.
3a	Conditions are similar to those described under the Base Transfer Scenario.
4a	Conditions are similar to those described under the Base Transfer Scenario.

NO-ACTION ALTERNATIVE

For purposes of impact analysis, the structure of the regional economy in the No-Action Alternative is assumed to be similar to recent economic conditions as described in Chapter III. This assumption avoids speculation about how regional economies may change in the future, and allows an input-output model based on recent conditions to be used to assess alternatives. The PEIS regional economic analysis uses the 1991 IMPLAN database, as described in Chapter III, as a baseline condition for purposes of comparison. It is implicitly assumed that the structure of the California economy and the technical relationships and production processes incorporated into the input-output models will be valid at a 2020 level of development. Given this assumption, any overall growth (or decline) in the regional economy between now and 2020 would not affect the estimates of output, income, or employment changes.

TABLE IV-51

SUMMARY OF IMPACT ASSESSMENT FOR ALTERNATIVES WITHOUT WATER TRANSFERS REGIONAL ECONOMICS

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	1991 economic data provided as basis for comparison.
	Changes Compared to the No-Action Alternative
1	Annual statewide loss of $183 million output, $80 million personal income, and 2,790 jobs. Adverse impacts concentrated in the CVP water service areas, with some benefits to South Coast Region. Adverse impacts are partially offset by additional economic activity during the period of construction of restoration actions.
	Changes Compared to Alternative 1
1a	Conditions are similar to Alternative 1, with some additional negative impacts in CVP water service areas due to higher cost of pumping groundwater.
1b	Conditions are similar to Alternative 1.
1c	Large additional losses of jobs and income in the Sacramento River Region due to land out of production. Additional losses in San Joaquin River Region due to higher cost of pumping groundwater.
1d	Conditions are similar to Alternative 1, with small additional negative impacts in CVP water service areas due to higher cost of pumping groundwater.
1e	See summary of impacts of Alternatives with Water Transfers.
1f	See summary of impacts of Alternatives with Water Transfers.
1g	Conditions are similar to Alternative 1, with some additional negative impacts in Sacramento River Region CVP water service areas due to higher cost of pumping groundwater.
1h	Conditions are similar to Alternative 1.
1i	Conditions are similar to Alternative 1.
	Changes Compared to the No-Action Alternative
2	Annual statewide loss of $241 million output, $100 million personal income, and 3,550 jobs. Adverse impacts concentrated in the CVP water service areas, and some benefits to South Coast Region. Impacts from land fallowing due to (b)(3) water acquisition are somewhat offset by revenue from water sold. Adverse impacts are partially offset by additional economic activity during the period of construction of restoration actions.

TABLE IV-51. CONTINUED

	Changes Compared to Alternative 2
2a	Conditions are similar to Alternative 2.
2b	See summary of impacts for Alternatives with Water Transfers.
2c	See summary of impacts for Alternatives with Water Transfers.
2d	Changes are similar to those described under Supplemental Analysis 1c.
	Changes Compared to the No-Action Alternative
3	Annual statewide loss of $143 million output, $26 million personal income, and 2,060 jobs. Adverse impacts in CVP water service areas, and large benefits to South Coast Region. Impacts from land fallowing due to (b)(3) water acquisition are somewhat offset by revenue from water sold. Adverse impacts are partially offset by additional economic activity during the period of construction of restoration actions.
	Changes Compared to Alternative 3
3a	See summary of impacts for Alternatives with Water Transfers.
	Changes Compared to the No-Action Alternative
4	Annual loss of $457 million output, $194 million personal income, and 6,540 jobs. Adverse impacts concentrated in CVP water service areas. Impacts from land fallowing due to (b)(3) water acquisition are somewhat offset by revenue from water sold. Adverse impacts are partially offset by additional economic activity during the period of construction of restoration actions.
	Changes Compared to Alternative 4
4a	See summary of impacts for Alternatives with Water Transfers.

ALTERNATIVE 1

Table IV-52 shows the overall change in employment, output, and place-of-work income for Alternative 1. Alternative 1 would result in the loss of about 2,790 jobs, $183 million in output, and $80 million in place-of-work income statewide. Most of the adverse effect occurs in the San Joaquin River Region, with some offsetting economic stimulus in the Central and South Coast. Results by economic sector are provided in the Regional Economics Technical Appendix. The largest total impacts (sum of direct, indirect, and induced) in California occur in the agricultural sector because of both land fallowing and higher water costs. The next largest impacts would be in the trade sector because of reduced spending by farmers for production inputs and for household items; lower recreational spending; and lower spending on non-water items by all households that must pay higher water costs.

TABLE IV-52

TOTAL REGIONAL ECONOMIC IMPACTS CHANGES RELATIVE TO THE NO-ACTION ALTERNATIVE

	Alternatives			
	1	2	3	4
Region	Absolute Change Relative to No-Action			
Sacramento River				
Employment (#)	-260.0	-560.0	-1,310.0	-1,310.0
Output ($MM)	-19.6	-46.3	-111.8	-110.8
Income ($MM)	-9.8	-20.5	-46.7	-46.3
San Joaquin River				
Employment (#)	-2,450.0	-2,999.0	-2,960.0	-3,860.0
Output ($MM)	-166.3	-201.9	-197.7	-257.0
Income ($MM)	-77.5	-89.7	-79.0	-105.4
Tulare Lake				
Employment (#)	-940.0	-870.0	-800.0	-1,100.0
Output ($MM)	-59.6	-55.3	-51.1	-69.4
Income ($MM)	-27.0	-25.0	-22.7	-31.4
Bay Area				
Employment (#)	-100.0	-100.0	-90.0	-100.0
Output ($MM)	-7.4	-7.4	-7.0	-7.4
Income ($MM)	-4.2	-4.2	-4.0	-4.2
South & Central Coast				
Employment (#)	960.0	960.0	3,110.0	-180.0
Output ($MM)	69.6	69.6	225.0	-12.7
Income ($MM)	38.9	38.9	125.9	-7.1
California Total				
Employment (#)	-2,790.0	-3,550.0	-2,060.0	-6,540.0
Output ($MM)	-183.4	-241.3	-142.7	-457.2
Income ($MM)	-79.6	-100.5	-26.5	-194.5

Sacramento River Region

Total direct, indirect, and induced impacts of Alternative 1 include losses of about 260 jobs, $19.6 million in output, and $9.8 million in place-of-work income. The greatest total regional effects on employment, output, and income would be attributable to the direct impacts on agriculture. Alternative 1 results in reduced personal income because of higher water costs, due primarily to the installation of household water meters and Restoration Fund payments.

The largest employment, output, and income impacts would be in services. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Reduced recreation expenditures and higher M&I water costs affect the trade and service sectors as well.

San Joaquin River Region

Total direct, indirect, and induced impacts include losses of about 2,450 jobs, $166.3 million in output, and $77.5 million in place-of-work income compared to the No-Action Alternative. The largest employment impacts would be in agriculture, trade, and services. The largest output impacts would be in agriculture, manufacturing, and finance, insurance, and real estate (FIRE). The largest income impacts would be in FIRE, trade, and services. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the manufacturing, FIRE, and trade and services sectors. Reduced recreation expenditures and higher M&I water costs affect the trade and service sectors as well.

Tulare Lake Region

Total direct regional impacts due to Alternative 1 changes in agriculture include direct losses of about 430 jobs, $30.3 million in output, and $11.3 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 940 jobs, $59.6 million in output, and $27.0 million in place-of-work income.

The largest employment impacts would be in agriculture, trade, and services. The largest output impacts would be in agriculture, trade, and manufacturing. The largest income impacts would be in trade, agriculture, and FIRE. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts would be attributable primarily to those originating in agriculture.

San Francisco Bay Region

Alternative 1 directly results in reduced personal income of $3.8 million per year in the San Francisco Bay Region because of higher water costs, due primarily to restoration payments. The resultant declines in consumer spending cause direct losses of about 40 jobs, $3.5 million in output, and $1.9 million in place-of-work income. Total impacts include losses of about 100 jobs, $7.4 million in output, and $4.2 million in place-of-work income.

Central and South Coast Region

Alternative 1 directly results in increased direct personal income of $32.8 million per year in the Central and South Coast Region because of reduced water costs resulting from greater deliveries of SWP water for M&I purposes. The resultant increases in consumer spending cause direct gains of about 410 jobs, $30.6 million in output, and $16.3 million in place-of-work income. Total impacts include gains of about 960 jobs, $69.6 million in output, and $38.9 million in income.

Total Impacts

Total direct impacts across all affected regions in California include losses of about 1,130 jobs, $92.9 million in output, and $31.0 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 2,790 jobs, $183.4 million in output, and $79.6 million in place-of-work income. Total regional job losses due to agricultural impacts include about 2,190 due to fallowed land and 1,280 due to reduced net income. Those losses would be offset in part by the positive effects of increased M&I water deliveries and resultant job gains in the South Coast Region.

ALTERNATIVE 2

Table IV-52 shows the overall change in employment, output, and place-of-work income for Alternative 2. Results by sector are provided in the Regional Economics technical Appendix.

Sacramento River Region

Total direct impacts of Alternative 2 include losses of about 110 jobs, $18.9 million in output, and $5.5 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 560 jobs, $46.3 million in output, and $20.5 million in place-of-work income. The greatest total regional effects on employment, output, and income would be attributable to the direct impacts on agriculture.

The largest employment impacts would be in agriculture. The largest output impacts would be in manufacturing. The largest income impacts would be in services and FIRE. Reduced rice output and lower net farm income cause reduced output by the rice milling sector and lower demands for production inputs. Reduced recreation expenditures and higher M&I water costs also affect the trade and services sectors.

San Joaquin River Region

Total direct impacts of Alternative 2 include losses of about 1,330 jobs, $94.3 million in output, and $30.9 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 2,990 jobs, $201.9 million in output, and $89.7 million in place-of-work income. The largest employment impacts would be in agriculture, trade, and services. The largest output impacts would be in agriculture, manufacturing, and FIRE. The largest income impacts would be in FIRE, agriculture, and services.

Tulare Lake Region

Total direct impacts of Alternative 2 on the Tulare Lake Region include direct losses of about 390 jobs, $28.0 million in output, and $10.4 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 870 jobs, $55.3 million in output, and $25.0 million in place-of-work income.

The largest employment impacts would be in agriculture, trade, and services. The largest output impacts would be in agriculture, trade, and manufacturing. The largest income impacts would be in trade, agriculture, and FIRE. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts would be attributable primarily to those originating in agriculture.

San Francisco Bay Region

The impacts would be the same as those for Alternative 1.

Central And South Coast Region

The impacts would be the same as those for Alternative 1.

Total Impacts

The total direct impacts of Alternative 2 across all affected regions in California include losses of about 1,270 jobs, $114.2 million in output, and $32.4 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 3,550 jobs, $241.3 million in output, and $100.5 million in place-of-work income.

ALTERNATIVE 3

Table IV-52 shows the overall change in employment, output, and place-of-work income for Alternative 3. Results by affected economic sector are provided in the Regional Economics Technical Appendix.

Sacramento River Region

Total direct impacts of Alternative 3 include losses of about 170 jobs, $43.0 million in output, and $9.4 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 1,310 jobs, $111.8 million in output, and $46.7 million in place-of-work income.

The largest employment and output impacts would be in agriculture. The largest income impacts would be in FIRE. Reduced rice output and lower net farm income cause reduced output by the rice milling sector and lower demands for production inputs. Reduced recreation expenditures and higher M&I water costs also affect the trade and services sectors.

San Joaquin River Region

Total direct impacts of Alternative 3 include losses of about 290 jobs, $83.6 million in output, and $17.6 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 2,960 jobs, $197.7 million in output, and $79.0 million in place-of-work income.

The largest employment impacts would be in agriculture, services, and trade. The largest output impacts would be a decrease in agriculture, manufacturing, and FIRE. The largest income impacts would be in FIRE, services, and agriculture.

Tulare Lake Region

Total direct impacts of Alternative 3 on the Tulare Lake Region include direct losses of about 350 jobs, $25.6 million in output, and $9.1 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 800 jobs, $51.1 million in output, and $24.7 million in place-of-work income.

The largest employment and output impacts would be in agriculture. The largest income impacts would be in agriculture and trade. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts would be attributable primarily to those originating in agriculture.

San Francisco Bay Region

Alternative 3 results in reduced direct personal income of $3.6 million per year in the San Francisco Bay Region because of higher water costs. The resultant declines in consumer spending cause direct losses of about 40 jobs, $3.4 million in output, and $1.8 million in place-of-work income. Total impacts include losses of about 90 jobs, $7.0 million in output, and $4.0 million in place-of-work income.

Central and South Coast Region

Alternative 3 results in increased direct personal income of $105.9 million per year in the Central and South Coast Region because of reduced water costs resulting from greater deliveries of SWP water for M&I purposes. The resultant increases in consumer spending cause direct gains of about 1,330 jobs, $98.8 million in output, and $52.9 million in place-of-work income. Total impacts include gains of about 3,110 jobs, $225.0 million in output, and $125.9 million in place-of-work income.

Total Impacts

The total direct impacts of Alternative 3 across all affected regions in California include losses of about 240 jobs and $56.7 million in output, and a gain of $15.0 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 2,060 jobs, $142.7 million in output, and $26.5 million in place-of-work income.

The direct income impacts would be positive, while the total income impacts would be negative because of the relative magnitudes of the multipliers for fallowed land, increased water sales, and lower M&I water costs. The multiplier for fallowed land (reduced output) would be 3.6 for the specific combination of crop acres idled under this Alternative. The multiplier for income from reduced M&I water costs would be 2.4, and the multiplier for income from water sales would be 1.8. Therefore, every $1.00 in reduced income from fallowed land causes a $3.60 dollar decline in total regional income across all sectors. Every $1.00 reduction in M&I water costs is assumed to represent an equivalent increase in income, and causes a $2.40 increase in total regional income across all sectors, and every $1.00 in increased income from water sales causes a $1.80 increase in total regional income. As a result, while the direct negative impacts of fallowed land do not outweigh the direct positive impacts of water sales and reduced M&I water costs, the total negative impacts on income from fallowed land more than offset the total positive impacts from water sales and reduced M&I water costs.

ALTERNATIVE 4

Table IV-52 shows the overall change in employment, output, and place-of-work income for Alternative 4. Results by economic sector are provided in the Regional Economics Technical Appendix.

Sacramento River Region

Total direct impacts of Alternative 4 include losses of about 170 jobs, $42.6 million in output, and $9.4 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 1,310 jobs, $110.8 million in output, and $46.3 million in place-of-work income. The largest employment and output impacts would be in agriculture. The largest income impacts would be in FIRE.

San Joaquin River Region

Total direct impacts of Alternative 4 include losses of about 1,340 jobs, $111.0 million in output, and $26.6 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 3,860 jobs, $257.0 million in output, and $105.4 million in place-of-work income.

Tulare Lake Region

Total direct impacts of Alternative 4 on the Tulare Lake Region include direct losses of about 490 jobs, $35.0 million in output, and $13.0 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 1,100 jobs, $69.4 million in output, and $31.4 million in place-of-work income.

The largest employment and output impacts would be in agriculture. The largest income impacts would be in trade. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts would be attributable primarily to those originating in agriculture.

San Francisco Bay Region

Alternative 4 results in reduced direct personal income of $3.8 million per year in the San Francisco Bay Region because of higher water costs. The resultant declines in consumer spending cause direct losses of about 40 jobs, $3.5 million in output, and $1.9 million in place-of-work income. Total impacts include losses of about 100 jobs, $7.4 million in output, and $4.2 million in place-of-work income.

Central and South Coast Region

Alternative 4 results in reduced direct personal income of $6.0 million per year in the Central and South Coast Region because of higher water costs resulting from reduced deliveries of SWP water for M&I purposes. The resultant declines in consumer spending cause direct losses of about 70 jobs, $5.6 million in output, and $3.0 million in place-of-work income. Total impacts include losses of about 180 jobs, $12.7 million in output, and $7.1 million in place-of-work income.

Total Impacts

The total direct impacts on Alternative 4 across all affected regions in California include losses of about 2,130 jobs, $197.7 million in output, and $53.9 million in place-of-work income. Total direct, indirect, and induced impacts include losses of about 6,540 jobs, $457.2 million in output, and $194.5 million in place-of-work income.

ADDITIONAL IMPACTS DURING THE PERIOD OF CONSTRUCTION

The 2020 analysis of alternatives included the impact of restoration fund payments as reduced agricultural net income and increased M&I water costs. However, the analysis did not include all restoration fund expenditures as part of the impact assessment, because much of this is spent on construction activities that will be complete by 2020. The expenditure of restoration funds may offset some of the adverse regional effects of restoration fund payments. Estimated capital, operating and maintenance costs of CVPIA-mandated actions were developed and used to estimate construction-related regional economic impacts.

In the Sacramento Valley, total direct and indirect increases in employment, output and income caused by restoration fund expenditure would be 1,530 jobs, $101 million, and $30 million, respectively. Alternatives 1 and 2 would result in a net increase in employment, output and income in the Sacramento Valley during the period of construction. In Alternatives 3 and 4, employment would increase and output and income decrease by very small amounts relative to the size of the regional economy.

In the San Joaquin Valley, restoration fund expenditure would result in 690 jobs, $45 million in output, and $13 million of place-of-work income. These amounts are much smaller than the negative effects, so overall effects on employment, output and income remain negative.

In California as a whole, results are adjusted for the $15.0 million State contribution included in the $67.0 million total. The $15.0 million would have no net impact on the state economy because it would induce a reduction in final demand elsewhere in the State. Therefore, the statewide gain of 1,730 jobs, $113 million in output and $33 million in income is less than the sum of these impacts for the Sacramento Valley and San Joaquin Valley. Even with the restoration fund expenditure included, overall impacts of the Alternatives on the State economy remain negative.

MUNICIPAL AND INDUSTRIAL WATER USE AND COSTS

The implementation of CVPIA actions, as considered in the PEIS alternatives, could result in changes in municipal water costs due to changes in the availability of CVP and SWP water and, for CVP water service contractors, other costs induced by the CVPIA. The main alternatives considered in the PEIS do not include water transfers from or within the Central Valley as a means to obtain replacement water supplies for municipal and industrial (M&I) use. To evaluate the potential effects of water transfers on municipal water costs, supplemental analyses were conducted. Results of the supplemental analyses are expressed as the difference between the results with transfers and results without transfers. In this manner, the supplemental analysis shows the effect of water transfers on M&I water costs and use for one alternative. Assumptions associated with alternatives are summarized in Table IV-53.

The analysis includes ten groups of M&I providers aggregated into four regions: the Sacramento Valley, the San Joaquin Valley, the San Francisco Bay Area, and the Central and South Coast. The Central and South Coast region, which includes the Los Angeles and San Diego metropolitan areas, is approximately twice as large in terms of water demand as the other three regions combined. All of the regions, except the Central and South Coast, include M&I users that obtain some CVP contract supplies. All of the regions, except the Sacramento Valley, include M&I users that obtain some SWP supplies, which can also be affected by CVPIA alternatives. All regions obtain some M&I water supplies from other sources that are not expected to be affected by the implementation of CVPIA, and are therefore excluded from this analysis.

The estimated reductions or increases in M&I water costs are relatively small as compared to the entire M&I water economy of each region. However, some water providers within three of the four regions (all but the Central and South Coast) are entirely dependent on CVP contract supplies. Two relatively large CVP M&I contractors have been identified with the potential need to implement water meter retrofits under the CVPIA water measurement requirements. Customers of these water providers could experience relatively large cost increases as a result of implementation of CVPIA provisions. Results for alternatives with and without water transfers are summarized in Table IV-54 and IV-55.

TABLE IV-53

SUMMARY OF ASSUMPTIONS FOR MUNICIPAL WATER COSTS

Assumptions Common to All Alternatives and Supplemental Analyses	
For each Alternative or Analysis, CVP and SWP water deliveries are estimates from the corresponding Surface Water and Facilities Operations analysis. Urban water demand levels are similar to those presented in the California Department of Water Resources Bulletin 160-93 for year 2020 with level 1 conservation, except that additional conservation may be induced by increased price if supplies must be developed to balance demand and supply. Mandatory conservation in dry years considers demand hardening due to level 1 conservation, and providers develop supplies to eliminate any remaining shortage. In the long run, demand must equal supply and revenue must equal cost. In dry years, additional shortage eliminated with more conservation up to maximum, then additional supplies are developed.	
Alternative or Supplemental Analysis	**Assumptions Specific to the Alternative or Supplemental Analysis**
No-Action Alternative	Common assumptions only.
1	Restoration payments and conservation costs resulting from CVPIA are imposed and affect retail water price and demand.
1a	Assumptions are the same as Alternative 1.
1b	Assumptions are the same as Alternative 1.
1c	Assumptions are the same as Alternative 1, except that CVP water prices begin at the full cost rates for the first 80 percent of contract total, with delivery between 80 and 90 percent priced at 110 percent of full cost rates, and deliveries more than 90 percent priced at 120 percent of full cost rates.
1d	Assumptions are the same as Alternative 1.
1e	Same as Alternative 1 except water transfers are allowed to replace new developed supplies. Transfers of CVP water service and exchange contract water are allowed, subject to the charges and conditions specified in CVPIA. Water transfers to South Coast are limited to 100,000 AF in average years and 400,000 AF in dry years.
1f	Same assumptions as Supplemental Analysis 1e, except an additional $50 per acre-foot fee is charged to any CVP water transferred.
1g	Assumptions are the same as Alternative 1.
1h	Assumptions are the same as Alternative 1.
1i	Assumptions are the same as Alternative 1.
2	Assumptions are the same as Alternative 1.
2a	Assumptions are the same as Alternative 1.

TABLE IV-53. CONTINUED

Alternative or Supplemental Analysis	Assumptions Specific to the Alternative or Supplemental Analysis
2b	Assumptions are the same as Supplemental Analysis 1e.
2c	Assumptions are the same as Supplemental Analysis 1f.
2d	Assumptions are the same as Supplemental Analysis 1c.
3	Assumptions are the same as Alternative 1.
3a	Assumptions are the same as Supplemental Analysis 1e.
4	Assumptions are the same as Alternative 1.
4a	Assumptions are the same as Supplemental Analysis 1e.

TABLE IV-54

SUMMARY OF IMPACT ASSESSMENT FOR ALTERNATIVES WITHOUT WATER TRANSFERS MUNICIPAL WATER COSTS

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	Similar to DWR Bulletin 160-93, plus South Coast would develop supplies and increase price to meet 2020 average demand. All municipal water use regions would impose conservation and develop supplies in dry years.
	Changes Compared to the No-Action Alternative
1	CVP M&I water supplies are reduced, and restoration payments ($6.4 million on average) and conservation costs increase price and reduce water use. Most of the impact is on CVP contractors with no other supplies. Increased SWP supplies reduce water costs and retail price. Most benefit is in the Central and South Coast Region.
	Changes Compared to Alternative 1
1a	Conditions are similar to Alternative 1.
1b	Conditions are similar to Alternative 1.
1c	Conditions are similar to Alternative 1, except that M&I payments into the Restoration Fund are increased to $11.5 million annually.
1d	Conditions are similar to Alternative 1.
1e	See summary of impacts of Alternatives with Water Transfers.
1f	See summary of impacts of Alternatives with Water Transfers.
1g	Conditions are similar to Alternative 1.
1h	Conditions are similar to Alternative 1.
1i	Conditions are similar to Alternative 1.
	Changes Compared to the No-Action Alternative
2	Same as Alternative 1.
	Changes Compared to Alternative 2
2a	Conditions are similar to Alternative 1.
2b	See summary of impacts for Alternatives with Water Transfers.
2c	See summary of impacts for Alternatives with Water Transfers.
2d	Changes are similar to those described under Supplemental Analysis 1c.
	Changes Compared to the No-Action Alternative
3	Similar to Alternative 1, except SWP supplies increase.

TABLE IV-54. CONTINUED

	Changes Compared to Alternative 3
3a	See summary of impacts for Alternatives with Water Transfers.
	Changes Compared to the No-Action Alternative
4	Similar to Alternative 1, except SWP supplies are similar to No-Action Alternative. Some additional shortages are imposed on CVP Municipal users.
	Changes Compared to Alternative 4
4a	See summary of impacts for Alternatives with Water Transfers.

TABLE IV-55

SUMMARY OF IMPACT ASSESSMENT FOR ALTERNATIVES WITH WATER TRANSFERS MUNICIPAL WATER COSTS

Alternative or Supplemental Analysis	Impact Assessment
Base Transfer Scenario	M&I users in the Sacramento Valley and San Joaquin regions do not participate in water transfer markets. The San Francisco Bay Area purchases very little water in the average condition, but about 160,000 acre-feet are purchased in a dry year at a cost of $90 million delivered to retail users. In the Central and South Coast, 105,000 acre-feet are purchased in the average condition at a cost of $39 million delivered, and 363,000 acre-feet are purchased in the dry condition at a cost of $209 million delivered.
	Changes Compared to the Base Transfer Scenario
1e	In an average year, results are similar to the Base Transfer Scenario. The Central and South Coast purchases about the same amount of water, but $1 million is saved due to lower water transfer prices. In a dry year, the San Francisco Bay Area purchases about 180,000 acre-feet transfers worth roughly $30 million annually in net cost savings as compared to the base transfer analysis. The Central and South Coast Region purchases about the same as in the Base Transfer Scenario, but lower transfer prices are worth $37 million in cost savings.
1f	Quantities purchased would be similar to Supplemental Analysis 1e, but almost no CVP water would be purchased and costs would be higher due to the additional fee imposed on CVP water transferred.
2b	Changes are similar to those described under Supplemental Analysis 1e, except that average condition transfers to the Central and South Coast cost about $2 million more than in the Base Transfer Scenario. The San Francisco Bay Area purchases about 180,000 acre feet in the dry condition. These transfers are worth about $30 million annually as compared to the Base Transfer Scenario. In the Central and South Coast, dry year transfers are worth $28 million in cost savings in comparison to the Base Transfer Scenario.
2c	Changes are similar to those described under Supplemental Analysis 1f.
3a	Changes are similar to those described under Supplemental Analysis 1e, except that the San Francisco Bay Area purchases about 160,000 acre feet in the dry condition. These transfers are worth about $18 million annually as compared to the base transfer analysis. In the Central and South Coast, dry year transfers are worth $22 million in cost savings in comparison to the Base Transfer Scenario.
4a	Changes are similar to those described under Supplemental Analysis 1e, except that average condition transfers to the Central and South Coast cost about $2 million more than in the Base Transfer Scenario. The San Francisco Bay Area purchases about 190,000 acre-feet in the dry condition. These transfers are worth about $20 million annually as compared to the base transfer analysis. In the Central and South Coast, dry year transfers are worth $16 million in cost savings in comparison to the Base Transfer Scenario.

ALTERNATIVE 1

In the Sacramento Valley, M&I water supplies would be reduced by about 3,000 acre-feet on average and 1,500 acre-feet in the dry condition, as compared to the No-Action Alternative. Annual costs of M&I water, due to the imposition of CVPIA provisions, would be $4.9 million in the average condition and $2.8 million annually in the dry condition, as shown in Table IV-56. These increase in costs would result primarily from restoration payments and implementation of metering requirements.

TABLE IV-56
SUMMARY OF M&I WATER USE AND ECONOMICS ANALYSIS COMPARISON OF CVPIA PEIS ALTERNATIVES

		Change from the No-Action Alternative			
Result	**No-Action Alternative**	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Average Condition Supplies, 1,000 acre-feet (1)					
Sacramento Valley	933	-8	-8	-8	-8
Bay Area	1,025	-2	-2	-1	-2
San Joaquin Valley	708	-7	-7	-6	-8
Central and South Coast	5,797	20	20	64	-4
Average Condition Economic Costs, Million $ (2)					
Sacramento Valley		4.9	4.9	4.9	4.9
Bay Area		4.9	4.9	4.7	4.9
San Joaquin Valley		4.4	4.4	3.2	5.0
Central and South Coast		-32.9	-32.9	-105.6	6.1
Dry Condition Supplies, 1,000 acre-feet (3)					
Sacramento Valley	992	-1.5	-1.5	-1.5	-1.5
Bay Area	886	1.6	1.6	21.7	-7.5
San Joaquin Valley	663	3.9	3.9	12.9	-1.1
Central and South Coast	4,890	89.9	89.9	215.7	0.0
Annual Cost of Dry Condition, Million $ (4)					
Sacramento Valley	3.1	2.8	2.8	2.8	2.8
Bay Area	177.7	0.3	0.3	-19.3	9.5
San Joaquin Valley	8.8	4.9	4.9	4.5	5.1
Central and South Coast	823.1	-67.3	-67.3	-119.9	-8.0

Notes:
Water transfers not considered as replacement supplies in this comparison.
(1) After purchase or development of non-transfer replacement supplies to make supply equal demand.
(2) Total costs include replacement supplies, restoration payments and metering. A negative cost means a net gain is estimated.
(3) Before development of any replacement supplies. A positive means the Alternative provides more water supply than the No-Action Alternative. Dry condition results do not include supply changes from the average condition.
(4) The annual cost of shortage following the average condition.

The Bay Area receives M&I water from both CVP and SWP supplies. Under Alternative 1, average CVP contract supplies would decrease and SWP supplies would increase, for a net decrease of 6,000 acre-feet. Because most water users in the region are projected to have excess supplies in average years, this relatively small change in water supplies would have little economic effect. Annual costs to the San Francisco Bay Area M&I water supplies associated with restoration payments and net supply reductions to CVP contractors would total approximately $4.9 million in average conditions. These costs would be passed on to water customers in the form of higher retail water prices. Under dry conditions, M&I supplies to the Bay Area would increase slightly (1,600 acre-feet), due to the interaction between lower CVP and higher SWP supplies, and would partially offsets costs of restoration payments. Net annual dry condition costs are estimated at $0.3 million.

San Joaquin Valley providers also obtain both CVP and SWP supplies, and results also reflect a mixture of gains and losses. The region obtains about 1,000 acre-feet more supplies, on average, in Alternative 1. The costs of these supplies are similar to the costs of make-up supplies (groundwater), but CVP contractors would pay more in the form of metering and restoration payments. CVPIA costs amount to $4.4 million annually, and costs during the dry condition amount to $4.9 million annually.

Municipal water costs in the Central and South Coast region would be affected only through changes in SWP supplies. Hydrologic analysis, and operational assumptions which allow the SWP to export a share of increased Delta inflows, suggest that this region gains water supply in Alternative 1. Because this region is projected to be in a substantial average condition supply deficit by the year 2020, additional SWP supplies of 51,000 acre-feet would be valuable in terms of cost avoided. The result is an average annual benefit of $32.9 million. During dry conditions, larger supply increases (89,900 acre-feet) are obtained, and annual economic benefits amount to $67.3 million.

ALTERNATIVE 2

Estimates of municipal water costs are identical to those described under Alternative 1.

ALTERNATIVE 3

Results for the Sacramento Valley are nearly identical to results for Alternatives 1 and 2, so they are not repeated here.

The San Francisco Bay Area would obtain more water supplies (10,000 acre-feet) in the average condition relative to the No-Action Alternative, but the region is already estimated to be in a supply surplus. The region would pay a cost associated with restoration payments and supply reductions to CVP contractors amounting to $4.7 million per year in the average condition. The region would obtain more water (21,700 acre-feet) in the Alternative 3 dry condition, which creates a benefit of $19.3 million annually during this dry period.

Compared to the No-Action Alternative, the San Joaquin Valley would also obtain more water supplies on average, but these supplies are worth little in comparison to the other costs of other supplies. The region would pay a net cost of $3.2 million annually which consists mostly of metering costs and restoration payments. Costs during the dry condition are estimated to be $4.5 million.

In the Central and South Coast, additional SWP supplies of 168,000 acre-feet in the average condition are quite valuable in terms of costs avoided, resulting in an annual average benefit of $106 million. The supply increase in the average condition would allow retail water price to be kept lower, causing demand to be higher going into the drought and reducing the economic value of any supply increase in the dry condition. An even larger SWP supply increase (216,000 acre-feet) would occur in the dry condition, but the effective supply increase is only 112,000 acre-feet because 104,000 acre-feet are needed to serve the increased demand from the average condition. Annual economic benefits amount to $120 million in the dry condition.

ALTERNATIVE 4

Results for the Sacramento Valley are nearly identical to results for Alternatives 1 so they are not repeated.

In the San Francisco Bay Area, 13,000 acre-feet less supply is available in an average supply condition, but the region is already estimated to be in a supply surplus. The region would pay costs associated with restoration payments and supply reductions amounting to $4.9 million per year in the average condition. The region would obtain less supply in the dry condition (7,500 acre-feet) which is associated with an annual cost of $9.5 million relative to the No-Action Alternative.

As compared to the No-Action Alternative, the San Joaquin Valley would obtain less water supplies on average, but these supplies are worth little in comparison to the costs of other supplies. The region would pay a net cost of $5.0 million annually consisting mostly of metering and restoration payments. Costs during the dry condition are estimated to be $5.1 million.

Average condition supplies for the Central and South Coast in Alternative 4 would be 9,000 acre-feet less than under the No-Action Alternative and economic costs associated with this supply reduction are estimated to be $6.1 million. In the dry condition there would be no change in supplies, but demand reduction from the average condition would result in a dry condition benefit of $8.0 million annually.

ALTERNATIVES WITH WATER TRANSFERS

Supplemental Analysis 1e

The supplemental analysis of municipal water costs with water transfers allowed assumes that M&I providers could buy consumptive use and non-recoverable losses from willing agricultural sellers. In the base transfer scenario, transfers of CVP water service contract water and San Joaquin River exchange water are not allowed. In this supplemental analysis, all Alternative 1 assumptions are in effect. In addition, M&I providers could transfer from CVP water service and exchange contractors as well as the non-CVP sellers allowed in the base transfer scenario.

The analysis finds that M&I users in the Sacramento Valley and San Joaquin regions would not participate in water transfer markets because supplies available under Alternative 1 would be generally adequate to meet demands, and groundwater is less expensive than water transfers as a replacement supply.

M&I providers in the San Francisco Bay Area would purchase little water under average hydrologic conditions, but they would purchase up to 181,000 acre-feet under the dry condition. These transfers would provide a cost savings of roughly $30 million annually as compared to the cost of acquiring transfers and other replacement supplies under the base transfer scenario. These cost savings would occur largely because the transferred water under this supplemental analysis would be up to $139 per acre-foot less than transferred water from non-CVP sources, and some of the costs of other, more expensive replacement supplies would be avoided.

For all water transfer analyses, it is assumed that no more than 100,000 acre-feet of Central Valley water would be transferred to the south coast in the average condition. Much of the average condition value of transfers is obtained in the base transfer scenario where water can be bought from non-CVP sellers. In the base transfer scenario, cost savings of up to $55 million would be realized in comparison to the No-Action Alternative. The changes of Supplemental Analysis 1e would have little additional effect on the value of average condition transfers, resulting in only $1 million of additional cost savings annually. In this situation, CVPIA water transfer provisions have little effect on the source or price of water transfers.

Under the dry condition, only half of the average-condition transfer is assumed to be available, and the Central and South Coast region would purchase about 363,100 acre-feet of additional water from Central Valley agricultural sellers. The addition of CVPIA water transfer provisions in Supplemental Analysis 1e would result in approximately $37 million of cost savings during the dry condition, in comparison to the base transfer scenario.

Supplemental Analysis 2b

The assumptions for a supplemental analysis of the effects of water transfers from CVP water users to M&I water providers under Supplemental Analysis 2b are the same as those described under Supplemental Analysis 1e. The results of the transfer analysis under Supplemental Analysis 2b, however, are slightly different than those under Supplemental Analysis 1e because of the effects of the water acquisition program. Similar to conditions under Supplemental Analysis 1e, Supplemental Analysis 2b finds that M&I users in the Sacramento Valley and San Joaquin regions would not participate in water transfer markets because supplies are generally adequate to meet demands and groundwater is less expensive than water transfers as a replacement supply.

M&I providers in the San Francisco Bay Area would purchase little water under average hydrologic conditions, but up to 181,000 acre-feet would be purchased under the dry condition. These transfers would provide a cost savings of roughly $28 million annually as compared to the cost of obtaining transfers and other replacement supplies under the base transfer scenario. These savings would occur largely because the transferred water under Supplemental Analysis 2b would cost up to $124 per acre-foot less than transferred water from non-CVP sources, and some of the costs of other, more expensive replacement supplies would be avoided.

Again, it is assumed that no more than 100,000 acre-feet of Central Valley water would be transferred to the south coast in the average condition. Much of the average condition value of transfers is obtained in the base transfer scenario where water can be bought from non-CVP sellers. Supplemental Analysis 2b would have little effect on the value of average condition transfers, resulting in an additional $1.8 million in annual cost savings.

Under the dry condition, only half of the average-condition transfer is assumed to be available, and the Central and South Coast Regions would again purchase about 363,100 acre-feet more water from Central Valley agricultural sellers. The addition of CVPIA water transfer provisions in Supplmental Analysis 2b would result in approximately $28 million of cost savings in comparison to the base transfer scenario. The difference between cost savings from water transfers under Supplemental Analyses 1e ($37 million) and 2b ($28 million) is due to water price changes induced by water acquisition for fish and wildlife in Supplemental Analysis 2b.

Supplemental Analysis 3a

Supplemental Analysis 3a finds that M&I users in the Sacramento Valley and San Joaquin regions do not participate in water transfer markets. The Bay Area purchases little water in the average hydrologic condition, but 162,000 acre-feet are purchased in the dry condition. These transfers are worth about $18 million annually as compared to the base transfer scenario, largely because the region pays less for transfers ($102 per acre-foot less).

In the Central and South Coast region, 102,000 acre-feet are bought in the average condition. Supplemental Analysis 3a is worth only $0.2 million annually in cost savings, relative to the base transfer analysis. In the dry condition 360,000 acre-feet of transfers are worth $22 million in cost savings in comparison to the base transfer scenario.

Supplemental Analysis 4a

Again, Supplemental Analysis 4a finds that M&I users in the Sacramento Valley and San Joaquin regions do not participate in water transfer markets.

The San Francisco Bay Area purchases little water in the average hydrologic condition, but 190,000 acre-feet are purchased in the dry condition. These transfers are worth about $20 million annually as compared to the base transfer scenario, largely because the region pays less for transfers ($82 per acre foot less) and $15.5 million of costs of other make-up supplies are avoided.

In the Central and South Coast region, 105,000 acre-feet are bought in the average condition. These transfers cost $2.6 million more than in the base transfer analysis because price is about $25 per acre-foot higher. In the dry condition 363,000 acre-feet of transfers are worth $16 million in cost savings in comparison to the base transfer analysis.

THE DELTA AS A SOURCE OF DRINKING WATER

NO-ACTION ALTERNATIVE

Under the No-Action Alternative, water quality conditions in the Delta would be governed by the Bay-Delta Plan Accord and D-1422. In general, salinity concentrations would be reduced in some months as compared to recent Delta conditions described in the Affected Environment, particularly during dry years. Agricultural return flow quantities would not change significantly from conditions described in the Affected Environment. However, agricultural return flow quality would improve by the year 2022, due to the recent or pending implementation of more stringent water quality requirements for point and non-point discharges. Also in the No-Action Alternative, the operations of New Melones Reservoir would attempt to meet all requirements of D-1422 provisions before releases would be made for other purposes.

ALTERNATIVE 1

Under Alternative 1, inflow to the Delta from the Sacramento River system would be slightly less than under the No-Action Alternative, primarily as a result of reduced diversions from the Trinity River Basin. Delta exports would be reduced in February through September due to reduced Trinity diversions and (b)(2) Water Management. The overall change in Delta outflow would be relatively small under Alternative 1 as compared to the No-Action Alternative. As a result of the operations under Alternative 1, salinity in the Delta at Collinsville would be similar to conditions under the No-Action Alternative, except for a slight increase in September due to reduced Sacramento River inflows.

During some dry years, salinity in the San Joaquin River at Vernalis would increase, as compared to concentrations under the No-Action Alternative. This would occur due to increased deliveries to and return flows from the San Luis Complex refuges. In addition, the management of (b)(2) water on the Stanislaus River would lower storage conditions in New Melones Reservoir, and would result in the imposition of the maximum water quality release threshold more frequently. During those years, less water would be released for water quality maintenance at Vernalis than under the No-Action Alternative, and the salinity concentration would be higher.

ALTERNATIVE 2

Under Alternative 2, inflow to the Delta from the Sacramento River system would be similar to conditions under Alternative 1, and would be slightly less than under the No-Action Alternative. Total irrigated acreage upstream of the Delta (including the San Joaquin River, Tulare Lake, and Sacramento River regions) would be reduced by less than 2 percent under this alternative as compared to the No-Action Alternative. Most of this change would be related to reductions in acreage of pasture and hay, rice, cotton, and other field crops such as sugar beets. This reduction in irrigated acreage would result in reduced return flows, which could reduce concentrations of DBP precursors.

The delivery of Level 4 water supplies to wildlife refuges would increase the return flows from the San Luis Complex refuges as compared to the No-Action Alternative and Alternative 1, particularly in the early spring. The release of up to 170,000 acre-feet of acquired water on the

Merced, Tuolumne, and Stanislaus rivers (combined) for instream flows and Delta outflow, however, would increase instream flows on these rivers and on the San Joaquin River. This increased flow would result in lower salinity concentrations on the San Joaquin River at Vernalis, and a slight increase in Delta inflow.

As a result of the operations under Alternative 2, salinity in the Delta at Collinsville would be similar to conditions under the No-Action Alternative, except for a slight increase in September due to reduced Sacramento River inflows. Therefore, based upon the minor changes in Delta inflows and salinity, and minor reductions in irrigated acres and associated return flows, Delta water quality for drinking water uses would be similar or slightly improved in Alternative 2 as compared to the No-Action Alternative.

ALTERNATIVE 3

Under Alternative 3, inflow to the Delta from the Sacramento River system would be similar to conditions under Alternative 1, and would be slightly less than under the No-Action Alternative. Total irrigated acreage upstream of the Delta (including the San Joaquin River, Tulare Lake, and Sacramento River regions) would be reduced by less than 4 percent under this alternative as compared to the No-Action Alternative. Most of this change would be related to reductions in acreage of pasture and hay, rice, cotton, and other field crops such as sugar beets. This reduction in irrigated acreage would result in reduced return flows, which could reduce concentrations of DBP precursors.

The delivery of Level 4 water supplies to wildlife refuges would increase the return flows from the San Luis Complex refuges as compared to the No-Action Alternative and Alternative 1, particularly in the early spring. The release of up to nearly 800,000 acre-feet of acquired water on the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Yuba rivers (combined) for instream flows, however, would increase instream flows on these rivers and on the San Joaquin River. This increased flow would result in lower salinity concentrations on the San Joaquin River at Vernalis, and an increase in Delta inflow by about 400,000 acre-feet on an average annual basis.

Under Alternative 3, acquired water may be exported by CVP and SWP facilities during times when the Delta is in an excess condition. As a result, the net change in Delta outflow under Alternative 3, as compared to the No-Action Alternative, would be an increase of approximately 200,000 acre-feet on an average annual basis. Therefore, based upon the changes in Delta inflows and salinity, minor reductions in irrigated acres and associated return flows, and increased Delta outflow, it is anticipated that Delta water quality for drinking water uses would be similar or slightly improved in Alternative 3 as compared to the No-Action Alternative.

ALTERNATIVE 4

Alternative 4 includes the same water management and water acquisition actions as those described under Alternative 3. Therefore, Delta inflow from all sources would be similar to conditions described under Alterative 3. However, under Alternative 4, the CVP and SWP would not be allowed to export acquired water. As a result of this operation, Delta outflow under Alternative 4 would be approximately 700,000 acre-feet greater than under the No-Action Alternative, on an average annual basis.

Therefore, based upon the increase in Delta inflows, and minor reductions in irrigated acres and associated return flows, Delta water quality for drinking water uses would be similar or slightly improved under Alternative 4 as compared to the No-Action Alternative.

MOSQUITOS

As compared to the No-Action Alternative, the alternatives considered in Draft PEIS could result in changes in the location and area of mosquito breeding habitats. The incidence of mosquito breeding habitat is highly dependent on local conditions not considered in the programmatic nature of the Draft PEIS analyses. Existing local vector abatement programs are authorized to adapt to changing local mosquito breeding conditions in order to protect public health. Therefore, no changes in public health risks would result from the implementation of the alternatives. However, because of the potential effect on local conditions, changes in local mosquito breeding conditions and funding sources for abatement will be evaluated as part of site-specific environmental documentation and potential mitigation measures.

SOCIAL CONDITIONS

The Draft PEIS alternatives have the potential to affect several social groups. The social groups identified for this analysis are farmers, farm workers and agribusiness workers, commercial fishermen and fishing businesses, recreationists and recreation workers, and Native American tribes. The alternatives evaluation for the social analysis is based on the regional economics analysis and projected changes to regional employment. These findings have been applied to the analysis for the identified social groups. Assumptions associated with the alternatives are summarized in Table IV-57.

TABLE IV-57

SUMMARY OF ASSUMPTIONS FOR SOCIAL CONDITIONS

Assumptions Common to All Alternatives or Supplemental Analyses
Social analyses based on information estimated in the corresponding analyses for Agricultural Economics and Land Use, Regional Economics, and M&I Land Use and Demographics.

Results of the impact analyses for the alternatives are summarized in Table IV-58**.**

TABLE IV-58

SUMMARY OF IMPACT ASSESSMENT FOR SOCIAL CONDITIONS

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	Population would continue to increase in most regions.
	Changes Compared to the No-Action Alternative
1	Annual statewide loss of $183 million output, $80 million personal income, and 2,790 jobs. Primary loss in San Joaquin River Region (2,400 jobs) primarily in agriculture. May have minimal impact if uniformly distributed. May have significant impact if all near one community.
	Changes Compared to Alternative 1
1a	Conditions are similar to Alternative 1.
1b	Conditions are similar to Alternative 1.
1c	Large additional losses of jobs and income in the Sacramento River Region due to land out of production.
1d	Conditions are similar to Alternative 1.
1e	Average conditions are similar to Alternative 1.
1f	Average conditions are similar to Alternative 1.
1g	Conditions are similar to Alternative 1.
1h	Conditions are similar to Alternative 1.
1i	Conditions are similar to Alternative 1.
	Changes Compared to the No-Action Alternative
2	Annual statewide loss of $241 million output, $100 million personal income, and 3,550 jobs, mostly in the San Joaquin River Region. Increases in recreation jobs.
	Changes Compared to Alternative 2
2a	Conditions are similar to Alternative 2.
2b	Average conditions are similar to Alternative 2.
2c	Average conditions are similar to Alternative 2.
2d	Changes are similar to those described under Supplemental Analysis 1c.

TABLE IV-58. CONTINUED

	Changes Compared to the No-Action Alternative
3	Annual statewide loss of $143 million output, $26 million personal income, and 2,060 jobs. Job gains in municipal areas with increased water supplies. Significant job losses in the San Joaquin River Region (3,000 jobs).
	Changes Compared to Alternative 3
3a	Average conditions are similar to Alternative 3.
	Changes Compared to the No-Action Alternative
4	Annual loss of $457 million output, $194 million personal income, and 6,540 jobs. Job losses primarily in the San Joaquin River Basin (3,800 jobs) and municipal areas.
	Changes Compared to Alternative 4
4a	Average conditions are similar to Alternative 4.

NO-ACTION ALTERNATIVE

The demand for social services within each region is expected to remain constant or to increase and would depend on the characteristics of the local area affected. This assumption is based on population projections for the Central Valley and the projected changes in social make-up. The total population for the San Joaquin Valley is expected to continue to increase and a larger percentage of the population would be children. This change would be translated into an overall decrease in per capita income, because children do not earn income but are included in the total population when calculating per capita income.

The number of agricultural jobs available may increase in some areas due to projected changes in crop production to higher value and more labor intensive crops. However, agricultural employment would remain seasonal. There could be improvements in mechanization for picking and sorting crops and other improvements that could eliminate some tasks that are currently labor intensive. Changes in irrigation technology also may occur that could change farm labor needs. Changes to the population, crop production, and technology resulting in a decrease in employment opportunities or the duration of employment may create an increased need for social services to provide food, health care, and housing for those facing economic hardship. These needs may be seasonal or could be year-around depending on the extent of the change and the education, training, and technical skills of the population in the area affected.

The demand for social services by less technically skilled workers, particularly unemployment insurance and food and welfare programs, may increase as the demand for highly skilled workers in technical fields rises. Less technically skilled workers and those lacking basic education levels and English language skills may find employment more difficult. While seasonal employment may be available, the opportunity to receive income from year-around employment may become more difficult.

ALTERNATIVE 1

Implementation of the actions proposed for each alternative, as compared to No-Action Alternative, with regard to employment is shown on Table IV-59. In the Sacramento River Region the total number of jobs lost includes approximately 160 jobs due to changes in the agricultural sector and 20 jobs gained due to increases in the recreation sector. In the San Joaquin River Region, approximately 2,400 jobs would be lost from the agricultural sector and 10 would be gained from changes in the recreation sector. The Tulare Lake Region would experience losses approaching 940 jobs, of which all would be within the agricultural sector. These losses represent less than one percent reduction in agricultural jobs for each region. The projected reduction in agricultural jobs includes not only direct farm labor inputs but also related and secondary declines in manufacturing, service, construction, and retail employment opportunities throughout the region.

In the Sacramento Valley job losses in the agricultural sector would be limited to the west side. Recreation employment losses would occur at CVP reservoir facilities and could affect sport fishing and river recreation activities.

TABLE IV-59

CHANGES IN REGIONAL EMPLOYMENT

Region	No-Action Alternative (1)	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Sacramento River	1,297,260	-260	-560	-1,310	-1,310
San Joaquin River	890,220	-2,450	-2,990	-2,960	-3,860
Tulare Lake	468,700	-940	-870	-800	1,100
San Francisco Bay	3,129,540	-100	-100	-90	-100
South and Central Coast	9,603,010	960	960	3,110	-180
Total	15,388,730	-2,790	-3,550	-2,060	-6,540

NOTES:
(1) Regional Economic Analysis Baseline Data, 1991.

In the San Joaquin River and Tulare Lake regions agriculture job losses would occur mainly on the west side due to reductions in irrigated agricultural acreage. This would affect the areas near the communities of Mendota, Firebaugh, Huron, and Coalinga the greatest. Because these areas already are experiencing high levels of unemployment and the labor force is primarily farm workers, the social and economic structure of these communities could be affected further when compared to No-Action Alternative. Examples may include higher demand for social services, loss of community-specific fire and police protection services in favor of less expensive area-wide services merged with one or more other communities, increased crime such as shoplifting, and loss of local small businesses such that customers may have to travel further to purchase supplies.

There would be no other adverse impacts resulting from job losses in other regions, except the San Francisco Bay Region, where a loss of less than 100 jobs could occur due to increased water costs. Given the size of the employment base for the region, employment losses would not increase the need for social services.

In the South Coast and Central Coast regions, jobs would increase due to increased water availability. While this would be a benefit to the regions, the changes would be very small given the size and large population of the affected areas.

In discussions with the staff of agencies providing social services in all regions, the primary concern was the need for increased social services to accommodate the loss of jobs in the agricultural sector. The Sacramento River Region also is affected by the timber industry and any losses that may occur in this industry, although unaffected by the CVPIA, would stretch the need for social services. For example, when labor reductions in the timber industry occurred following listing of the spotted owl, there were significant increases in the demand for social services; primarily unemployment assistance, medical assistance, and food stamps.

In the San Joaquin River and Tulare Lake Regions the principal concern of social service agencies was the potential for job losses to those with limited skills, such as field laborers. However, because no changes are anticipated to labor intensive farm production under this alternative, the need to provide services for these persons is not expected to occur. Rather job losses would most likely be for farm managers and skilled irrigation technicians or machine operators. According to those interviewed involved in farming operations there is a demand for persons with these higher skill levels. It is anticipated that displaced farm managers and technicians could find work in other regions or other jobs related to agriculture. While there may be a temporary increase in the need for social services to provide training or economic assistance for a portion of these displaced workers, this need is not expected to be large. The need to relocate families or for family members to spend more time apart could create additional social burdens on the family and the individual members as new friendships and family structure within a new community may need to be built.

If all projected job losses were to occur near one community, the total effect to the area could be devastating. For example, the communities of Huron, Kerman, Mendota, and Coalinga have existing (1990) populations ranging from approximately 4,600 to 8,000 respectively. If all jobs lost for the San Joaquin River Region were to affect Huron, Kerman, or Mendota, over half the total population and more than half of the working population of these communities could be affected. It is impossible to determine the exact percentage of these changes in irrigated acres and associated impacts at this time. This information would be determined in subsequent environmental documents for contract renewals.

Displaced recreation workers would likely need to receive social service benefits. Interviews with recreation service employers indicate that many recreation workers are seasonal and part-time employees. Many are students who look for seasonal employment. Loss of recreation jobs for these individuals would likely cause them to seek temporary employment elsewhere. However, in towns located adjacent to CVP recreational facilities, where employees are local townspeople, job losses could cause some displaced workers to apply for social assistance. Displaced workers that held permanent seasonal jobs have indicated a need to utilize social service programs during the off-season months. Therefore it is anticipated that if these workers are displaced they may require year-round assistance until other employment could be found.

A benefit of the reallocation of water supplies from agricultural uses to fish and wildlife habitat uses may result in improved recreation opportunities and the income generated from hunters, birders, and sport fishermen visiting the wildlife refuges and streams. In addition there could be improvements to aesthetic values in rivers and refuge lands and environmental benefits that are difficult to quantify.

The lack of data for the north coastal area makes projections of potential impacts to fishermen difficult. However a decrease in water deliveries and subsequent increases in water held in reservoirs, rivers, and streams could benefit fisheries. The benefits to fishermen would not be as great because it cannot be assumed that the catch of fish would be equal to increases in fish numbers. Fishing regulations govern catch limits and may remain in place. Therefore, the true potential benefits to fishermen and fishing businesses cannot be quantified.

The Hoopa Valley and Yurok tribes would benefit from the provision of increased flows in the Trinity River. These benefits are currently being evaluated in a separate EIS for the Trinity River operations. Increased flows may improve the fishery of the river and its tributaries. Because the culture of these tribes is dependent on the fishery for subsistence and ceremonial uses, the social value of the increased flow is important. Tribal members believe that increased flows would lead to less unemployment and aid in a return to traditional lifestyles. There would be no change to housing costs or per capita income for tribal members. However, there could be intangible social benefits from the ability to lead a subsistence lifestyle.

ALTERNATIVE 2

Approximately 490 jobs would be lost from changes in the agricultural sector. There would be an increase of approximately 40 jobs due to recreation. In the San Joaquin River Region nearly all job losses would result from changes in the agricultural sector. There would be an increase of approximately 30 jobs due to recreation. The Tulare Lake Region would experience losses approaching 900 jobs, of which all would result from changes within the agricultural sector. The need for the level of social services to assist agricultural workers displaced due to implementation of Alternative 2 could increase over the level projected for Alternative 1.

Job losses in the San Francisco Bay Region would be identical to the losses projected to occur under Alternative 1. In the South Coast and Central Coast regions, jobs would increase more than in Alternative 1 due to increased water availability. While this would be a benefit to the regions, the change would be very small given the size and large population of the affected areas.

In the Sacramento River Region job losses would occur along the west side. Land owners and farm managers may seek other employment opportunities locally or may elect to relocate to other areas for employment. The losses would be spread throughout the west side and would not affect one community more than another.

In the San Joaquin River and Tulare Lake regions agriculture job losses would occur mainly on the west side of the region and could affect the areas near the communities of Mendota, Firebaugh, Huron, and Coalinga the greatest. Because these areas already are experiencing high levels of unemployment and the labor force is primarily farm workers, socio-economic impacts to this area are of concern. The social impacts to these communities would be greater under Alternative 2 than under Alternative 1. Other job losses could occur on the east side of the region near Oakdale, Modesto, and Turlock. These job losses would not be due to CVP water supply reductions, but due to a reduction in irrigated acreage resulting from the sale of water rights on the Stanislaus, Tuolumne, and Merced rivers by persons with water rights that are willing to sell those rights for other beneficial uses. Per capita income for farmers on the east side of the San Joaquin Valley that could sell water supplies could increase.

There could be a secondary impact to persons employed by businesses, such as seed, fertilizer, pesticide, equipment, and labor inputs, that supported agriculture production activities on the west side of the Sacramento Valley and the west and east sides of the San Joaquin Valley. The need for social service program to support these individuals would increase unless these workers can find other employment. Support businesses and local retail businesses could be affected by the loss of income generated from farm production. However, on the east side of the San Joaquin River Region these losses could be offset by new economic opportunities generated by the purchasing power of growers receiving income from the sale of water.

As discussed for Alternative 1, if all employment loss impacts were to occur within one community, the total effect to that community could be devastating. The projected changes to agricultural employment for this alternative are greater, but would affect the east and west sides of the San Joaquin River Region and therefore could be dispersed over several communities.

A benefit of the reallocation of water supplies from agricultural uses to fish and wildlife habitat uses could be an increase in recreation opportunities and the income generated from hunters, birders, and sport fishermen visiting the wildlife refuges and streams. In addition there may be aesthetic values and environmental benefits that are difficult to quantify for social value. Restoration activities to improve habitat also could provide limited employment opportunity. Impacts for recreation communities near reservoirs would be similar to those anticipated for Alternative 1.

Improved habitat in streams could benefit fisheries in those streams and the Delta when compared to No-Action Alternative. There also may be secondary benefits to commercial fishermen who rely on salmon harvest for their living. The benefits to commercial fishermen could be greater than under Alternative 1 because of increased flows in the tributaries of the San Joaquin Valley. This may result in improved fishing conditions leading to increased income and less demand for social services in fishing communities as fishermen and fishing businesses are better able to provide for their families.

The Hoopa Valley and Yurok tribes would benefit from the provision of increased flows in the Trinity River similar to the effects experienced under Alternative 1.

ALTERNATIVE 3

In the Sacramento River Region approximately 1,240 jobs would be lost due to changes in the agricultural sector. There would be an increase of 40 recreation related jobs, equivalent to the employment gains under Alternative 2. In the San Joaquin River Region, approximately 3,000 jobs would be lost due to changes in agriculture. There would be a gain of approximately 50 jobs caused by increases in the recreation sector. The Tulare Lake Region would experience losses approaching 800 jobs, of which all would be due to changes in the agricultural sector. The loss of jobs for the Tulare Lake Region under Alternative 3, when compared to that anticipated under Alternatives 1 and 2, would be less. There would be an increase in more labor intensive crop production in the Tulare Lake Region for areas receiving water from the SWP, and therefore a corresponding increase in farm employment opportunities. This increase offsets labor losses for other areas of the Tulare Lake Region that receive CVP supplies and in the San Joaquin River Region anticipated under this Alternative 3.

Job losses occurring in the San Francisco Bay Region would be identical to the losses projected to occur under Alternative 1. In the South Coast and Central Coast regions jobs would increase more than in Alternative 1 due to increased water availability. While this would be a benefit to the regions, the changes would be very small given the size and large population of the affected areas.

Communities that lie within the areas that could be affected by the loss of agricultural employment in the Sacramento Valley are Willows, Orland, Colusa, and Chico. Landowners that are willing to sell their water supplies and remove their lands from irrigated production would be compensated and may not require other employment. Per capita income could improve for those farmers able to sell water rights. However displaced farm managers and workers would likely seek other jobs within the area or relocate to other areas. Families could be affected if they are required to move and leave behind established community connections to schools, family, church and friends.

In the San Joaquin River and Tulare Lake regions agriculture job losses would occur on the west side of the region and would affect areas near the communities of Mendota, Firebaugh, Huron, and Coalinga the greatest. Changes to farm labor needs would be similar to those experienced under Alternative 2 when compared to the No-Action Alternative. Other job losses would occur on the east side of the region near Oakdale, Modesto, and Turlock. These job losses would not be due to CVP water supply reductions, but due to the sale of water rights on the Stanislaus, Tuolumne, and Merced Rivers. Farm managers and workers displaced from the removal of irrigation on some lands may be required to relocate or accept jobs that require less skill and training leading to underemployment of these individuals. Farmers and water rights holders able to sell water rights could receive higher per capita incomes and may generate new sources of income for other non-agriculture related business, or could use the available income from water sales to make improvements to other agricultural lands not affected by the water sales.

Skilled farm workers and machinery operators would lose employment, but may find other employment because of their skill levels. However, unlike under Alternative 2, these workers may be required to find work at a less pay and a lesser skill level or to travel further or relocate for employment opportunities. This is because more skilled workers would be displaced under Alternative 3 and therefore the potential to find similar employment opportunities could be limited and more difficult. Some skilled workers and farmworkers displaced by the reduction in irrigated acreage may choose to relocate to the Tulare Lake Region where employment opportunities may be better. Employment opportunities in the Tulare Lake Region would be seasonal, and therefore workers may require social services when seasonal employment is not available. This could stretch the availability of social services to existing residents of the region. If workers from the San Joaquin River Region choose to relocate, additional social burdens could be placed on these workers and their families as the existing social structure and support groups are left behind and new friendships and social support groups are formed in another area.

The need for social services to support displaced farm laborers with limited skills would likely increase under Alternative 3, when compared to Alternative 2 and the No-Action Alternative. The need for training programs and language programs could increase if laborers are unable to find agricultural work elsewhere in the state, such as the Tulare Lake Region or if they are unable to relocate.

The per capita and family income of the displaced workers would decrease and could affect the ability of these persons to maintain their current standard of living. If these displaced workers cannot find other employment or are unable or unwilling to relocate to other potential labor markets, the families of displaced workers and potentially their communities could be adversely affected. Examples include the possible inability of displaced workers to meet mortgage payments for homes, less opportunity for the workers or their families to obtain higher education because of lack of income to support the cost of going to school, and less income for purchases of supplies, clothing, and larger items such as cars and appliances. The lack of income and purchasing power could indirectly affect local businesses that rely on the purchases of persons within the community. If local businesses are lost then all members of a community would need to travel further to obtain supplies. Similar changes could occur to fire and police protection services, churches, schools, and other social institutions if local communities cannot support community specific institutions, mergers may be required to maintain basic social support and protection services. If all employment losses were to affect one or several communities the effects could be devastating to the area. For example the communities of Mendota and Firebaugh combined population of approximately 11,000. The loss of nearly 3,000 jobs within the area would likely affect every family and local businesses.

More water would be allocated to in stream fishery uses under Alternative 3 when compared to the No-Action Alternative and therefore it is anticipated that recreationists and recreation workers would benefit from implementation of this alternative to a greater extent. Employment projections for recreation also include indirect benefits to local businesses that support the recreation industry such as food stores, gas stations, and other businesses within a recreation community. Changes to per capita income would be negligible.

Restoration of watershed and improved habitat in streams may create secondary benefits to commercial fishermen who rely on salmon harvest for their living. In stream flows under Alternative 3 would be greater than under the No-Action Alternative and Alternatives 1 and 2. Therefore fishery numbers could improve as habitat improves.

The Hoopa Valley and Yurok tribes would benefit from the provision of increased flows in the Trinity River similar to the effects experienced under Alternative 1.

ALTERNATIVE 4

In the Sacramento River Region job losses would be nearly identical to those projected under Alternative 3. Of these, nearly all are due to changes in the agricultural sector. There would be an increase of approximately 40 recreation related jobs, identical to those projected for Alternatives 2 and 3.

In the San Joaquin River Region, approximately 3,800 jobs would be lost. Nearly all of these would result from changes within the agricultural sector. More land would be removed from production on the west side in the CVP Delta Mendota Canal service area. Water supply reductions to these areas would affect less labor intensive production as anticipated for each of the other alternatives. Cotton, irrigated pasture, and grains would be removed from production with CVP supplies and land would be fallowed. Because these crops are not labor intensive adverse impacts are limited to farmers, farm managers, and technically skilled farm workers such as machinery operators and irrigation technicians. Workers with farm management skills are needed throughout the Central Valley. However, given the large number of farm managers displaced under this alternative, it is not likely that each would find similar employment within the affected area. Displaced farm managers may have to relocate to other areas, accept underemployment, or displace other managers that are less skilled. Employment losses on the westside could be greater than the total job losses (3,800 jobs). This is because income from east side water sales is anticipated to generate approximately 1,500 jobs and offsets most losses experienced on the westside of the region.

Farmers and agricultural workers in this area and the communities of Mendota, Firebaugh, Huron, and Coalinga would be adversely affected by the reduction in irrigated lands. As discussed under Alternative 3, these communities may not be able to support local businesses, fire and police protection services, schools, and churches because of the employment and income losses. Therefore, the small communities may be required to merge social and institutional services to provide for local residents. This could lead to a declining social support structure as people have to drive further to participate in social events, church, and schools. Family income would decline for displaced workers and additional burdens could be placed on family members if additional members are required to work to support the family, or relocation is necessary to find other employment. If workers are unable to find other employment or are unwilling or unable to relocate to other jobs, the demand for social services such as welfare, food, and health programs would be expected to increase.

In the Tulare Lake Region, approximately 200 more workers would be displaced than under the Alternatives 1, 2, and 3. These would include farm managers who may be able to find other jobs, but as with the San Joaquin River Region, employment opportunities may be limited. Displaced farm managers may require additional job training or education to be able to enter other employment fields and may have to relocate within the region to major economic centers or to other regions to find employment opportunities. Displaced workers within the Tulare Lake Region represent employment losses withing the Kern County State Water Project service area and the Cross Valley Canal service area. These regions also would experience losses under each alternative, with the Cross Valley service area experiencing identical losses, and the Kern County State Water Project service area experiencing acreage losses of a much higher magnitude, nearly double those anticipated under the other alternatives when compared to the No-Action Alternative. The need for social assistance for farmers, agricultural workers, and workers in supporting businesses displaced due to implementation of Alternative 4 would be more extensive than those projected for Alternatives 2 and 3.

The San Francisco Bay Region would experience a loss identical to those anticipated for Alternatives 1, 2, and 3. Unlike under Alternatives 1, 2, and 3, the South Coast and Central Coast Regions would experience job losses under Alternative 4 due to reduction in water availability. These losses would be due to increases in urban water costs that could adversely affect businesses. However, the loss of jobs is small and negligible when compared to the total employment base for the regions.

There would be no change in recreation or commercial fishing employment or the projected need for social services from those anticipated under Alternative 3 when compared to No-Action Alternative.

The Hoopa Valley and Yurok tribes would benefit from the provision of increased flows in the Trinity River similar to the effects experienced under Alternative 1.

ENVIRONMENTAL JUSTICE

Executive Order 12898 requires that federal agencies analyze the impacts of proposed alternative actions to evaluate disproportionate impacts to minorities or low income populations.

Table IV-60 shows the ethnic structure of the Sacramento, San Joaquin, and Tulare Lake Regions. These areas would be affected the greatest by implementation of the alternatives. As discussed in Chapter III, the population of the Sacramento River Region is primarily white. The population of the San Joaquin River and Tulare Lake Regions are also primarily white, but there also is a large Hispanic population for the regions. One reason for the higher percentage of Hispanics in the San Joaquin River and Tulare Lake Regions could be the larger population of Hispanic farm laborers that support truck and fruit, nut, and vine production in these regions. This results in a higher potential for effects upon this ethnic group, as shown in Table IV-61.

TABLE IV-60

ETHNICITY BY REGION

Region	Ethnicity			
	White (percent)	Black (percent)	Asian (percent)	Hispanic (percent)
Sacramento River	73	7	7	13
San Joaquin River	58	4	8	29
Tulare Lake	60	4	3	33
San Francisco Bay	59	9	16	16

SOURCE:
California Department of Finance, 1990.

TABLE IV-61

ETHNICITY OF POTENTIALLY AFFECTED COMMUNITIES IN THE SAN JOAQUIN RIVER REGION

	Ethnicity			
San Joaquin River Region	White (percent)	Black (percent)	Asian (percent)	Hispanic (percent)
Coalinga	66	1	1	33
Firebaugh	31	23	1	67
Huron	13	>1	1	86
Kerman	52	1	4	43
Mendota	15	1	1	83

SOURCE:
New United Way, Vision 20/20, May 1994

Areas where water purchases are proposed have populations that are primarily white, except in Merced County where Hispanics and Asians make up a large portion of the population. In the Tulare Lake Region, acreage reductions would occur in areas within Kern County served by the

State Water Project and areas served by the Cross Valley Canal. The Tulare Lake Region, like the San Joaquin River Region is primarily white, but also has a large Hispanic population.

It is difficult to conclude that one social group would be adversely affected to a greater extent by implementation of any of the alternatives. In addition, because the impacts of the alternatives occur throughout the Central Valley area of California no one ethnic group is affected more than another. Moreover, the impacts are more reflective of the type of labor requirements required for agricultural production and the skill and education level of those employees that determines the total impact to any social group. Scoping meetings were held in Mendota to specifically obtain input about these concerns.

There could be indirect adverse impacts to farm laborers, who are generally economically disadvantaged, may lack English language skills and education or training to obtain other employment, and are from minority groups, however it is not the intent of the CVPIA to affect these groups. Potential impacts to these groups are a result of direct and adverse impacts to land owners and farmers that receive CVP supplies. These persons are generally not economically disadvantaged and do not represent minority groups. However, as lands are removed from production either by reductions in CVP deliveries, land retirement programs implemented as part of the SJVDP, or through purchase of water rights from willing sellers, some labor intensive crops would be removed from production. Indirect and adverse effects to farm laborers would occur as a result of this action.

There could be direct benefits from implementation of the CVPIA to the Native American tribes from increased flows in the Trinity River under all alternatives. These benefits are being evaluated in separate environmental documentation.

Adverse impacts to the social groups would occur throughout the Sacramento River, San Joaquin River, and Tulare Lake regions and specific areas have not been targeted for implementation of the alternatives. The west side of the San Joaquin River Region is affected particularly because of reductions in agricultural acreage that would occur under the No-Action Alternative. Implementation of the alternatives would add to the adverse impacts that would be experienced by land owners and communities resulting from implementation of the No-Action Alternative.

CULTURAL RESOURCES

Cultural resources in the study area could be affected by implementation of the CVPIA in many ways. Changes in reservoir and river operations could affect cultural resources at reservoir margins by changing historical patterns of reservoir filling and emptying. Cultural resources located in the drawdown zone of reservoirs are prone to damage from exposure caused by hydrologic changes. The most damaging impacts would probably be caused by erosion. Less obvious, but also potentially destructive, is wet/dry cycling, which is caused by repeated inundation and exposure of resources. This causes perishable items (e.g., bone, wood, shell, ceramics, pollen, and leather) to disintegrate rapidly. Other impacts tied to the exposure of resources during drawdown are potential damage caused by animals.

Vandalism, whether caused by organized artifact collectors or by inadvertent disturbance, is a constant threat to the public's cultural resources. As the number of recreationists at facilities increases (because of better boating, swimming, or fishing opportunities), cultural resources are at greater risk. These risks occur not only at sites that are exposed at water margins, but also in the zone above inundation. Increased numbers of recreationists at CVP facilities (expected when water levels are higher) may require construction of new recreational facilities that, in turn, could affect cultural resources. Impacts could occur from construction of new roads, restrooms, parking lots, marinas, and boat ramps. Lowering water levels could also require new construction to extend boat ramps, create new beaches, or relocate marinas.

Changes in river-flow patterns that result in improved fishing would attract more anglers who may walk through sensitive areas to reach the river. Increased visits to recreation areas could lead to the discovery and possible looting of cultural resources.

Agricultural practices can lead to lesser or greater impacts on cultural resources depending on the type of crop. For example, planting rice (where it is necessary to recontour the landscape) or planting orchards (where it is necessary to plow the land to a depth of approximately 2 meters) can be very destructive to cultural resources. Changes in agricultural patterns from crops that require substantial ground disturbance to pasture or grains, which involve minimal ground disturbance, would be beneficial to the preservation of cultural resources. In some cases, prehistoric sites located on agricultural land have already been disturbed (through leveling, plowing, or disking); therefore, the cessation of agricultural practices on this land would not provide a benefit to cultural resources. However, because other sites on agricultural land may not have been disturbed, this analysis assumes that the fallowing or retirement of agricultural lands provides a benefit by reducing the likelihood that cultural resources would be disturbed.

Some of the land that would be fallowed or retired under the action alternatives would be restored for terrestrial habitat. During restoration, if extensive recontouring of land takes place, an increased potential to cause disturbance to cultural resources could occur.

Cultural resources could be damaged by fish habitat restoration activities through ground-disturbing activities where cultural resources are located and through increased recreation. Installing fish screens, relocating diversions, creating escape channels, replenishing gravelbeds to restore spawning grounds, constructing pumping plants, revegetation of watercourse banks, and dredging are fish restoration actions that could affect cultural resources through ground disturbance. Dredging activities that would disturb shipwrecks are of special concern.

The delivery of water above historical levels to wildlife refuges could affect cultural resources by flooding previously dry land, applying water to existing flooded areas for longer periods of time, or through increased risk to vandalism caused by increased recreational visitation. It is assumed that, prior to any CVPIA undertaking, the lead federal agency will comply with Section 106 of the National Historic Preservation Act (NHPA). Section 106 requires federal agencies to take into account the effect of an undertaking on historic properties prior to implementation.

A summary of assumptions for the cultural analysis is presented in Table IV-62. The results of the impact assessment are summarized in Table IV-63.

Changes in impacts to cultural resources in the Trinity River Basin would be the same between all alternatives and the No-Action Alternative. The specific impacts are being evaluated under separate environmental documentation.

TABLE IV-62

SUMMARY OF ASSUMPTIONS FOR CULTURAL RESOURCES

Assumptions Common to All Alternatives and Supplemental Analyses
Municipal, and recreational land uses as described in DWR Bulletin 160-93.
Changes in cultivated acreage, visitor use of recreational areas, and river and reservoir water elevations based on Agricultural Economics and Land Use, and Surface Water Supplies and Facilities Operations analyses.

NO-ACTION ALTERNATIVE

Under the No-Action Alternative, it is anticipated that growth would continue during the period of analysis, resulting in changes to agricultural practices and land use in general. These changes could cause additional impacts to cultural resources. The nature, location, and extent of these changes cannot be known at this time and, therefore, are not identified in this programmatic document.

ALTERNATIVE 1

Under Alternative 1, the high water levels at Sacramento River Region reservoirs would be the same as those under the No-Action Alternative and the low water level would vary slightly from the low water level under the No-Action Alternative. The drawdown levels would be much lower for New Melones Reservoir, resulting in potential impacts. Resources could be exposed more frequently than under the No-Action Alternative, therefore subject to greater risk to vandalism and more frequent wet-dry cycling. Under Alternative 1, small increases in annual recreation use at reservoirs would not have an impact on cultural resources.

Potential impacts may occur along Clear Creek and the Sacramento and American rivers. Changes in flow patterns to meet Service flow targets would increase recreation visitation, although this increase in recreational use would probably be too small to have an impact on cultural resources.

The minimal amount of change in agricultural land use under Alternative 1 would not have an impact on cultural resources. Similarly, the amount of restored terrestrial habitat that would take place under Alternative 1 would be small and would not have impacts on cultural resources.

TABLE IV-63

SUMMARY OF IMPACT ASSESSMENT FOR CULTURAL RESOURCES

Alternative or Supplemental Analysis	Impact Assessment
No-Action Alternative	Conditions are similar to Affected Environment.
	Changes Compared to the No-Action Alternative
1	Cultural resources at New Melones Reservoir are potentially exposed to vandalism during periods of reservoir drawdown. There is the potential for flooding of or increased erosion of cultural resources at wildlife refuges in the Sacramento River and San Joaquin River regions. Cultural resources in the Sacramento River, San Joaquin River, and Sacramento-San Joaquin Delta regions are potentially effected by the construction and operation of new facilities and the modification of existing facilities for anadromous fisheries habitat restoration.
	Changes Compared to Alternative 1
1a	Conditions are the same as Alternative 1.
1b	Conditions are the same as Alternative 1.
1c	Impacts could range from those similar to Alternative 1, to the potential increased risk of exposure of cultural resources near reservoirs and/or rivers in the Sacramento River and San Joaquin River regions.
1d	Conditions are the same as Alternative 1.
1e	Conditions are similar to Alternative 1, except the fallowing of agricultural land could reduce risk of exposure of cultural resources due to cultivation.
1f	Conditions are similar to Alternative 1.
1g	Conditions are the same as Alternative 1.
1h	Conditions are similar to Alternative 1.
1i	Conditions are the same as Alternative 1.
	Changes Compared to the No-Action Alternative
2	Conditions are the same as Alternative 1, except for the potential reduced risk of exposure of cultural resources in the San Joaquin River and Tulare Lake regions due to impacts from cultivation.

TABLE IV-63. CONTINUED

	Changes Compared to Alternative 2
2a	Conditions are the same as Alternative 2.
2b	Conditions are similar to Alternative 2, except the fallowing of agricultural land could reduce risk of exposure of cultural resources due to cultivation.
2c	Conditions are similar to Supplemental Analysis 2b.
2d	Conditions are similar to Supplemental Analysis 2c.
	Changes Compared to the No-Action Alternative
3	Conditions are the same as Alternative 2, except Vandalism on cultural resources on the Stanislaus River is potentially increased due to an increase in the number of recreational visitors. The risk of exposure of cultural resources in the San Joaquin River Region is potentially reduced due to impacts from cultivation.
3a	Conditions are similar to Alternative 3, except the fallowing of agricultural land could reduce risk of exposure of cultural resources due to cultivation.
	Changes Compared to the No-Action Alternative
4	Conditions are the same as Alternative 3, except for the potential reduced risk of exposure of cultural resources in the Sacramento River due to impacts from cultivation.
4a	Conditions are similar to Alternative 4, except the fallowing of agricultural land could reduce risk of exposure of cultural resources due to cultivation.

Under Alternative 1, refuges in this region would receive Level 2 water, resulting in the delivery of more water to some refuges under this alternative than under the No-Action Alternative. Cultural resources in the areas receiving additional water could be affected by flooding or increased erosion. An increase in the number of visitors at the refuges, compared to the number under the No-Action Alternative, could lead to increased risk to vandalism.

The proposed actions to improve anadromous fisheries habitat under Alternative 1 would include some ground disturbance. Because many of these actions would occur in areas that have a high probability of containing cultural resources, it is likely that these resources would be affected. Direct impacts on cultural resources could result from the effects of constructing and operating new facilities and modifying existing facilities.

ALTERNATIVE 2

Under Alternative 2, the impacts to reservoirs and rivers would be similar to those discussed under Alternative 1.

Under Alternative 2, less than 2 percent of the irrigated lands in the Central Valley would be fallowed. This amount of change could result in a minimal benefit to cultural resources resulting from the reduced potential for disturbance and exposure of resources.

Under Alternative 2, refuges in the study area would receive Level 4 water supplies, resulting in delivery of more water than under the No-Action Alternative. Resources in the areas receiving additional water could be flooded or subjected to increased erosion. Increased visitation at these sites could also lead to increased risk to vandalism.

Under Alternative 2, changes resulting from implementation of terrestrial and anadromous fisheries restoration actions would be similar to those actions discussed under Alternative 1.

ALTERNATIVE 3

Under Alternative 3, the potential impacts to cultural resources at reservoirs and rivers in the Sacramento River Region would be similar to those discussed under Alternative 1. Because of higher river-flows under Alternative 3, the potential for increased risk to vandalism and more frequent wet-dry cycling would occur along the Stanislaus River.

Under Alternative 3, less than 3 percent of the irrigated lands in the Central Valley would be fallowed. A potential beneficial impact on cultural resources could result from this fallowing and from the changes in crop mix that would occur in the San Joaquin River and Tulare Lake regions.

Under Alternative 3, the potential impacts on cultural resources at study area refuges would be the same as those discussed under Alternative 2. Potential impacts resulting from implementation of terrestrial and anadromous fisheries restoration actions would be the same as those discussed under Alternative 1.

ALTERNATIVE 4

Under Alternative 4, the potential impacts to cultural resources at reservoirs and rivers in the study area would be similar to those discussed under Alternative 3. Similarly, the beneficial impacts resulting from changes in agricultural land uses from fallowing and changes in crop mix would be similar to those discussed under Alternative 3.

Under Alternative 4, potential impacts on cultural resources at refuges in the study area would be the same as those discussed under Alternative 2. Potential impacts resulting from implementation of terrestrial and anadromous fisheries restoration activities would be the same as those discussed under Alternative 1.

INDIAN TRUST ASSETS

Reclamation policy is to protect American Indian Trust Assets (ITAs) from adverse impacts of its programs and activities whenever possible. Although there is no concise legal definition of Indian Trust Assets, courts have traditionally interpreted them as being tied to real property. ITAs are property interests held in trust by the United States for benefit of Indian tribes or individuals. Indian reservations, rancherias, and allotments are common ITAs. Other ITAs included traditional-use areas, and, of particular relevance to the actions considered in the Draft PEIS, the fishery resource.

The assessment of potential impacts to ITAs is based on a review of proposed actions that could affect the use and enjoyment of the trust assets. Types of actions that could affect trust assets include an interference with the exercise of a reserved water right, degradation of water quality where there is a water right, impacts to fish and wildlife where there is a hunting or fishing right, or noise near a land asset where it adversely impacts uses of reserved land. Actions evaluated in the Draft PEIS include the management of water resources and the implemetation of physical actions to provide restoration and enhancement of fishery and wildlife resources in the Central Valley and Trinity River Basin.

The implementation of Alternatives 1, 2, 3, or 4, or the associated supplemental analyses evaluated in the Draft PEIS would not result in adverse impacts to Indian Trust Assets. Increased flows associated with any of the alternatives would be within the normal floodplain of affected rivers, and would not negatively affect Indian Trust Assets located adjacent to rivers. Increases in fishery resources in Central Valley rivers and in the Trinity River would be beneficial to ITAs associated with fishing rights.

AIR QUALITY

As compared to the No-Action Alternative, agricultural land use conditions would change in Alternatives 1, 2, 3, and 4, and all associated supplemental analyses. As presented in the description of impacts associated with Agricultural Economics and Land Use, the total changes in land use under these alternatives would be small (less than 6 percent) in each region in the Central Valley as compared to the No-Action Alternative.

Changes to agricultural land uses resulting from the reduction of water supplies due to changes in CVP operations would be made consistent with existing land management practices. Lands fallowed due to the acquisition of water would be planted with a cover crop and irrigated during the first year of fallowed conditions to establish wind erosion controls, and would not result in increased potential for elevated PM_{10} concentrations. Specific actions to reduce air quality impacts due to land fallowing associated with the acquisition of water from willing sellers will be addressed in site-specific environmental documentation.

SOILS

Potential changes to soils resources due to implementation of Draft PEIS alternatives are associated with changes in drainage, instream gravel mining, and stream erosion. A description of potential impacts related to drainage is provided in the discussion of groundwater.

As compared to the No-Action Alternative, aggregate removal would be reduced or eliminated in many Central Valley streams under Alternatives 1, 2, 3, and 4, and all associated supplemental analyses. The reduction of aggregate gravel mining would reduce sediment loadings in rivers and streams, and would reduce the rate of removal of soils with nutrients and vegetation. The implementation of instream habitat restoration actions, including gravel replenishment, bank stabilization and vegetation, and the use of pulse flows to reduce scouring would reduce the potential for erosion in rivers.

VISUAL RESOURCES

Changes in visual resources can occur both regionally and locally. Due to the programmatic nature of the analysis in the Draft PEIS, changes in local conditions are not evaluated in detail. Under all alternatives considered in the Draft PEIS, it is anticipated that changes to agricultural land uses would be regionally distributed, and would occur within the existing distribution of agricultural land character types. As compared to the No-Action Alternative, changes in stream flow conditions would generally result in increased stream flow levels, which is considered a beneficial visual impact. These responses would be further enhanced with the implementation of stream habitat restoration actions. As compared to the No-Action Alternative, the continued operation of water supply facilities would occur within the same range operating conditions, and would therefore not affect the visual character of these facilities.

CHAPTER V

CUMULATIVE EFFECTS

Chapter V

CUMULATIVE EFFECTS

Cumulative effects are defined as the impact upon the environment which results from the incremental impact when added to other past, present, and reasonably foreseeable future actions undertaken by the same or other agencies or persons. The PEIS alternatives, including the No-Action Alternative, are limited to those actions clearly addressed by the CVPIA and environmental consequences analyzed based upon closely related actions. However, it is recognized that the provisions of the CVPIA may be implemented in an interactive manner with other concurrent and subsequent projects. The non-CVPIA actions implemented concurrently with CVPIA may affect the results of implementation of the CVPIA, and may have impacts different from those associated with implementation of CVPIA in isolation.

Actions that may contribute to cumulative affects, include the following actions which are described on the following pages:

- SWRCB water rights process and CALFED Bay-Delta Program,
- changes in water transfer actions,
- changes in farm programs,
- changes in demand for agricultural products,
- studies assessing future use of hatcheries, and
- changes to the commercial and recreational harvest actions for commercial fishing.

In addition, the cumulative analysis addresses potential impacts from CVPIA projects not addressed in the PEIS but which may occur following the completion of the PEIS. These actions include implementation of the yield increase plan, development of additional wetlands, and contract renewals.

A summary of the potential effects of these actions and how they may influence the effects of implementing the alternatives considered in the Draft PEIS is presented in Table V-1.

TABLE V-1

SUMMARY OF CUMULATIVE EFFECTS

Action	Potential Results	Affects to Draft PEIS Alternatives
SWRCB Water Rights and CALFED Bay-Delta Planning Programs	Changes in Delta inflow and associated instream releases	Changes in flows that may influence methodology for Reoperation, (b)(2) water, or water acquisition for instream or Delta flows.
	Restoration of habitat in streams and actions to improve water quality	Programs that will lead to partnerships with CVPIA actions or eliminate need for specific AFRP actions to be implemented under CVPIA.
	Development of new storage and/or Delta conveyance facilities	Water delivery shortages may not be as severe as identified in Draft PEIS.
Changes Water Transfer Actions	More extensive non-CVPIA water transfers than assumed in Base Transfer Scenario for alternatives with CVPIA transfers	Competition for water from water rights holders would reduce available water supplies for transfers under CVPIA water acquisition programs or increase cost of water beyond assumptions for Draft PEIS. Both of these impacts could reduce the amount of water acquired by Interior.
Changes in Federal Farm Programs	If lands fallowed or retired due to CVPIA actions continue to accumulate support payments, the net revenue to farmer may increase and the revenue to the Federal Treasury may not increase.	Farmers may decided to increase participation in water transfer programs, including water acquisition programs by Interior. The price of water also may be reduced which could lead to an opportunity for higher purchases by Interior.

TABLE V-1. CONTINUED

Action	Potential Results	Affects to Draft PEIS Alternatives
Changes in Demand for Agricultural Products	If changes in demand increase crop value, the price of water would increase and/or farmers would be less willing to sell water.	Increases in price or reduction in willing sellers would reduce the ability of Interior to acquire water.
	If changes in demand decrease crop value, the price of water could decrease and/or farmers would be more willing to sell water.	Decreases in price or an increase in willing sellers would reduce the ability of Interior to acquire water.
	Changes in demands may cause farmers to change cropping patterns.	Changes in cropping patterns could change the impacts of water shortages, especially if the ratio of permanent to annual crops changes.
Fishery Programs	Changes in use of hatcheries could occur based upon future studies	Whether changes in hatchery operations increase fish populations may depend upon habitat, hatchery practices, and other factors such as predation. Use of hatcheries also could reduce natural stock and the overall population through competition or reduction in genetic diversity.
	Changes in harvest limitations could occur in the future	Changes in harvest limitations may increase fish. However, the impact of domestic harvest may not be noticeable if larger numbers of fish are lost to international harvest, ocean conditions, or predation.
Yield Increase Plan	Development of facilities and programs to increase CVP water supplies to reduce impact of shortages from CVPIA actions	The programs may also increase the amount of water available for use by Interior for fish and wildlife purposes. The programs also may compete for the same sources of water that the Draft PEIS identified as sources for the water acquisition program.
Additional Wetlands	Improve reliability of water supplies to private wetlands and develop new wetlands. A portion of the new wetlands considered in the Draft PEIS alternatives.	For the new wetlands, water supplies would probably be obtained with the land. Water obtained from other sources could be acquired for multiple purposes or water available for transfers may be reduced.

SWRCB WATER RIGHTS PROCESS AND CALFED BAY-DELTA PROGRAM

The purpose of the SWRCB water rights process for Delta water quality and quantity is to develop a methodology to provide adequate flows to meet the Bay-Delta Plan Accord. The purpose of the CALFED program is to develop a long-term solution to problems affecting the Delta. The SWRCB process is evaluating several alternatives which would require different agencies, including the CVP and SWP, to release water in a manner to protect Delta quality. The CALFED program is evaluating alternatives, including several water storage options that include groundwater banking, offstream surface water storage, and conjunctive use.

Both programs are developed to improve the ecosystem and water quality and possibly implement many of the same programs identified by the AFRP under CVPIA. Therefore, actions implemented under CVPIA could serve as all or part of the Federal share of CALFED actions. It also is possible that the under the SWRCB process or CALFED, water rights holders may release water in a new pattern that would partially or fully meet the target flows suggested by the AFRP. Therefore, the CVPIA water acquisitions may not need to be as extensive.

CALFED also could develop more reliable water supplies, and thereby reduce the impacts of CVPIA actions on CVP contractors through the construction of new storage and conveyance facilities.

NON-CVPIA WATER TRANSFERS

The use of water transfers to allow water trades between willing sellers and buyers is expected by many experts to be used increasingly in the future. Transfers provide an opportunity to increase or replace water supplies to support future demands. The success of the 1991 Drought Water Bank demonstrated the potential for transfers to ameliorate severe localized shortages. Currently, the DWR is proposing a Supplemental Water Purchase Program to allow water transfers by SWP contractors over a 6-year program. The draft environmental impact report for the Supplemental Water Purchase Program indicated that there was approximately 200,000 acre-feet of water available for a short-term water transfer program. The report also identified several potential adverse impacts associated with water transfers, including reduced Delta inflow during certain time periods, entrainment losses of some fish due to diversions at new locations, losses to fish due to changes in flow patterns which may raise temperatures or dewater or flood spawning areas, reduced reservoir levels and associated recreation actions, and reduced irrigated acreage and wetlands due to changes in use of water. These same types of issues could occur under long-term transfers.

The PEIS evaluated transfers with respect to use of water for fish and wildlife purposes under the Water Acquisition Program and the opportunities for water transfers to agricultural and municipal users. Each of the transfer analyses assumes a well-functioning water transfer market. Future conditions could potentially increase demands for transfers beyond what has been assumed in the PEIS. This could lead to greater competition for the water which would increase the cost of water to all purchasers including Interior.

CHANGES IN FEDERAL FARM PROGRAMS

The 1996 Farm Bill revised the way commodity payments are determined, and decoupled the size of the payment from the actual production level. There remains, however, some uncertainty about how the U.S. Department of Agriculture (USDA) will handle lands that are part of a grower's base acreage yet are retired or fallowed as CVPIA is implemented. For purposes of the PEIS analysis, it was assumed that USDA would remove such lands from the grower's base acreage and reduce the deficiency payment accordingly. The estimates of changes in farm commodity payments are based on that assumption.

If, instead, growers who retire or fallow their land as part of CVPIA implementation continue to receive program payments associated with that land, then no savings would accrue to the federal treasury. However, net revenues to the farmers would increase. This may lead to greater participation in the water transfer market which may lead to a lower cost for water. Either or both of these impacts could increase the amount of water purchased by Interior for water acquisitions. Because the 1996 Farm Bill extends for only a limited number of years, great uncertainty remains about interactions between CVPIA and federal commodity programs.

CHANGING DEMAND FOR AGRICULTURAL PRODUCTS

The PEIS analysis used real, 1992 prices and costs, and did not attempt to estimate differential increases in prices and costs in the future. However, some evidence exists that demands for farm produce, especially fruits and vegetables grown in California, will increase in the future and cause their price to increase faster than the overall inflation rate. If this occurs, then the cost associated with acreage reductions estimated in this study are understated. Higher value for crops would increase the cost of water or reduce the willingness of sellers to participate in the transfer market. This would decrease the opportunities for Interior to acquire water for fish and wildlife purposes.

Another view is that increasing competition from expanding production regions, especially in Central and South America, will hold future price increases to below the level of inflation. Lower value for crops would decrease the cost of water or increase the willingness of sellers to participate in the transfer market. This would increase the opportunities for Interior to acquire water for fish and wildlife purposes.

Changes in demand could change the ratio of permanent to annual crops. If more permanent crops were planted, the affects of changes in water availability on an annual basis could become more significant.

FISHERIES ISSUES

Although artificial production of many species of game fish, including west coast anadromous fish, has become an essential tool in fishery management, the CVPIA by necessity focused on the natural production of anadromous fish in the Central Valley rivers and streams. Therefore, the PEIS does not attempt to evaluate in detail either the positive or negative benefits of hatchery production of fish. The analysis recognizes that there are numerous federal, state, and local fish hatcheries and rearing facilities that appear to be making successful and substantial contributions to the management of anadromous fish species. Most of these programs are well founded and funded annually by their respective agencies. Associated with the physical facilities that contribute to sustaining fish populations, the Coleman National Fish Hatchery is undergoing a major rehabilitation to improve water quality and production facilities. The CVPIA provided for an evaluation of the alternatives that would provide the most acceptable and balanced method to sustain on a long-term basis the anadromous fish populations using natural production methods. At a future time, it may be possible to evaluate the impact of artificially produced anadromous fish and how to accomplish the balance of resource use and doubling of native populations, as discussed in the CVPIA.

The same holds true for an accurate analysis of evaluating the impacts on salmon that spend over two-thirds of their life cycle in the ocean. During this stage of their lives, they are not available for intensive scientific study. Certainly, both sport and commercial harvest play a major role in resolving year class success. However, until the physical loss to harvest can be adequately equated with natural phenomena of the sea (such as temperature changes, upwelling, current changes and food availability), there is no exact method to assign negative or positive benefits. The NMFS has made good advances in resolving some of these issues and will continue to address these concerns.

YIELD INCREASE PLAN

As part of the CVPIA, the Least-Cost Yield Increase Plan was completed to describe possible actions to increase CVP yield. The yield increase options considered in the plan ranged from purchase of water supplies, land fallowing, conjunctive use, water conservation, urban wastewater reuse, and offstream storage. Use of new facilities, water reuse, and conjunctive use could be methods to reduce the shortages that are projected under the PEIS alternatives. The PEIS identified land fallowing and water conservation as measures to provide additional water supplies for fish and wildlife purposes. Implementation of water purchases for both purposes could cause conflicts, or could be implemented in a way that would benefit both programs. For example, if acquired water purchased to increase instream flows is diverted downstream of the critical reaches and stored in an offstream storage facility, both purposes would benefit. In addition, the cost to both users would be less.

ADDITIONAL WETLANDS

Another section of CVPIA, Section 3406(d) (6)AB, requires investigations addressing water needs and supplies. Part A will address the alternative means of improving the reliability and quality of water supplies currently available to privately owned wetlands in the Central Valley and the need, if any, for additional supplies; part B of this Section requires investigations of water supply and delivery requirements necessary for full habitat development of water dependent wildlife on 120,000 acres of new wetlands. To date, about 50,000 acres have been protected and much has been restored toward the goal, including additions to existing refuges and San Joaquin Basin Action Plan lands. It is likely that future wetland development would occur by fee acquisition or easement with willing landowners, in areas where water is currently available through water rights or contract. Water supply to those areas would likely result from converting one type of land use to wetland and associated habitat. If additional water purchase is necessary for these lands, water for other purposes could be reduced.

CONTRACT RENEWALS

The Draft PEIS No-Action Alternative and other alternatives assume that all renewable CVP contracts would be renewed. It is further assumed that the contract renewal process would include the completion of a needs analysis to identify and quantify beneficial uses/demands and a biological assessment of lands that would receive CVP water. Either of these analyses could limit the amount of water that could be delivered. In addition, the lack of diversion facilities could limit the amount of water that could be delivered. It was not feasible to complete these analyses during the preparation of the PEIS. Therefore, for the purposes of the PEIS, the maximum amount of water delivered under the contracts was assumed to be limited by the maximum historical delivery amount up to the maximum contract amount, the maximum amount that had been considered in a previous environmental document up to the maximum contract amount, or the maximum amount that could be diverted with existing facilities, as described in Chapter II and summarized in Table V-2.

It is recognized that as beneficial use needs analyses and biological assessments are completed, the contract amounts may be modified. If these analyses lead to renewal of contracts at the existing contract amounts, the amounts to be delivered by the CVP would be different than analyzed in the Draft PEIS alternatives. To evaluate this condition on deliveries by the CVP, a Cumulative Impact Analysis was completed based upon Alternative 1. Alternative 1 was selected because the water delivery impacts evaluated in Alternative 1 primarily occur to the CVP, and the impacts of this analysis would primarily occur to the CVP users. The analysis includes the full contract amounts for all existing CVP contractors and proposed contract amounts for new contracts provided for under Section 206 of PL101-514 per 3404(b) of CVPIA.

IMPACT ASSESSMENT

The conditions for the Cumulative Impact Analysis were evaluated for surface water operations, groundwater resources, and agricultural economics.

Surface Water Operations

In the Cumulative Impact Analysis, the operations of the CVP and SWP are in accordance with all operational criteria described in Alternative 1. The difference between Alternative 1 and the Cumulative Impact Analysis is the increase to full CVP contract allocation. Refuge contracts are the same as Alternative 1. Table V-2 shows a comparison of the CVP contract allocations between the Cumulative Impact Analysis and Alternative 1.

TABLE V-2

CVP CONTRACT ALLOCATIONS IN ALTERNATIVE 1 AND CUMULATIVE IMPACT ANALYSIS

	Total Contract Allocations (in 1,000 af)		
CVP Water Users	**No-Action Alternative & Alternative 1**	**Cumulative Impact Analysis**	**Calculated Change in Contract Allocations**
North of the Delta			
Agricultural Water Service Contractors	480	570	+90
Sacramento Water Rights Contractors	1,870	1,940	+70
Municipal Water Service Contractors	260	540	+280
South of the Delta			
Agricultural Water Service Contractors	1,980	1,980	0
San Joaquin River Exchange Contractors	880	880	0
Municipal Water Service Contractors	140	140	0
CVP Contracts on the Stanislaus River	160	160	0
Friant Division			
Madera Canal Contractors	490	490	0
Friant-Kern Canal Contractors	1,450	1,450	0

CVP Operations and Impacts

Operations in the Trinity River, Shasta, and Sacramento River Divisions are similar to those in Alternative 1. A frequency plot of Folsom Lake end-of-water year reservoir storage is presented in

Figure V-1. Average end-of-water year reservoir storage is 50,000 acre-feet less than in Alternative 1 and the target flows on the American River are met in fewer months due to additional reservoir releases to meet increased full contract water demands on the American River. Average monthly flows on the American River below Nimbus Dam are presented in Figure V-2. Average monthly flows are less than in Alternative 1 due to water deliveries for additional agricultural and municipal water service contractors on the American River.

Operations in the Eastside, Delta, and West San Joaquin Divisions are similar to those in Alternative 1.

The majority of the increase to full contract allocations is in municipal water service contractors located north of the Delta. This increase in contract amounts results in additional and more frequent reductions in deliveries to agricultural water service contracts compared to the No-Action Alternative and Alternative 1. Deliveries to CVP contractors in the Cumulative Impacts Analysis, as compared to deliveries in the No-Action Alternative and Alternative 1 are provided in Table V-3. The net difference in CVP deliveries is a function of increased deliveries to Sacramento River Water Rights Contractors and municipal water service contractors and reduced deliveries to agricultural water service contractors.

TABLE V-3

COMPARISON OF CVP DELIVERIES IN THE FULL CONTRACTS ANALYSIS, ALTERNATIVE 1, AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual CVP Deliveries (in 1,000 af)		
		No-Action Alternative	Alternative 1	Full Contracts Analysis
1922 - 1989	Simulation Period	6,030	5,790	5,520
1928 - 1934	Dry Period	4,780	4,470	4,130
1967 - 1971	Wet Period	6,570	6,510	6,370

Frequency plots of the simulated percent of full annual deliveries to CVP agricultural and municipal water service contractors north of the Delta, in the No-Action Alternative, Alternative 1, and Cumulative Impacts Analysis are presented in Figure V-3.

Full contract deliveries are reduced between 15 and 20 percent for CVP agricultural and municipal water service contractors north of the Delta in the Cumulative Impacts Analysis as compared to Alternative 1. Under the Cumulative Impacts Analysis, CVP agricultural water service contractors north of the Delta experience 100 percent delivery shortages in 15 percent of the years as compared to about 5 percent of the years in Alternative 1.

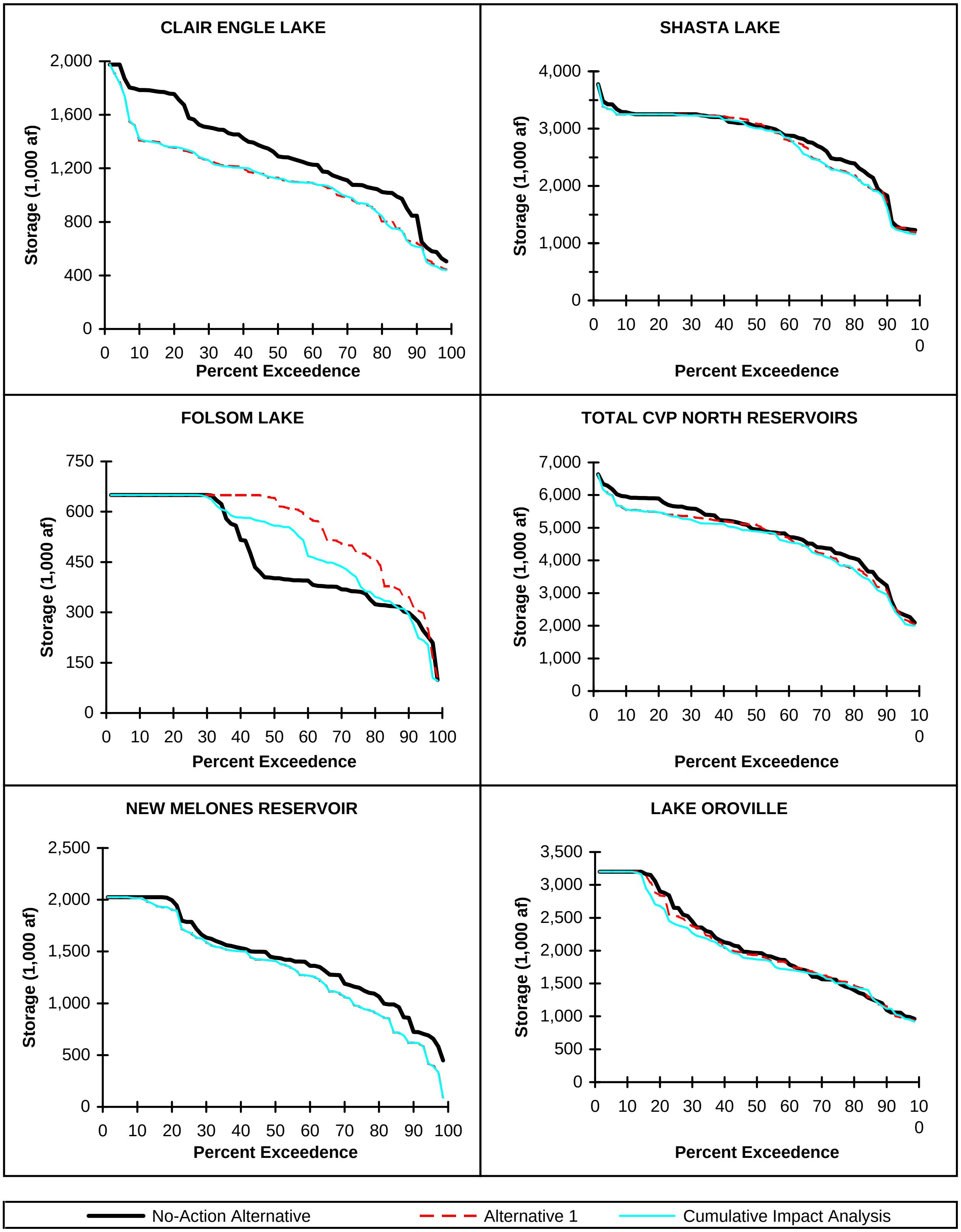


FIGURE V-1

SIMULATED FREQUENCY OF END-OF-WATER YEAR STORAGE 1922-1990

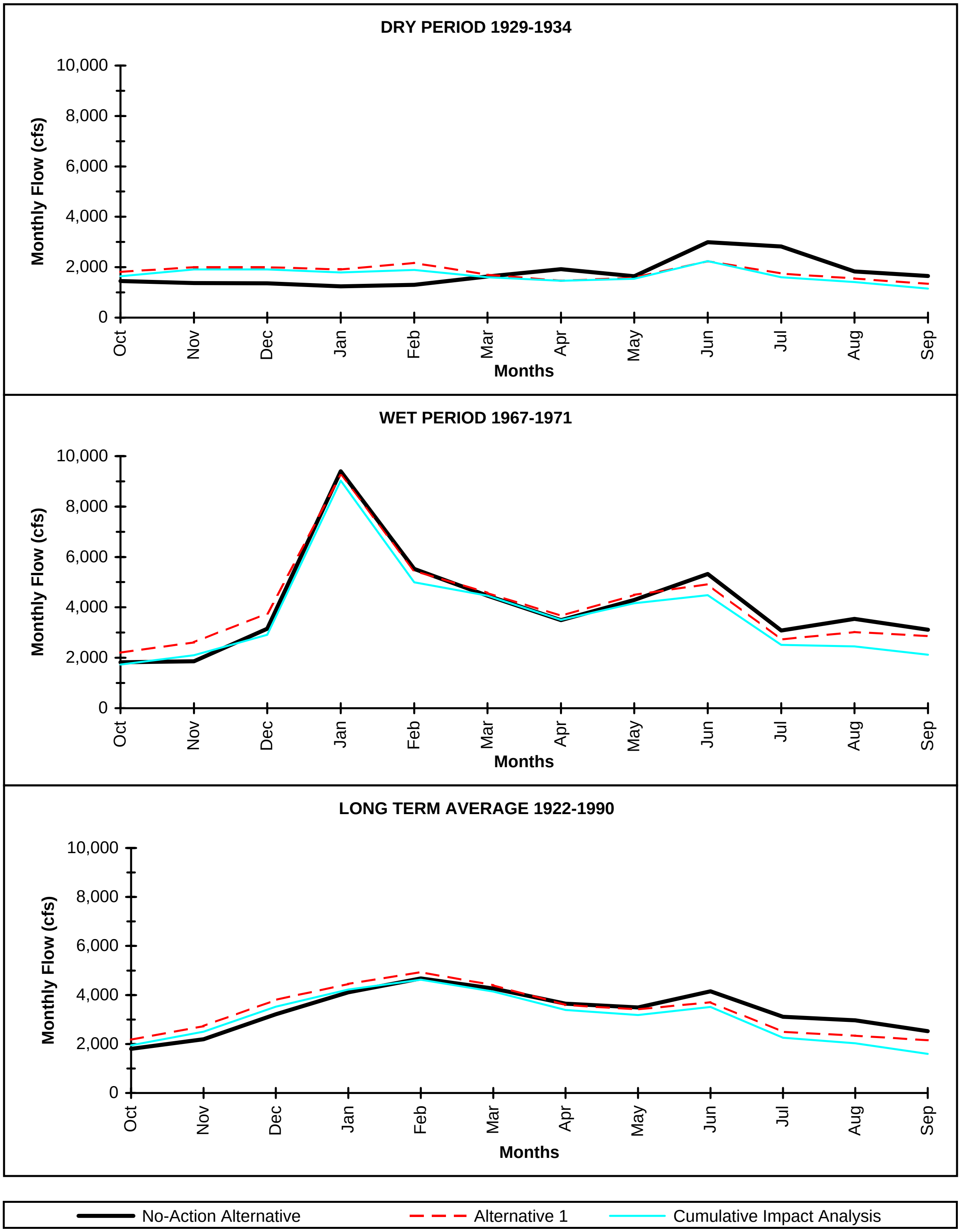
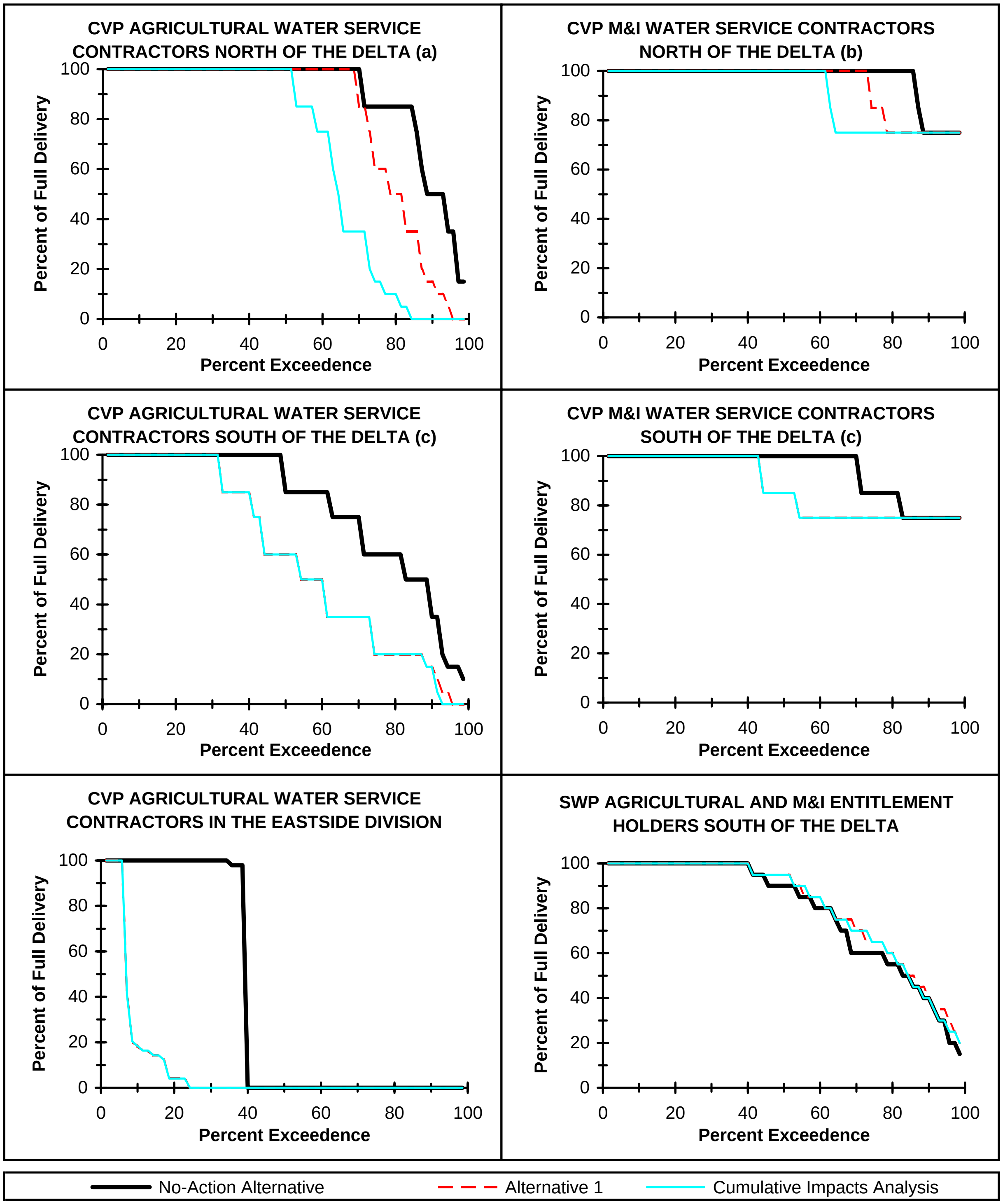


FIGURE V-2

AMERICAN RIVER BELOW NIMBUS SIMULATED AVERAGE MONTHLY FLOWS



NOTE: (a) Includes Sacramento River and American River Divisions.
(b) Includes Sacramento River and American River Divisions plus Contra Costa exports.
(c) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE V-3
SIMULATED FREQUENCY OF PERCENT OF FULL ANNUAL DELIVERIES 1922-1990

With the addition of full American River agricultural and municipal water service contract allocations in the Cumulative Impacts Analysis, the minimum contract deliveries, reservoir storage, and instream flow requirements cannot be maintained on the American River in some critical dry years. Delivery reductions of up to 50 percent are imposed on American River municipal water service contractors in these critical dry years due to lack of water supply.

CVP water deliveries to the Eastside Division and refuges are the same as in Alternative 1.

Frequency plots of the simulated percent of full annual deliveries to CVP agricultural and municipal water service contractors south of the Delta, in the No-Action Alternative, Alternative 1, and Cumulative Impacts Analysis are presented in Figure V-3. Full contract deliveries are similar for CVP agricultural and municipal water service contractors south of the Delta in the Cumulative Impacts Analysis as compared to Alternative 1, except for agricultural contractors which experience additional shortages in the critical dry years.

Impacts to SWP Operations and Deliveries

This section provides a comparison of the Cumulative Impacts Analysis and the No-Action Alternative and Alternative 1 SWP reservoir operations and water deliveries to SWP entitlement holders. A frequency plot of Lake Oroville end-of-water year reservoir storage is presented in Figure V-1. End-of-water year reservoir storage is reduced slightly compared to Alternative 1. SWP operations are affected by the changes in releases from upstream CVP reservoirs to meet full contract deliveries. Deliveries to SWP Entitlement Holders south of the Delta under the Cumulative Impacts Analysis, as shown in Table V-4, are similar to Alternative 1.

TABLE V-4

COMPARISON OF SWP DELIVERIES IN THE CUMULATIVE IMPACTS ANALYSIS, ALTERNATIVE 1, AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual SWP Deliveries (in 1,000 acre-feet)		
		No-Action Alternative	Alternative 1	Cumulative Impacts Analysis
1922 - 1990	Simulation Period	3,350	3,450	3,410
1928 - 1934	Dry Period	2,050	2,200	2,140
1967 - 1971	Wet Period	4,140	4,100	4,100

Groundwater Impact Assessment

A summary of groundwater resources as simulated under the conditions of the Cumulative Impacts Analysis in comparison to the No-Action Alternative and Alternative 1 is presented below.

Sacramento River Region

Under the Cumulative Impacts Analysis, average annual groundwater pumping was 20,000 acre-feet/year less than under the No-Action Alternative on the west side, and 109,000 acre-feet/year on the east side of the Sacramento River Region. These decreases are in direct response to additional CVP deliveries. Given the decrease in average annual groundwater pumping under the Cumulative Impacts Analysis in comparison to the No-Action Alternative, groundwater storage is improved in comparison to the No-Action Alternative, even with a decrease in gains from streams.

Differences in the end of simulation period groundwater levels under the Cumulative Impacts Analysis and the No-Action Alternative are shown in Figure V-4 for the Sacramento River Region. There were no differences in regional groundwater levels from the Tehama-Glenn county line north to Redding. In several areas along the west side of the Sacramento Valley, groundwater levels are lower under the Cumulative Impacts Analysis than under the No-Action Alternative by approximately 10 to 20 feet. This response is due primarily to a reduction in CVP project water deliveries to the Tehama Colusa Canal service area. Groundwater levels generally improved in areas where groundwater pumping decreased in comparison to No-Action Alternative.

Under the Cumulative Impacts Analysis groundwater levels declined very little in areas of potential land subsidence. No additional land subsidence would be induced in comparison to the No-Action Alternative and Alternative 1.

San Joaquin River Region

Under the Cumulative Impacts Analysis, San Joaquin River Region average annual groundwater pumping, groundwater levels, and land subsidence are similar to Alternative 1. These simulation results indicate that on a regional basis the San Joaquin River Region would be in a state of groundwater overdraft.

Tulare Lake Region

Under the Cumulative Impacts Analysis, Tulare Lake Region average annual groundwater pumping, groundwater levels, and land subsidence are slightly increased as compared to Alternative 1. These simulation results indicate that on a regional basis the Tulare Lake Region would be in a state of groundwater overdraft.

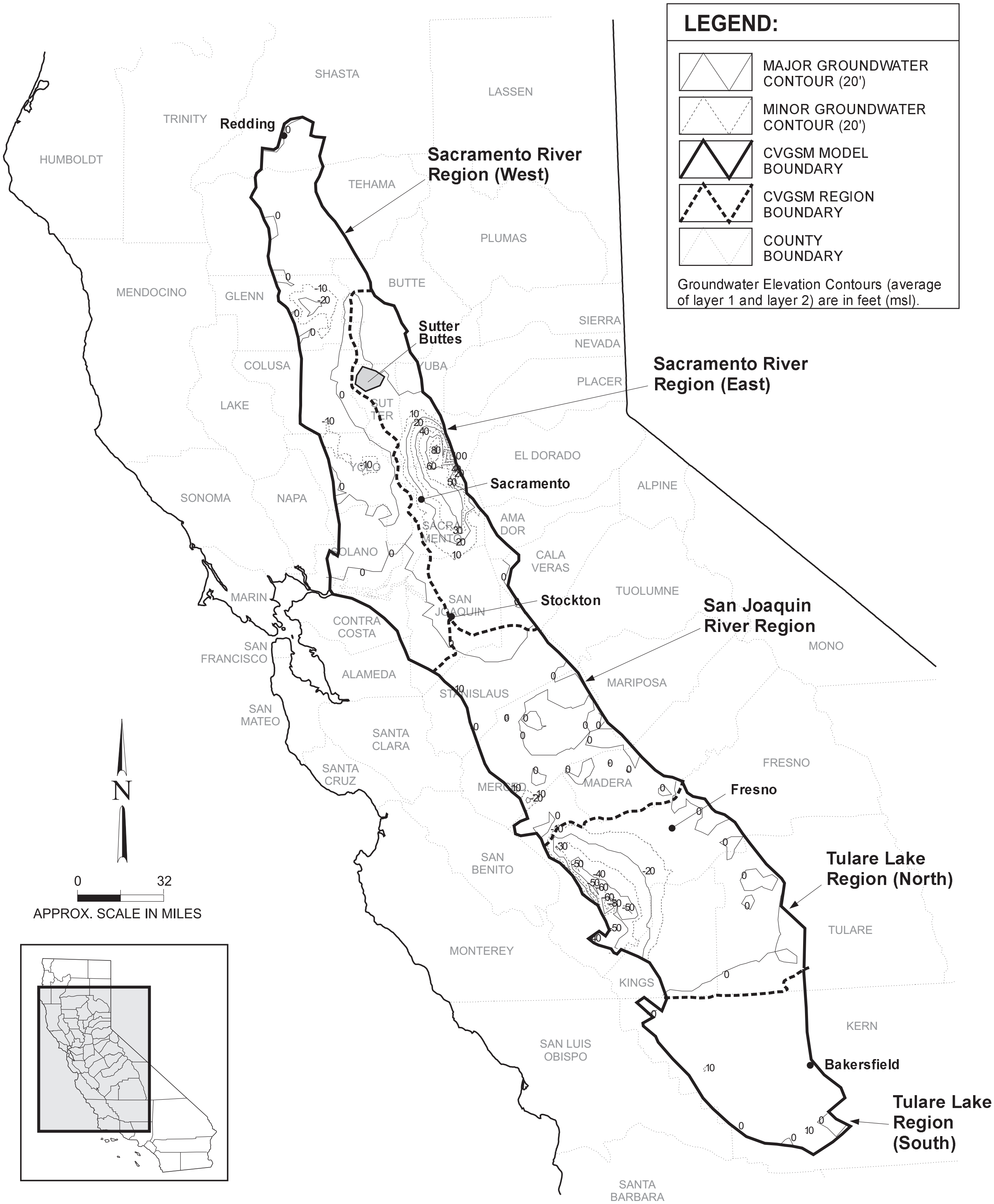


FIGURE V-4

DIFFERENCES IN END OF SIMULATION GROUNDWATER ELEVATIONS FOR CUMULATIVE IMPACT ANALYSIS AS COMPARED TO NO-ACTION ALTERNATIVE

Agricultural Impact Assessment

The results of the analysis assuming full contract quantities are delivered when possible are presented for average year conditions in Table V-5. The table shows a direct comparison of the Cumulative Impact Analysis results with those of Alternative 1.

TABLE V-5

COMPARISON OF AGRICULTURAL ECONOMIC IMPACTS IN THE CUMULATIVE IMPACTS ANALYSIS, ALTERNATIVE 1, AND NO-ACTION ALTERNATIVE SIMULATIONS

Item/ Region	No-Action Alternative	Alternative 1	Cumulative Impact Analysis
Surface Water Use (1,000 af)			
Sacramento River	4,524	4,485	146
San Joaquin River	4,453	4,151	-4
Tulare Lake	2,761	2,739	-4
San Felipe (CVP only)	71	53	0
Total	11,809	11,428	138
Groundwater Use (1,000 af)			
Sacramento River	2,603	2,628	-139
San Joaquin River	3,427	3,561	3
Tulare Lake	3,297	3,253	4
San Felipe (CVP only)	na	na	na
Total	9,327	9,442	-132
Irrigated Acreage (1,000 acres)			
Sacramento River	2,020	2,018	1
San Joaquin River	2,558	2,527	0
Tulare Lake	2,009	1,993	0
San Felipe (CVP only)	25	16	0
Total	6,611	6,554	1
Gross Revenue ($ Million)			
Sacramento River	1,828	1,828	0
San Joaquin River	4,436	4,405	0
Tulare Lake	3,893	3,878	0
San Felipe (CVP only)	88	57	0
Total	10,245	10,168	0
Net Revenue ($ Million)			
Sacramento River	268	267	5
San Joaquin River	558	525	0
Tulare Lake	522	509	0
San Felipe (CVP only) on	8	5	0
Total	1,356	1,306	5

Total expected increase in CVP agricultural water deliveries is about 139,000 acre-feet. A net increase to the Sacramento River Region (146,000 acre-feet) is largely due to increased delivery to Sacramento River Water Rights Contractors and to American River contractors. The San Joaquin River and Tulare Lake regions are estimated to lose about 4,000 acre-feet each. Delivery of more water during full supply years means that existing water service contractors would take more frequent and larger deficiencies. The Tehama-Colusa, Delta-Mendota, San Luis, and Cross Valley Canal service areas would be among the areas most impacted. The changes in deliveries are estimated to be almost matched in each region by changes in groundwater use. Groundwater use declines in the Sacramento River Region and increases in the other two regions. A small increase in irrigated acreage is estimated in the Sacramento River Region. Net revenue impacts in the Sacramento and Tulare Lake regions are minor, but in the San Joaquin River Region the net revenue is expected to increase about 2 percent, due almost entirely to lower groundwater pumping costs. Supply impacts on the San Felipe Unit are estimated not to change.

Other Issue Areas

Other factors considered in the Draft PEIS analysis also would change as compared to the conditions described under Alternative 1. The primary differences would occur to fisheries and wildlife habitat in and along the American River due to reduced flows and to recreational opportunities and associated revenues for recreation at Folsom Lake due to reduced storage. The reduced storage also could increase the potential for vandalism of cultural resources as more soils are exposed along the American River and at Folsom Lake. Wetland areas along the shores of Folsom Lake also would be reduced in the Cumulative Impact Analysis as compared to Alternative 1.

CHAPTER VI

COORDINATION OF PEIS AND OTHER ACTIONS

Chapter VI

COORDINATION OF PEIS AND OTHER ACTIONS

The PEIS evaluates the direct and indirect impacts of implementing a wide range of actions related to CVPIA. The PEIS evaluated the system-wide benefits and impacts of several broad alternatives, but not site-specific changes. Following the PEIS, project-specific alternatives can be developed for each action, watershed, or CVP division. This chapter presents several ways that information from the PEIS can be used to assist in the implementation and review of the subsequent actions.

PURPOSE OF A PROGRAMMATIC ENVIRONMENTAL DOCUMENT

A PEIS can be an "umbrella-document" for subsequent detailed analyses. A PEIS must address the probable environmental impacts and benefits that can be identified without undue speculation. A PEIS is frequently used to evaluate new programs or regulations; analyze a series of actions that are part of a larger project; or consider broad policy alternatives and programmatic mitigation measures prior to implementation of initial actions that may preclude subsequent measures. A PEIS is especially important in evaluating the "system-wide" impacts of multiple actions.

As the project-specific actions are considered, the lead agencies must determine if the specific impacts were fully analyzed in the PEIS. If the actions would have no greater impacts than those analyzed in the PEIS or would not require additional mitigation measures, the actions could be considered part of the overall program previously approved. In such a case, an administrative decision could be made that no further environmental documentation would be necessary. If the lead agency cannot with certainty determine the level of significant impacts associated with a site-specific action, an Environmental Assessment (EA) could be prepared to determine if the action would require additional evaluation.

If it is determined that the proposed action was not fully addressed in the PEIS, a tiered document could be prepared, or possibly a separate NEPA document would be required. If a tiered document is appropriate, the tiered document may be an EIS or an EA. The tiered documents can use the PEIS by reference to avoid duplication. For example, the analysis of systemwide impacts related to water management could be incorporated by reference on tiered activities to avoid a rediscussion of these issues. In addition, tiered documents would need only to revisit factors that are changed. Therefore, if specific actions are discussed in the tiered documents, only changes from the alternatives considered in the PEIS would be addressed in detail.

The PEIS can continue to be used as the umbrella-document as long as no substantial changes have occurred in the overall project or the Affected Environment, or unless significant new information has become known subsequent to the completion of the PEIS. If that occurs, the portion of the PEIS that is affected by the changes would need to be modified.

USE OF THE PEIS FOR IMPLEMENTATION OF CVPIA

This PEIS has been prepared under NEPA requirements. The subsequent actions may require preparation of a tiered EIS or EA, or the action may be subject to a Categorical Exclusion. The Reclamation NEPA Handbook includes a Categorical Exclusion Checklist that can be completed to determine if either an EA or an EIS should be prepared.

If the actions would probably lead to significant adverse impacts that would be greater than discussed in the PEIS, or if multiple options must be considered in equal detail, a tiered-EIS should be prepared. If the lead agency is unsure if significant adverse impacts would occur, a tiered-EA may be prepared to summarize findings and obtain public input. If no significant impacts would occur, either with or without mitigation measures, then an administrative decision of no significant adverse impacts would result from the action and a Finding of No Significant Impact (FONSI) can be filed. If significant adverse impacts are identified, and several alternatives need to be considered in detail, a tiered-EIS should be prepared.

COMPARISON OF FEDERAL AND STATE ENVIRONMENTAL DOCUMENTS

Many of the actions to be implemented under CVPIA will either be fully or partially implemented and/or funded by State or local agencies in California, or require State or local permits and approvals. Implementation, funding, and permitting actions by State and local agencies must comply with the California Environmental Quality Act (CEQA). The CEQA requirements are similar to NEPA requirements and include provisions for programmatic and tiered environmental documents.

Under CEQA, an environmental impact report (EIR) is prepared as compared to an EIS under NEPA. The CEQA provides for an Initial Study with a Negative Declaration in a similar manner to the EA with a FONSI. In most instances, information presented in NEPA documents can be used for CEQA analysis. However, a NEPA document may need to be changed as part of CEQA compliance to meet CEQA requirements.

In CEQA documents the impacts of implementation of alternatives are compared to the Existing Conditions. However, in cases such as the PEIS, when the alternatives are developed using a No-Action Alternative condition which is a future condition, CEQA would require comparison of the alternatives to both the Existing Conditions and to the future No-Action Alternative, or No Project Alternative. Because the PEIS includes a description of the Existing Conditions, the additional effort to provide CEQA compliance can be accomplished with relatively little effort in data collection.

ENVIRONMENTAL COMPLIANCE FOR CVPIA ACTIONS

The PEIS provides the programmatic coverage for implementation of the CVPIA. The coverage of most of the CVPIA provisions in the PEIS is programmatic in nature, and will require additional environmental documentation. Several of the actions are related to CVP-wide water and power operations, and therefore, may not require additional environmental documentation. Other actions are currently undergoing separate NEPA analyses, such as changes in the Trinity River watershed. Most of the actions may need to be evaluated on a smaller geographic basis, such as within a watershed, a refuge complex, or a CVP division.

For example, a range of actions for a watershed may define specific types of habitat restoration activities, possibly using phased implementation with a monitoring program. This watershed approach would specify both minimum and maximum actions to be taken without the need for further system-wide analysis. By using a range of actions to be implemented, adaptive management techniques could be used to identify the most effective methods. This approach may lead to implementation of different types of actions for different watersheds and different water year types, such as using purchased water for increased stream flows in above normal years and for wetland in critical dry years.

TIERED ENVIRONMENTAL DOCUMENTATION

As discussed above, the tiered environmental documentation may be most effective if CVPIA activities are grouped for analysis. The most effective groupings may be within a watershed or within a CVP division. Examples of actions that may be grouped are summarized below.

Contract Renewals

Water contract renewals may need to be considered at two different levels. A CVP-wide document, or an umbrella document, could be used to present CVP-wide evaluations of the following items, as well as other items.

- 3404(c) Contract Renewals (including periods of renewal, shortage criteria, price modifications under 3405(d))
- 3405(b) Measurement of Water Use
- 3405(d) Water Pricing Modifications
- 3405(e) Water Conservation Standards
- 3406(c) Assessment and Collection of the Friant Division Surcharge
- 3407 Assessment and Collection of Restoration Funds

CVP-wide water contract renewal environmental document could rely significantly on the PEIS. Additional implementation options for some of the CVPIA provisions may be identified following completion of the PEIS and could be evaluated in the CVP-wide water contract renewal environmental document. If the anticipated impacts of the additional options would be less than the impacts shown in the PEIS, detailed analyses may not be needed. As an alternative, this information could be discussed for each CVP division in division-specific documents.

The division-specific documents would include an evaluation of impacts to land use and economics as related to the Water Needs Analysis, shortage criteria, and Best Management Practices (BMPs) for water conservation in each CVP division. These documents also may include evaluation of impacts to vegetation and wildlife as related to irrigation of lands that had not recently been irrigated with CVP water but were proposed to be irrigated with CVP water; or vegetation and wildlife impacts for lands that may become fallowed in the future due to reduced reliability of CVP water supplies. The division-specific documents also would include any specific factors for that division.

Rules and Regulations

As with a CVP-wide contract renewal environmental document, the rules and regulations environmental document would include analysis of groups of actions. Additional implementation options for some of the CVPIA provisions may be identified following completion of the PEIS and could be evaluated in the rules and regulations environmental document. If the anticipated impacts of the additional options would be less than the impacts shown in the PEIS, detailed analyses may not be needed. However, the environmental documents could include a description of these additional options and the reasons for not completing additional environmental analysis.

Fish Habitat Improvements

In actions subsequent to the PEIS, fishery habitat improvements may include changes in stream flows; improvements to structures, such as construction of fish screens; or channel improvements, such as bank restoration. To evaluate all of these interrelated activities, the actions may need to be considered on a watershed or partial watershed basis. This type of analysis would allow for development of phased implementation of actions, and adaptive management to incorporate information collected during the monitoring programs. This type of watershed analysis also could be effective in avoiding implementation of an action that would not be appropriate without a related action. For example, improving streambed conditions with gravel restoration or bank improvements may not be effective if stream flows or water temperatures are not improved. For watersheds with minimal actions to be implemented within the next 5 to 10 years, individual environmental documents could be developed without an analysis of the entire watershed program.

Refuge Water Supplies

Project-specific environmental documents for the refuges may group actions by refuge complexes, such as the Sacramento Valley refuges. This type of grouping may be appropriate because conveyance facilities may be constructed to serve multiple refuges. In addition, adaptive management procedures may be developed to coordinate refuge activities to maximize the ecosystem approach to the extent possible with associated wetlands programs identified under CVPIA. Impact analysis of water acquisition from willing sellers that would be utilized for increased refuge water supplies could be coordinated with documents for other water acquisitions.

Water Acquisition

Project-specific environmental documentation for water acquisitions may need to be specific to the proposed sale of water by willing sellers. The environmental documentation for use of the acquired water could be included in fish habitat or refuge water supply environmental documents. However, the impacts due to the sale of the water would need to be considered individually by the selling agency. The willing seller would need to comply with all appropriate State laws, including the requirements of the SWRCB. Some of the water transfers may require the SWRCB to consider the petition for change in the place of use and beneficial use. A CEQA document is required as part of this SWRCB review process. The CEQA document must identify any potential impacts and mitigation measures to reduce the adverse impacts to a less than significant level with relation to fish, vegetation and wildlife, land use, economics, human, and cultural resources. Some of the issues may require mitigation if the water sale would significantly reduce available jobs in the region or the availability of water to downstream water users who have historically depended upon releases and/or return flows from the willing sellers for water supplies. Water purchased under the water right of the United States or from pre-1914 water rights holders may not require water rights changes or SWRCB approval. However, Reclamation would require NEPA documentation for any changes in use of water under CVP contract or any water purchased by Interior.

Summary

The PEIS has been developed in a manner that allows for flexibility in the implementation of the CVPIA and to limit the need to re-evaluate the Central Valley-wide impacts. The PEIS also has been prepared in a manner to maximize the ability of future environmental documents to incorporate significant amounts of information by reference, especially as related to the Affected Environment. Future environmental documents should consider grouping actions to the extent possible to allow decision makers and the public to evaluate cumulative impacts of associated actions and to minimize the number of project-specific environmental documents. Environmental documents for fish and wildlife management actions should consider a range of recommendations to allow for adaptive management with well-defined minimum and maximum actions and impacts to land use, economics, and water supplies.

Environmental documents are also needed by agencies that issue permits and approvals. Depending upon the agency, either a NEPA or a CEQA document is generally reviewed to determine if the issuance of the approval will cause an adverse environmental impact.

A summary of the coverage of different CVPIA provisions in the Draft PEIS is presented in Table VI-1. This summary includes a brief description of issues that may need to be evaluated in future environmental documents. This initial listing should be considered preliminary in nature and would need to be expanded during the scoping process for each analysis.

TABLE VI-1

AN ESTIMATE OF ADDITIONAL ENVIRONMENTAL COMPLIANCE REQUIREMENTS

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3404(a)	**New Contracts**				
		Approval of New Contracts	Impact to CVP water Supplies and Operations, and to place of use	NO	YES - need for CVP-wide and project-specific analyses, should include information from Needs Analysis, and Biological Evaluation of lands not currently irrigated with CVP water and for lands that will be converted from agricultural to municipal
3404(c)	**Contract Renewals**				
		Renewal for 25 years	Impact to CVP water Supplies and Operations	YES - included in all alternatives	NO - no need for CVP-wide analysis unless total contract allocations exceed allocations in Draft PEIS
		Renewal for less than 25 years	Impact to CVP water Supplies and Operations	YES -all alternatives assume that renewals would continue to occur	NO
		No renewals	Impact to CVP Water Supplies and Operations	NO	YES - evaluate CVP & SWP operations; fish habitat;& subregional and regional economics
			Impact to each CVP Contractor	NO	YES - need to specifically evaluate local habitat, land use and economics
		Quantity of water available to CVP Contractors	Impact to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need for CVP-wide analysis unless total contract allocations exceed total allocations presented in Draft PEIS
			Impact to each CVP Contractor or Area of Use	NO	YES - evaluate local habitat, land use Needs Analysis, Biological Assessment, and economics, it is anticipated that allocations within a division maybe changed in the specific environmental documents

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3404(c)	**Contract Renewals (continued)**	Conversion of the Use of CVP Water from irrigation to municipal or to conjunctive use	Impact to CVP Water Supplies and Operations and Vegetation and Wildlife	PARTIALLY- did not address new conjunctive uses	YES - depends upon CVP division and amount of conversion. Use information from individual Needs Analysis and Biological Evaluations
			Impact to each CVP Contractor or Area of Use	NO	YES - specifically evaluate local habitat, land use and economics. Use information from individual Needs Analysis and Biological Assessments
		Availability of Additional Water or Rescheduling of water	Impact to CVP Water Supplies and Operations	NO	POSSIBLY- depends upon maximum amount of water that could be made available
			Impact to each CVP Contractor or Area of Use	NO	YES - depends upon the historic use of additional water; and the maximum amount of water available
		Delivery to areas outside of CVP Service Area	Impact to CVP Water Supplies and Operations and Vegetation and Wildlife	NO - unless included in CVP Place of Use (as being considered in current Place of Use petition to the SWRCB)	YES - unless currently served by another CVP contractor. Use information from individual Needs Analysis and Biological Assessments
		Conveyance, Use, and Disposal of CVP water by Contractor	Impact to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to evaluate on systemwide basis
			Impact to each CVP Contractor or Area of Use	NO	YES - evaluate need for changes in diversion or conveyance facilities, beneficial use, and discharge of return flows or drainage flows. Use information from individual Needs Analysis, Conservation Plans, Drainage Plans and Biological Assessments

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3404(c)	**Contract Renewals (continued)**	Temporary reductions in deliveries due to physical constraints, with or without increases in deliveries	Impact to CVP Water Supplies and Operations, and Impact to each CVP Contractor or Area of Use	NO	NO- if term "temporary reduction or disruption" is defined and within accuracies of analytical tools
		Right to reuse Seepage and Return Flows into streams	Impact to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to evaluate on a systemwide basis
		Allocation of CVP water during shortage periods	Impact to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to evaluate on a systemwide basis
			Impact to each CVP Contractor or Area of Use	NO	YES - specifically evaluate land use and economics. Use information from Needs Analysis, evaluation of alternate supplies, and economic analysis.
3405(a)	**Transfers of CVP Water**				
		Water Transfers of CVP Water	Impact to CVP Water Supplies and Operations, and Vegetation and Wildlife. Impacts to each CVP Contractor or Area of Use	YES	YES - include analysis of impacts on CVP and Central Valley streams, land use and economics in sellers' service area, and impacts of providing water to buyers' service area - including secondary impacts. Evaluation if transfers would change stream patterns or Delta export patterns that would require additional releases to comply with WR Order 95-06 or modified D-1422. In addition, transfers would need to comply with State Water Code to ensure no adverse impacts to habitat or economics (Water Code Sections 1025.5(b), 1725, 1736, 1810(d))

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3405(b)	**Measurement of Water Use**				
		Measurement of Water Use	Impact to CVP Water Supplies and Operations, and Impact to each CVP Contractor or Area of Use	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis
		Reporting Procedures for Measurement of Water Use	Impact to CVP Water Supplies and Operations, and Impact to each CVP Contractor or Area of Use	NO	POSSIBLY, if reporting requirements would require extensive economic investments. Identify specific additional reporting requirements as compared to current CVP requirements, including RRA reporting
3405(c)	**Compliance with State and Federal Water Quality Requirements**				
		Inclusion in Contracts	Impacts would only occur if contractors did not comply with requirements that are mandatory for all water dischargers in California. If discharger is in non-compliance, Reclamation could eliminate deliveries until user complies with requirements. However, state agencies would implement non-compliance actions.	PEIS assumes compliance with applicable water quality requirements.	NONE

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3405(d)	**Water Pricing Modification**				
		Water Pricing with Tiered Pricing	Impact to CVP Water Supplies and Operations, and Impact to each CVP Contractor or Area of Use	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis
3405(e)	**Water Conservation Standards**				
		Implementation of Additional Water Conservation Measures	Impact to CVP Water Supplies and Operations	YES, assuming compliance with RRA and DWR guidelines, and implementation of appropriate and cost-effective BMPs	NO - no need to reevaluate on systemwide basis
			Impact to each CVP Contractor or Area of Use	NOT SPECIFICALLY	POSSIBLY - could be included in Contract Renewal analysis. Water Conservation Plan, including evaluation of all BMP to identify appropriate and cost-effective BMPs,
		Reporting Procedures for Water Conservation	Impact to CVP Water Supplies and Operations, and Impact to each CVP Contractor or Area of Use	NO	POSSIBLY - if reporting requirements would require extensive economic investments. Identify specific additional reporting requirements as compared to current CVP requirements, including RRA reporting

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(b)(1)	**Anadromous Fish Restoration Program**				
		Fish Management and Water Management Packages	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - included in all alternatives	YES - Most actions are included in the analysis in a programmatic manner. Therefore, CVP-wide impact assessment would not need to be completed. However, site-specific analyses will need to be completed. Watershed or partial watershed analyses may need to be completed to coordinate the evaluation of all actions in a geographic area.
3406(b)(1) "other"	**Fish and Wildlife (b)(1) "other" Program**				
		Implementation of Habitat Restoration Measures not specifically addressed in other provisions of CVPIA	Impact to CVP and other Water Supplies and Operations, Impacts to Power Generation, and Impact to Agricultural Land Use	YES - included in all alternatives	POSSIBLY - may need to evaluate specific programs that would affect existing land uses, water supply operations, or power generation. May not need to evaluate actions such as acquisition of land for habitat protection.
3406(b)(1)(B)	**Reoperation of the CVP to meet Anadromous Fish Restoration Program Goals**				
		Implementation of CVP Reoperation to improve fish and wildlife habitat without affecting CVP deliveries	Impacts to CVP operations and power generation	YES - included in all alternatives	POSSIBLY - only if reoperation methods are significantly different than considered in PEIS alternatives

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(b)(2)	**Management of 800,000 af to meet Anadromous Fish Restoration Program Goals**				
		Implementation of the Dedicated Water Methodology	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - included in all alternatives for instream uses, and in Alternative 1A for instream and Delta uses.	POSSIBLY - only if reoperation methods are significantly different than considered in PEIS alternatives. Compare CVP-wide results of Long-Term Dedicated Water Management with PEIS analysis to determine if different target goals on each stream are met, and impacts to contractors are similar or less
3406(b)(3)	**Acquisition of Supplemental Water**				
		Purchase of Water from Willing Sellers	Central Valley-wide Impacts, and Impacts to CVP Operations	YES - in Alternatives 2, 3, and 4	NO - no need to reevaluate on systemwide basis
			Impact to areas adjacent to willing seller or specific stream reaches	NO	YES - analyze land use and economics in areas adjacent to sellers' service area, and impacts of providing water to specific stream reaches, including impacts or benefits to fish and vegetation, flooding potential, and seepage. SWRCB approval may require a CEQA document and analysis to determine the impacts associated with methods to make the water available, including physical and economic impacts.

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(b)(4)	**Reduce impacts to fish at Tracy Pumping Plant**				
		Re-operation	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - included in all alternatives	NO - if similar to operations considered in Draft PEIS
		Modify facilities	Impacts at site of construction of fish protection facilities	NO	YES - documents to support selection of final facilities and obtain permits, include analysis of fishery and wildlife benefits; impacts to vegetation, cultural resources, and water quality due to construction; impacts to deliveries and economics to CVP south of the Delta
3406(b)(5)	**Reduce impacts to fish at Contra Costa Pumping Plant**				
		Re-operation	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis
		Modify facilities	Impacts at site of fish protection facilities	NO	YES - documents to support selection of final facilities and obtain permits, include analysis of fishery and wildlife benefits; impacts to vegetation, cultural resources, and water quality due to construction; impacts to deliveries and economics to Contra Costa Canal

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(b)(6)	**Shasta Temperature Control Device**				
		Authorization for construction and funding of Shasta Temperature Control Device	Central Valley-wide Impacts, Impacts to CVP Water Supplies and Operations, and impacts at construction site	YES - included in all alternatives	YES - was evaluated in separate EIS
3406(b)(8)	**Pulse Flow Releases**				
		Use of short pulse flows (generally several days to weeks)	Central Valley-wide Impacts, Impacts to CVP Water Supplies and Operations,	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis. Included in existing operations.
3406(b)(9)	**Minimize Flow Fluctuations**				
		Modify release patterns to minimize daily, weekly, and severe monthly flow fluctuations	Central Valley-wide Impacts, Impacts to CVP Water Supplies and Operations,	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis. Included in existing operations.
3406(b)(10)	**Modify Red Bluff Diversion Dam Fish Protection Facilities**				
		Modify gate operations and structure	Central Valley-wide Impacts, Impacts to CVP Water Supplies and Operations, and site specific impacts at Lake Red Bluff and Red Bluff Diversion Dam	YES - included in all alternatives	YES - documents to support selection of final facilities and obtain permits, include analysis of fishery and wildlife benefits; impacts to vegetation, cultural resources, and water quality due to construction; impacts to homes located along Lake Red Bluff and recreation during construction and operation; impacts to deliveries and economics on Tehama Colusa Canal

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(b)(11)	**Modify Coleman Fish Hatchery**				
		Modify facilities	Impacts at fish hatchery site	YES - funding only	YES - documents to support selection of final facilities and obtain permits, include analysis of fishery and wildlife benefits; impacts to vegetation, cultural resources, and water quality due to construction
3406(b)(12)	**Restore Clear Creek Habitat**				
		Improve streambed and fish ladder	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis
			Impacts at construction sites	NO	YES - documents to support selection of final facilities and obtain permits, include analysis of fishery and wildlife benefits; impacts to vegetation, cultural resources, and water quality due to construction.
3406(b)(13)	**Improve Spawning and Rearing Habitat**				
		Improve streambeds and channels	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - included in all alternatives	NO
			Impacts at construction sites	NO	YES - documents to support selection of final actions and obtain permits, include analysis of fishery and wildlife benefits; impacts to vegetation, cultural resources, and water quality due to construction

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(b)(14)	**Modify Operations and/or Structures at Delta Cross Channel and Georgiana Slough**				
		Modify Operations and Structures	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations, and impacts in Delta	YES - included in Supplemental Analyses 1b and 2a	POSSIBLY - depends upon final operations and design criteria considered at site-specific level and overall Delta operations
			Impacts at construction site, especially at Georgiana Slough	NO	YES - documents to support selection of final actions and obtain permits, include analysis of fishery benefits; impacts to vegetation, cultural resources, and water quality due to construction; impacts to SWP.
3406(b)(15)	**Modify Operations and/or Structures at Old River Barrier**				
		Modify Operations and Structures	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations, and impacts in Delta	YES - included in Supplemental Analyses 1b and 2a	YES - was evaluated in separate EIS
			Impacts at construction site	NO	YES -was evaluated in separate EIS

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(b)(17)	**Modify Operations and/or Structures at Anderson-Cottonwood Irrigation District**				
		Modify Operations and Structures	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis
			Impacts at construction site	NO	YES - documents to support selection of final actions and obtain permits, include analysis of fishery benefits; impacts to vegetation, cultural resources, and water quality due to construction; impacts to deliveries and economics to ACID
3406(b)(18)	**Restore Striped Bass Fishery**				
		Improve streambeds and channels	Central Valley-wide Impacts, Impacts to CVP Water Supplies and Operations, and impacts at sites, and acquisition of water	NO	YES - documents to support selection of final actions and obtain permits, include analysis of fishery and wildlife benefits; impacts to vegetation, cultural resources, and water quality due to construction
3406(b)(19)	**Use of CVP Carryover Storage for AFRP**				
		Use of carryover storage at Shasta and Trinity reservoirs to improve flows for anadromous fish	Central Valley-wide Impacts, Impacts to CVP Water Supplies and Operations,	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(b)(20)	**Modify Glenn-Colusa Irrigation District Diversion**				
		Modify Operations and Structures	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis
			Impacts at construction Site	NO	YES - documents to support selection of final actions and obtain permits, include analysis of fishery benefits; impacts to vegetation, cultural resources, and water quality due to construction; impacts to deliveries and economics to GCID
3406(b)(21)	**Reduce fish losses at diversions**				
		Modify Structures	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis
			Impacts at construction Sites	NO	YES - documents to support selection of final actions and obtain permits, include analysis of fishery benefits; impacts to vegetation, cultural resources, and water quality due to construction; impacts to individual water users
3406(b)(22)	**Flooding Fields for Enhanced Waterfowl Habitat**				
		Provide Incentives and Water for Field Flooding	Central Valley-wide Impacts, Impacts to CVP Water Supplies and Operations, and Impacts at field sites	YES	YES - documents to support selection of fields to flood, flood-release patterns, and associated actions.

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(b)(23)	**Implement recommendations of Trinity River Flow Evaluation Study**				
		Modify minimum instream flow releases in Trinity River	Central Valley-wide Impacts, Impacts to CVP Water Supplies and Operations, and Impacts in Trinity River Basin	PARTIALLY - limited analysis to one flow scenario to CVP under all alternatives	YES - impacts within Trinity River Basin and to CVP water supply operations and power generation of several flow scenarios. Include analysis of fishery benefits; impacts to vegetation, cultural resources, and water quality due to construction
3406(c)(1)	**San Joaquin and Stanislaus Rivers Studies**				
		Changes in operations	Impact to CVP Water Supplies and Operations, and other Water Users	NO	YES - documents to support selection of final actions, include analysis of fishery benefits; impacts to vegetation, cultural resources, and water quality; impacts to deliveries and economics to CVP and other users
3406(c)(1)	**Friant Division Surcharge**				
		Water Pricing - Friant Division Surcharge	Impact to CVP Water Supplies and Operations, and Impact to Friant Division	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis
3406(d)(1)	**Level 2 Refuge Water Supply**				
		Provide CVP water supply for Level 2 Refuge Water Supplies	Impact to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(d)(2)	**Level 4 Refuge Water Supply**				
		Acquire water supply for Level 4 Refuge Water Supplies	Central Valley-wide Impacts, and Impacts to CVP Water Supplies and Operations	YES - in Alternatives 2, 3, and 4	NO - no need to reevaluate on systemwide basis
			Impact to areas adjance to each willing seller or specific stream reaches	PARTIALLY	YES - analyze land use and economics in areas adjacent to sellers' service area. SWRCB approval may require a CEQA document and analysis to determine the impacts associated with methods to make the water available, including physical and economic impacts.
3406(d)(4)	**Level 2 Water Supply Delivery Reductions in Dry Years**				
		Reduce Deliveries per Shasta Index	Impacts to CVP water supply operations, and to the refuges	YES - in all alternatives	NO
		Reduce Deliveries in accordance with Agricultural Water Service Contractors Shortage Criteria	Impacts to CVP water supply operations, and to the refuges	YES	NO - analyze impacts to CVP water supply operations, and impacts to the refuges
3406(d)(5)	**Construct Conveyance Facilities for Refuges**				
		Construct Conveyance Facilities (use for Levels 2 and 4)	Impacts at the Sites	NO	YES - documents to support selection of final actions and obtain permits, include analysis of fishery and wildlife benefits; impacts to vegetation, cultural resources, and water quality due to construction

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3406(d)(6)	**Evaluate Methods to Improve Wetlands**				
		Changes in operations	Impact to CVP Water Supplies and Operations, and other Water Users, impacts to Wetlands	NO	YES - documents to support selection of final actions, include analysis of fishery and wildlife benefits; impacts to cultural resources, and water quality; impacts to deliveries and economics to CVP and other users
3406(e)	**Supporting Investigations**				
		Several studies to improve fish and wildlife habitat	Impact to CVP Water Supplies and Operations, and other Water Users, impacts to habitat	NO	YES - documents to support selection of final actions, include analysis of fishery and wildlife benefits; impacts to cultural resources, and water quality; impacts to deliveries and economics to CVP and other users
3407	**Collection of Restoration Fund**				
		Water Pricing - Restoration Fund	Impact to CVP Water Supplies and Operations	YES - included in all alternatives	NO - no need to reevaluate on systemwide basis
3408(b)	**Use of Project Use Energy Load for Fish and Wildlife Needs**				
		Use of Project Use Energy for Fish and Wildlife Needs, such as energy for pumping on refuges	Impact to Western's Preference Power Customers	NO	YES - determine impacts to available energy for sale to preference power customers and the need to acquire additional energy

TABLE VI-1. CONTINUED

CVPIA Provision	Description of Provision	Component of Provision	Potential Impact	Coverage in PEIS	Minimum Coverage in Additional Environmental Documents
3408(c-d)	**Coordination with non-CVP water users to improve water management**				
		Storage of CVP water in non-CVP facilities, and/or use of CVP facilities for water banking	Impact to CVP Water Supplies and Operations, and other Water Users, impacts to habitat	NO	YES - documents to support selection of final actions, include analysis of fishery and wildlife benefits; impacts to cultural resources, and water quality; impacts to deliveries and economics
3408(h)	**Land Retirement**				
		Land retirement as part of the San Joaquin Valley Drainage Plan	Impact to CVP Water Supplies and Operations	YES	YES - documents to support selection of final actions, include analysis of land use and economics, and other water supplies within service areas of lands to be retired
			Impact at Land Retirement Sites	NO	POSSIBLY - documents may be needed to support selection of final actions, include analysis of land use and economics, and other water supplies; impacts to vegetation an d wildlife
3408(j)	**Project Yield Increase**				
		Develop water resource projects to increase CVP yield	Impact to CVP Water Supplies and Operations, and Impacts at Sites of New Facilities	NO	YES - documents to support selection of final actions, include analysis of land use and economics, and other water supplies; impacts to vegetation an d wildlife and cultural resources
3412	**Extension of the Tehama Colusa Canal**				
		Extend the TCC and Identify Extension of the Service Area to be served by water conveyed in the extended canal	Impact to CVP Water Supplies and other Water Supplies, and Impacts at the Site	NO	YES - documents to support selection of final actions, include analysis of land use and economics, and other water supplies; impacts to vegetation an d wildlife and cultural resources

CHAPTER VII

CONSULTATION AND COORDINATION

Chapter VII

CONSULTATION AND COORDINATION

During the preparation of the Draft PEIS, input was actively solicited and incorporated from a broad range of cooperating and consulting agencies and the public. The Draft PEIS also was prepared in consultation and coordination with other Federal and state agencies in accordance with applicable requirements.

This chapter summarizes the public involvement program and key issues raised by the public and interest groups. This chapter also addresses the manner in which Federal statutes, implementing regulations, and executive orders potentially applicable to implementation of the CVPIA have been addressed. The conclusions of compliance are based on the Environmental Consequences presented in Chapter IV. The compliance summaries apply only to the alternatives discussed in the Draft PEIS and not the development of concurrent CVPIA implementation programs.

PUBLIC INVOLVEMENT

During the development of the PEIS, detailed information was prepared and presented to inform the public about the activities, assumptions, and decision making needs of the PEIS process. Through a variety of public involvement activities such as public meetings, workshops, and informational materials, Reclamation solicited public input about the activities and assumptions. The public involvement approach developed for the PEIS was a two-way process. This approach maximized the exchange of information between Reclamation, other agencies, and the public. Public interest was high and participants were well informed. This led to very active public participation on a wide range of issues, which played a significant role in guiding the PEIS process.

The process was divided into the Scoping, Project Development, Alternatives Refinement and Impact Analysis, and Preparation of the PEIS phases. Issues raised during these phases are summarized below. A more detailed discussion of the public involvement program is presented in the Public Involvement Technical Appendix.

SCOPING PHASE

Reclamation started the preparation of the PEIS during the Scoping Phase. Scoping served as a fact-finding process to identify public concerns and recommendations about the CVPIA, the PEIS process, issues that would be addressed in the PEIS, and the scope and level of detail for analyses. Scoping activities began in January 1993 after a Notice of Intent to prepare the PEIS was filed in the Federal Register. The scoping period formally ended in April 1993 with the release of the Scoping Report and the Public Involvement Plan. Scoping continued, however, on an informal basis during the technical analysis to ensure that new issues and concerns were considered throughout the PEIS process. Public input collected during this phase helped guide several important initial PEIS preparation activities and set a course for the remainder of the process.

Public involvement activities began with a series of discussions with interest groups and individuals to educate the public concerning the process and to identify important public issues and concerns to be addressed in the PEIS. The results of these discussions formed the basis of the Public Involvement Plan, which was the framework for public involvement activities through the four PEIS phases.

At public scoping meetings held around the state in March 1993, Reclamation and the Service provided information about the Draft PEIS process and solicited public comments, questions, and concerns. Participants commented about key issues that should be discussed in the PEIS, potential environmental impacts, public involvement activities, the PEIS preparation process, and alternatives development. At these early meetings, participants had numerous comments and questions about how important issues would be considered, analyzed, and addressed in the PEIS, including water contract renewals, the AFRP, tiered water pricing, the Endangered Species Act, and alternatives development. In addition, comments were received on the geographic scope of the PEIS and the level of detail of the analysis. Based on public comments, the geographic scope of the analysis was expanded to include an assessment of potential environmental impacts on areas throughout the state.

Reclamation received numerous comments about issues to be considered in the PEIS and methodologies for analyzing impacts. Although these comments would be addressed more specifically in the next two phases -- Project Development and Alternatives Refinement and Impact Analysis -- they helped expand the scope of analysis and refine the Plan of Action for preparing the PEIS.

Reclamation and the Service will jointly implement the CVPIA. The Secretary designated Reclamation as the lead agency in preparing the Draft PEIS.

During this phase, Reclamation established cooperative agreements with the public agencies who would assist in preparing the PEIS. Cooperating agencies were involved in substantial research, data collection, participation in development and evaluation of alternatives, and preparation of the Draft PEIS. The following Cooperating Agencies participated in the process.

- California Department of Fish and Game
- California Department of Water Resources
- California State Water Resources Control Board
- Hoopa Valley Tribe
- U.S. Army Corps of Engineers
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- National Marine Fisheries Service
- Western Area Power Administration

Consulting Agencies were involved in the development of analytical tools and background information. The following Consulting Agencies participated in the process.

- U.S. Geological Survey
- Natural Resource Conservation Service
- Bureau of Indian Affairs

The Cooperating and Consulting agencies met at Interagency Group Meetings (IAG) to provide input and direction into the Draft PEIS. The first IAG meeting was held in April 1993 to discuss scoping issues with the public agencies.

Interested Group Meetings (IGM) and public workshops were held with the public to obtain input and comments on the Draft PEIS. The IGMs were used to discuss technical issues in a smaller forum than the public workshops. The public workshops provided opportunities for the public throughout the study area to learn about the Draft PEIS process.

PROJECT DEVELOPMENT PHASE

Program activities of the Project Development phase consisted of the following goals.

- Prepare a Purpose and Need Statement
- Define Existing Conditions
- Prepare the Existing Conditions Technical Appendices
- Develop the No-Action Alternative
- Identify projects for the cumulative impacts analysis
- Develop the PEIS alternatives
- Screen and identify the preliminary analytical tools

Developing a set of alternatives that reflected the full range of feasible options was a significant challenge. To meet this challenge, Reclamation worked closely with the public and agencies to develop the Draft PEIS alternatives. Beginning in May 1993 and continuing to January 1995, the second phase was the longest of the four phases and resulted in the largest number of comments.

Public information efforts for this phase focused on explaining the process for developing the No-Action Alternative and preliminary PEIS alternatives and providing accurate information to support informed participation. Table VII-1 lists the public involvement activities that occurred during the Project Development phase.

During the first 18 months of the development of the Draft PEIS, each of the Cooperating Agencies provided technical experts to serve on designated work groups to define, outline, and initially develop the criteria and process for the alternative analysis. These experts served on one or more workgroup committees, including development of the purpose and need, level of detail, development of the No-Action Alternative and other alternatives, and selection of analytical tools. The results of the process were shared with the public and other agencies.

TABLE VII-1

PROJECT DEVELOPMENT PHASE PUBLIC INVOLVEMENT ACTIVITIES

Date	Public Involvement Activity
May 1993	IAG
June 1993	IAG; Public Meetings and Information Packet
July 1993	IAG; IGM
August 1993	Outflow Newsletter
September 1993	IAG; IGM; Congressional Briefing and Information Packet; Draft Response to Comments Report
October 1993	Media Packet; Public Meetings
November 1993	IAG; IGM; Public Meetings; Management Briefing and Materials; Elected Officials Newsletter
December 1993	Outflow Newsletter
January 1994	IAG; Small Group Meeting
February 1994	IGM; Media Packet; Draft Response to Comments Report
March 1994	Public Meetings and Information Packet; Small Group Meeting
April 1994	Stakeholder Meetings; Alternatives Briefings
May 1994	Alternatives Briefings; Small Group
June 1994	IAG; IGM; Small Group Meetings; Outflow Newsletter
July 1994	Stakeholder Meetings; Alternatives A to Z Report; Draft Response to Comments Report
August 1994	Public Meetings and Information Packet; Congressional Briefing and Information Packet; Management Briefing and Materials; Elected Officials Memo
September 1994	Public Meetings and Information Packet; Stakeholder Meetings
November 1994	Stakeholder Meetings
December 1994	IGM Meeting; Media Packet
January 1995	Small Group Meeting; Analytical Tools Workshop

ALTERNATIVES REFINEMENT AND IMPACT ANALYSIS PHASE

Program activities of the Alternatives Refinement and Impact Analysis phase consisted of the following goals.

- Select and refine analytical tools
- Develop criteria and refine assumptions for the No-Action Alternative and Draft PEIS alternatives
- Conduct preliminary impact analysis for the No-Action Alternative and Draft PEIS alternatives

In January 1995, Reclamation initiated the Alternatives Refinement and Impact Analysis phase. During this phase, the primary goal was to analyze the effects of the PEIS Alternatives and the No-Action Alternative and refine the alternatives. The analysis allowed Reclamation to assess the impacts and benefits of each alternative, and to compare these impacts to future conditions under a No-Action Alternative.

During this phase, Reclamation considered and discussed three substantial issues: refining the No-Action Alternative to incorporate new Bay-Delta Plan Accord water quality standards, refining the Dedicated Water Methodology, and incorporating the results of the Anadromous Fish Restoration Program activities and associated flow goals. As Reclamation discussed these issues and began preliminary impact analysis of the preliminary Draft PEIS alternatives, it became apparent that refinements to the alternatives would be necessary. During this phase, interagency and public comments helped to identify specific issues that warranted additional analyses. During the final screening phase of the alternatives in late 1996, it was determined that three of the five preliminary alternatives were eliminated from further analysis because they would have resulted in less balance of competing needs. Two additional alternatives were developed through discussions with the interagencies and the public.

Table VII-2 lists the public activities that occurred during the Alternatives Refinement and Impact Analysis phase.

TABLE VII-2

ALTERNATIVES REFINEMENT AND IMPACT ANALYSIS PUBLIC INVOLVEMENT ACTIVITIES

Date	Public Involvement Activities
February 1995	Outflow Newsletter; Draft Response to Comments Report
March 1995	Progress Report Newsletter
April 1995	Small Group Meeting; Progress Report Newsletter
May 1995	Progress Report Newsletter
June 1995	IAG; IGM
July 1995	Small Group Meeting
August 1995	Public Meetings; Congressional Briefing and Information Packet
October 1995	IAG; IGM; Small Group Meeting; Progress Report Newsletter
November 1995	Small Group Meeting
December 1995	Progress Report Newsletter
January 1996	Small Group Meeting
February 1996	Combined IAG/IGM Meeting; Small Group Meeting; Progress Report Newsletter
April 1996	Combined IAG/IGM Meeting; Draft Response to Comments Report
May 1996	Small Group Meeting
June 1996	Combined IAG/IGM Meeting
July 1996	Progress Report Newsletter
September 1996	IGM; Small Group Meeting
November 1996	Combined IAG/IGM Meeting
January 1997	Combined IAG/IGM Meeting
April 1997	Combined IAG/IGM Meeting

PREPARATION OF THE DRAFT AND FINAL PEIS PHASE

Program activities of the Preparation of the Draft and Final PEIS phase include the following goals.

- ♦ Prepare the Draft PEIS
- ♦ Circulate the Draft PEIS for public review
- ♦ Prepare the Final PEIS
- ♦ File Record of Decision for preferred actions or range of actions

In the fourth and final phase, Reclamation compiled the results and conclusions into the Draft PEIS for public review and comment. The Draft PEIS has been distributed to a wide range of agencies and interest groups, as summarized in Attachment B of the Draft PEIS. The public review period of the Draft PEIS will consist of a 90-day period. Reclamation will make the Draft PEIS available to the public for a 90-day review period to provide an opportunity to comment on the content and findings. A series of public hearings will take place around the state during the review period to gather verbal comments. Written comments will also be solicited. Once the public review period closes, Reclamation will prepare the Final PEIS, which will respond to public comments on the Draft PEIS.

Public input will be used by the Secretary as a guide in making the final decision about how the CVPIA will be implemented. A Record of Decision (ROD) will be prepared and the public will be formally notified of the decision.

CONSULTATION AND COORDINATION WITH OTHER AGENCIES

The Draft PEIS was prepared in accordance with the policies and regulations for the following issues. Brief discussions of these issues and how compliance was addressed in the Draft PEIS is discussed in the remaining sections of this chapter. Work is continuing on each of these requirements. As individual projects are implemented, compliance requirements will be considered.

- ♦ National Environmental Policy Act
- ♦ Endangered Species Act
- ♦ Fish and Wildlife Coordination Act
- ♦ Environmental Justice
- ♦ Indian Trust Assets
- ♦ Indian Sacred Sites
- ♦ National Historic Preservation Act
- ♦ State, Area-wide, and Local Plan and Program Consistency
- ♦ Floodplain Management
- ♦ Wetlands Protection
- ♦ Wild and Scenic Rivers Act

NATIONAL ENVIRONMENTAL POLICY ACT

This PEIS was prepared pursuant to regulations implementing the National Environmental Policy Act (NEPA) (42 USC 4321 *et seq.*). NEPA provides a commitment that Federal agencies will consider the environmental effects of their actions. It also requires that an EIS be included in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment. The Draft PEIS provides detailed information regarding the No-Action Alternative and alternatives, the environmental impacts of the alternatives, potential mitigation measures, and adverse environmental impacts that cannot be avoided.

ENDANGERED SPECIES ACT

The Endangered Species Act (ESA), most recently amended in 1988 (16 USC 1536), establishes a national program for the conservation of threatened and endangered species of fish, wildlife, and plants and the preservation of the ecosystems upon which they depend. Section 7(a) of the ESA requires Federal agencies to consult with the Service and/or NMFS on any activities that may affect any species listed as threatened or endangered. The Draft PEIS analyzes various alternative courses of action at the programmatic level, and the subsequent Record of Decision will identify general policy decisions. Implementation of these policies may affect listed species. These potential effects require initiation of the Section 7 consultation process. Reclamation and the Service have initiated informal consultation to develop the nature of formal consultation. Formal consultation cannot be mitigated until a proposed action is identified, which is expected to occur as the Final PEIS is developed. While specific details have yet to be developed, a conceptual approach with two basic elements has been identified: (1) a conservation program to address the needs of species that have been and continue to be impacted by the CVP; and (2) an agreement to consult on specific activities/programs that are initiated as part of the CVPIA or the CVP. The intent is to develop a conservation plan that addresses the needs of the species in such a way that potential impacts that could be identified in subsequent consultations on specific programs would, to a large extent (and perhaps entirely in specific cases) have been addressed through the Conservation Program. This approach will be refined through a public process that will include interaction with interested parties. Formal consultation will be concluded prior to the signing of the Record of Decision.

Under the No-Action Alternative, it is assumed that compliance with ESA will be addressed through consultation on discretionary actions such as contract renewals, operational changes, and other new activities that would be initiated. In addition, Reclamation has committed to consult on the overall effects of the CVP, specifically throughout the water service areas. The result of these activities is that under the No-Action Alternative, Reclamation would be in full compliance with requirements of the ESA.

Under the Draft PEIS alternatives, it is assumed that all compliance actions under the No-Action Alternative would occur. However, due to the CVPIA authorizing language and funding, the approach to compliance with ESA would be broader in nature and would, to a large extent, focus on the needs of species rather than on discrete impacts attributed to CVP operations. The level of protection would be similar to that under the No-Action Alternative, but conservation activities would be expanded to identify, prioritize, and assist in the implementation of actions to address the needs of listed species. In addition, individual actions would be consulted on as they are initiated to ensure that the needs of the species would be addressed with the implementation of CVPIA. The scope of subsequent consultations is expected to be minimal in most cases as a result of the implementation of both the (b)(1) “other” and the Conservation Program under the No-Action Alternative.

In addition to these considerations, Reclamation requested and received from the Service a listing of special status species to be considered in the impact assessment of the Draft PEIS. Consideration of these species is discussed in detail in the Fisheries and Vegetation and Wildlife technical appendices.

FISH AND WILDLIFE COORDINATION ACT

The Fish and Wildlife Coordination Act (FWCA) requires consultation with Service and consideration of these views and recommendations when any water body is impounded, diverted, controlled, or modified for any purpose. The Service and state agencies charged with administering wildlife resources are to conduct surveys and investigations to determine the potential damage to wildlife and the mitigation measures that should be taken. The Service may incorporate the concerns and findings of the state agencies and other Federal agencies, including the NMFS, into a report that addresses fish and wildlife concerns and provides recommendations for mitigating or enhancing impacts to fish and wildlife affected by a Federal project. Compliance can also be addressed by fully considering the Service’s recommendations and integrating the Service into the development of the selection of the preferred alternative and mitigation actions. Compliance with the Coordination Act will be coordinated with consultation for ESA, as described above.

NATIONAL HISTORIC PRESERVATION ACT

Section 106 of the National Historic Preservation Act (NHPA) requires that Federal agencies evaluate the effects of Federal undertakings on historical, archeological, and cultural resources and afford the Advisory Council on Historic Preservation opportunities to comment on the proposed undertaking. The first step in the process is to identify cultural resources included on (or eligible for inclusion on) the National Register of Historic Places that are located in or near the project area. The second step is to identify the possible effects of proposed actions. The lead agency must examine whether feasible alternatives exist that would avoid such effects. If an effect cannot reasonably be avoided, measures must be taken to minimize or mitigate potential adverse effects.

During preparation of the Draft PEIS, programmatic consultation was investigated. It was determined by the State Historic Preservation Office that compliance with Section 106 should be coordinated on a project-specific basis.

INDIAN TRUST ASSETS

The United States Government's trust responsibility for Indian resources requires Reclamation and other agencies to take measures to protect and maintain trust resources. These responsibilities include taking reasonable actions to preserve and restore tribal resources. Indian

Trust Assets (ITAs) are legal interests in property and rights held in trust by the United States for Indian tribes or individuals. Indian reservations, rancherias, and allotments are common ITAs.

During preparation of the Draft PEIS, Reclamation coordinated with Bureau of Indian Affairs to locate and review survey records of ITAs within the Central Valley and the Trinity River Basin. Based upon this analysis, the Draft PEIS includes consideration of ITAs in the impact assessment of alternatives.

INDIAN SACRED SITES ON FEDERAL LAND

Executive Order 13007 provides that in managing Federal lands, each Federal agency with statutory or administrative responsibility for management of Federal lands shall, to the extent practicable and as permitted by law, accommodate access to and ceremonial use of Indian sacred sites by Indian religious practioners, and avoid adversely affecting the physical integrity of such sacred sites. No sacred sites were identified during the scoping or planning process, and therefore were not included in the impact assessment of the Draft PEIS. If sites are identified in future scoping efforts for project-specific environmental documentation, efforts will be completed to identify and protect the sacred sites.

ENVIRONMENTAL JUSTICE

Executive Order 12898 requires each Federal agency to achieve environmental justice as part of its mission, by identifying and addressing disproportionately high and adverse human health or environmental effects, including social or economic effects, of programs, policies, and activities on minority populations and low-income populations of the United States.

Reclamation has evaluated the environmental, social, and economic impacts on minority and low-income populations in the impact assessment of alternatives.

STATE, AREA-WIDE, AND LOCAL PLAN AND PROGRAM CONSISTENCY

Agencies must consider the consistency of a proposed action with approved state and local plans and laws. Given the extremely large number of state and local jurisdictions within the study area, the lead agencies were not able to review all of the individual plans and laws that may be applicable. In accordance with Executive Order 12372, the Draft PEIS has been prepared with input from the Cooperating Agencies and Consulting Agencies. During the review period, the Draft PEIS will be circulated to the appropriate state clearinghouses to satisfy review and consultation requirements.

FLOOD PLAIN MANAGEMENT

If a Federal agency program will affect a flood plain, the agency must consider alternatives to avoid adverse effects in the flood plain or to minimize potential harm. Executive Order 11988 requires Federal agencies to evaluate the potential effects of any actions they might take in a flood plain and to ensure that planning, programs, and budget requests reflect consideration of flood hazards and flood plain management. Several of the Draft PEIS alternatives would impact the floodplains by increasing instream flows and Delta flows, as described in the impact assessment.

WETLANDS PROTECTION

Executive Order 11990 authorizes Federal agencies to take actions to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands when undertaking Federal activities and programs. Any agency considering a proposal that might affect wetlands must evaluate factors affecting wetland quality and survival. These factors should include the proposal's effects on the public health, safety, and welfare due to modifications in water supply and water quality; maintenance of natural ecosystems and conservation of flora and fauna; and other recreational, scientific, and cultural uses. In the Draft PEIS alternatives, several actions would provide for increased wetland habitat at refuge and non-refuge lands.

WILD AND SCENIC RIVERS ACT

The Wild and Scenic Rivers Act designates qualifying free-flowing river segments as wild, scenic, or recreational. The Act establishes requirements applicable to water resource projects affecting wild, scenic, or recreational rivers within the National Wild and Scenic Rivers System, as well as rivers designated on the National Rivers Inventory. Under the Act, a Federal agency may not assist the construction of a water resources project that would have a direct and adverse effect on the free-flowing, scenic, and natural values of a wild or scenic river. If the project would affect the free-flowing characteristics of a designated river or unreasonably diminish the scenic, recreational and fish and wildlife values present in the area, such activities should be undertaken in a manner that would minimize adverse impacts and should be developed in consultation with the National Park Service. None of the Draft PEIS alternatives would affect flows in wild and scenic portions of rivers.

ATTACHMENT A

CENTRAL VALLEY PROJECT IMPROVEMENT ACT

TITLE 34

(of Public Law 102-575)

SEC. 3401. SHORT TITLE.

This title may be cited as the "Central Valley Project Improvement Act."

SEC. 3402. PURPOSES.

The purposes of this title shall be:

(a) to protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California;

(b) to address impacts of the Central Valley Project on fish, wildlife and associated habitats;

(c) to improve the operational flexibility of the Central Valley Project;

(d) to increase water-related benefits provided by the Central Valley Project to the State of California through expanded use of voluntary water transfers and improved water conservation;

(e) to contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary;

(f) to achieve a reasonable balance among competing demands for use of Central Valley Project water, including the requirements of fish and wildlife, agricultural, municipal and industrial and power contractors.

SEC. 3403. DEFINITIONS.

As used in this title:

(a) the term "anadromous fish" means those stocks of salmon (including steelhead), striped bass, sturgeon, and American shad that ascend the Sacramento and San Joaquin rivers and their tributaries and the Sacramento-San Joaquin Delta to reproduce after maturing in San Francisco Bay or the Pacific Ocean;

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* Text of Bill downloaded from Westlaw Congressional Record Database 10-5-92 and formatted by the Department of Water Resources, October 23, 1992.(b)the terms "artificial propagation" and "artificial production" mean spawning, incubating, hatching, and rearing fish in a hatchery or other facility constructed for fish production;

(c) the term "Central Valley Habitat Joint Venture" means the association of Federal and State agencies and private parties established for the purpose of developing and implementing the North American Waterfowl Management Plan as it pertains to the Central Valley of California;

(d) the terms "Central Valley Project" or "project" mean all Federal reclamation projects located within or diverting water from or to the watershed of the Sacramento and San Joaquin rivers and their tributaries as authorized by the Act of August 26, 1937 (50 Stat. 850) and all Acts amendatory or supplemental thereto, including but not limited to the Act of October 17, 1940 (54 Stat. 1198, 1199), Act of December 22, 1944 (58 Stat. 887), Act of October 14, 1949 (63 Stat. 852), Act of September 26, 1950 (64 Stat. 1036), Act of August 27, 1954 (68 Stat. 879), Act of August 12, 1955 (69 Stat. 719), Act of June 3, 1960 (74 Stat. 156), Act of October 23, 1962 (76 Stat. 1173), Act of September 2, 1965 (79 Stat. 615), Act of August 19, 1967 (81 Stat. 167), Act of August 27, 1967 (81 Stat. 173), Act of October 23, 1970 (84 Stat. 1097), Act of September 28, 1976 (90 Stat. 1324) and Act of October 27, 1986 (100 Stat. 3050);

(e) the term "Central Valley Project service area" means that area of the Central Valley and San Francisco Bay Area where water service has been expressly authorized pursuant to the various feasibility studies and consequent congressional authorizations for the Central Valley Project;

(f) the term "Central Valley Project water" means all water that is developed, diverted, stored, or delivered by the Secretary in accordance with the statutes authorizing the Central Valley Project and in accordance with the terms and conditions of water rights acquired pursuant to California law;

(g) the term "full cost" has the meaning given such term in paragraph (3) of section 202 of the Reclamation Reform Act of 1982;

(h) the term "natural production" means fish produced to adulthood without direct human intervention in the spawning, rearing, or migration processes;

(i) the term "Reclamation laws" means the Act of June 17, 1902 (82 Stat. 388) and all acts amendatory thereof or supplemental thereto;

(j) the term "Refuge Water Supply Report" means the report issued by the Mid-Pacific Region of the Bureau of Reclamation of the U.S. Department of the Interior entitled Report on Refuge Water Supply Investigations, Central Valley Hydrologic Basin, California (March 1989);

(k) the terms "repayment contract" and "water service contract" have the same meaning as provided in sections 9(d) and 9(e) of the Reclamation Project Act of 1939 (53 Stat. 1187, 1195), as amended;

--Sec. 3403(j) - Sec. 3404(b)--

(l) the terms "Restoration Fund" and "Fund" mean the Central Valley Project Restoration Fund established by this title; and,

(m) the term "Secretary" means the Secretary of the Interior.

SEC. 3404. LIMITATION ON CONTRACTING AND CONTRACT REFORM.

(a) NEW CONTRACTS. - Except as provided in subsection (b) of this section, the Secretary shall not enter into any new short-term, temporary, or long-term contracts or agreements for water supply from the Central Valley Project for any purpose other than fish and wildlife before:

(1) the provisions of subsections 3406(b)-(d) of this title are met;

(2) the California State Water Resources Control Board concludes the review ordered by the California Court of Appeals in U.S. v. State Water Resources Control Board, 182 Cal. App. 3rd 82 (1986) and determines the means of implementing its decision, including the obligations of the Central Valley Project, if any, and the Administrator of the Environmental Protection Agency shall have approved such decision pursuant to existing authorities; and,

(3) at least one hundred and twenty days shall have passed after the Secretary provides a report to the Committee on Energy and Natural Resources of the Senate and the Committee on Interior and Insular Affairs and the Committee on Merchant Marine and Fisheries of the House of Representatives explaining the obligations, if any, of the Central Valley Project system, including its component facilities and contracts, with regard to achieving its responsibilities for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary as finally established and approved by relevant State and Federal authorities, and the impact of such obligations on Central Valley Project operations, supplies, and commitments.

(b) EXCEPTIONS TO LIMIT ON NEW CONTRACTS. - The prohibition on execution of new contracts under subsection (a) of this section shall not apply to contracts executed pursuant to section 305 of Pub. L. 102-250 or section 206 of Pub. L. 101-514 or to one-year contracts for delivery of surplus flood flows or contracts not to exceed two years in length for delivery of class II water in the Friant Unit. Notwithstanding the prohibition in the Energy and Water Development Appropriations Act of 1990, the Secretary is authorized, pursuant to section 203 of the Flood Control Act of 1962, to enter into a long-term contract in accordance with the Reclamation laws with the Tuolumne Regional Water District, California, for the delivery of water from the New Melones project to the county's water distribution system and a contract with the Secretary of Veteran Affairs to provide for the delivery in perpetuity of water from the project in quantities sufficient, but

--Sec. 3404(b) - Sec. 3404(c)--

not to exceed 850 acre-feet per year, to meet the needs of the San Joaquin Valley National Cemetery, California.

(c) RENEWAL OF EXISTING LONG-TERM CONTRACTS. - Notwithstanding the provisions of the Act of July 2, 1956 (70 Stat. 483), the Secretary shall, upon request, renew any existing long-term repayment or water service contract for the delivery of water from the Central Valley Project for a period of 25 years and may renew such contracts for successive periods of up to 25 years each.

(1) No such renewals shall be authorized until appropriate environmental review, including the preparation of the environmental impact statement required in section 3409 of this title, has been completed. Contracts which expire prior to the completion of the environmental impact statement required by section 3409 may be renewed for an interim period not to exceed three years in length, and for successive interim periods of not more than two years in length, until the environmental impact statement required by section 3409 has been finally completed, at which time such interim renewal contracts shall be eligible for long-term renewal as provided above. Such interim renewal contracts shall be modified to comply with existing law, including provisions of this title. With respect to all contracts renewed by the Secretary since January 1, 1988, the Secretary shall incorporate in said contracts a provision requiring payment of the charge mandated in subsection 3406(c) and subsection 3407(b) of this title and all other modifications needed to comply with existing law, including provisions of this title. This title shall be deemed "applicable law" as that term is used in Article 14(c) of contracts renewed by the Secretary since January 1, 1988.

(2) Upon renewal of any long-term repayment or water service contract providing for the delivery of water from the Central Valley Project, the Secretary shall incorporate all requirements imposed by existing law, including provisions of this title, within such renewed contracts. The Secretary shall also administer all existing, new, and renewed contracts in conformance with the requirements and goals of this title.

(3) In order to encourage early renewal of project water contracts and facilitate timely implementation of this title, the Secretary shall impose on existing contractors an additional mitigation and restoration payment of one and one-half times the annual mitigation and restoration payment calculated under subsection 3407(d) of this title for every year starting October 1, 1997 or January 1 of the year following the year in which the environmental impact statement required under section 3409 is completed, whichever is sooner, and ending on the effective date of the renewed contract payable prior to the

renewal of such contract, to be covered to the Restoration Fund; Provided, however, That this paragraph shall not apply to contracts renewed after January 1, 1988, and prior to the date of enactment of this title or, in the event the environmental impact statement required by section 3409 is not completed by October 1, 1997, to any holder of a contract in existence on the date of enactment of this title who enters into a binding agreement with the Secretary prior to October 1, 1997, to renew its contract immediately upon completion of that environmental impact statement, if such contract has not expired prior to such date.

SEC. 3405. WATER TRANSFERS, IMPROVED WATER MANAGEMENT AND CONSERVATION.

(a) WATER TRANSFERS. - In order to assist California urban areas, agricultural water users, and others in meeting their future water needs, subject to the conditions and requirements of this subsection, all individuals or districts who receive Central Valley Project water under water service or repayment contracts, water rights settlement contracts or exchange contracts entered into prior to or after the date of enactment of this title are authorized to transfer all or a portion of the water subject to such contract to any other California water user or water agency, State or Federal agency, Indian Tribe, or private non-profit organization for project purposes or any purpose recognized as beneficial under applicable State law. Except as provided herein, the terms of such transfers shall be set by mutual agreement between the transferee and the transferor.

(1) CONDITIONS FOR TRANSFERS. - All transfers to Central Valley Project water authorized by this subsection shall be subject to review and approval by the Secretary under the conditions specified in this subsection. Transfers involving more than 20 percent of the Central Valley Project water subject to long-term contract within any contracting district or agency shall also be subject to review and approval by such district or agency under the conditions specified in this subsection:

(A) No transfer to combination of transfers authorized by this subsection shall exceed, in any year, the average annual quantity of water under contract actually delivered to the contracting district or agency during the last three years of normal water delivery prior to the date of enactment of this title.

(B) All water under the contract which is transferred under authority of this subsection to any district or agency which is not a Central Valley Project contractor at the time of enactment of this title shall, if used for irrigation purposes, be repaid at the greater of the full-cost or cost of service rates, or, if the water is used for municipal and industrial purposes, at the greater of the cost of service or municipal and industrial rates.

(C) No transfers authorized by this subsection shall be approved unless the transfer is between a willing buyer and a willing seller under such terms and conditions as may be mutually agreed upon.

(D) No transfer authorized by this subsection shall be approved unless the transfer is consistent with State law, including but not limited to provisions of the California Environmental Quality Act.

(E) All transfers authorized by this subsection shall be deemed a beneficial use of water by the transferor for the purposes of section 8 of the Act of June 17, 1902, 32 Stat. 390, 43 U.S.C. 372.

(F) All transfers entered into pursuant to this subsection for uses outside the Central Valley Project service area shall be subject to a right of first refusal on the same terms and conditions by entities within the Central Valley Project service area. The right of first refusal must be exercised within ninety days from the date that notice is provided of the proposed transfer. Should an entity exercise the right of first refusal, it must compensate the transferee who had negotiated the agreement upon which the right of first refusal is being exercised for that entity's total costs associated with the development and negotiation of the transfer.

(G) No transfer authorized by this subsection shall be considered by the Secretary as conferring supplemental or additional benefits on Central Valley Project water contractors as provided in section 203 of Public Law 97-293 (43 U.S.C. 390(cc)).

(H) The Secretary shall not approve a transfer authorized by this subsection unless the Secretary has determined, consistent with paragraph 3405(a)(2) of this title, that the transfer will not violate the provisions of this title or other Federal law and will have no significant adverse effect on the Secretary's ability to deliver water pursuant to the Secretary's Central Valley Project contractual obligations or fish and wildlife obligations under this title because of limitations in conveyance or pumping capacity.

(I) The water subject to any transfer undertaken pursuant to this subsection shall be limited to water that would have been consumptively used or irretrievably lost to beneficial use during the year or years of the transfer.

(J) The Secretary shall not approve a transfer authorized by this subsection unless the Secretary determines, consistent with paragraph 3405(a)(2) of this title, that such transfer will have no significant long-term adverse impact on groundwater conditions in the transferor's service area.

(K) The Secretary shall not approve a transfer unless the Secretary determines, consistent with paragraph 3405(a)(2) of this title, that such transfer will have no unreasonable impact on the water supply, operations, or financial conditions of the transferor's contracting district or agency or its water users.

(L) The Secretary shall not approve a transfer if the Secretary determines, consistent with paragraph 3405(a)(2) of this title, that such transfer would result in a significant reduction in the quantity or decrease in the quality of water supplies currentlyused for fish and wildlife purposes, unless the Secretary determines pursuant to finding setting forth the basis for such determination that such adverse effects would be more than offset by the benefits of the proposed transfer. In the event of such a determination, the Secretary shall develop and implement alternative measures and mitigation activities as integral and concurrent elements of any such transfer to provide fish and wildlife benefits substantially equivalent to those lost as a consequence of such transfer.

(M) Transfers between Central Valley Project contractors within countries, watersheds, or other areas of origin, as those terms are utilized under California law, shall be deemed to meet the conditions set forth in subparagraphs (A) and (I) of this paragraph.

(2) REVIEW AND APPROVAL OF TRANSFERS. - All transfers subject to review and approval under this subsection shall be reviewed and approved in a manner consistent with the following:

(A) Decisions on water transfers subject to review by a contracting district or agency or by the Secretary shall be rendered within ninety days of receiving a written transfer proposal from the transferee or transferor. Such written proposal should provide all information reasonably necessary to determine whether the transfer complies with the terms and conditions of this subsection.

(B) All transfers subject to review by a contracting district or agency shall be reviewed in a public process similar to that provided for in section 226 of Pub. L. 97-293.

(C) The contracting district or agency or the Secretary shall approve all transfers subject to review and approval by such entity if such transfers are consistent with the terms and conditions of this subsection. To disapprove a transfer, the contracting district or agency or the Secretary shall inform the transferee and transferor, in writing, why the transfer does not comply with the terms and conditions of this subsection and what alternatives, if any, could be included so that the transfer would reasonably comply with the requirements of this subsection.

(D) If the contracting district or agency or the Secretary fails to approve or disapprove a proposed transfer within ninety days of receiving a complete written proposal from the transferee or transferor, then the transfer shall be deemed approved.

(3) Transfers executed after September 30, 1999 shall only be governed by the provisions of subparagraphs 3405(a)(1)(A)-(C), (E), (G), (H), (I), (L), and (M) of this title, and by State law.

(b) METERING OF WATER USE REQUIRED. - All Central Valley Project water service or repayment contracts for agricultural, municipal, or industrial purposes that are entered into, renewed, or amended under any provision of Federal Reclamation law after the date of enactment of this title, shall provide that the contracting district or agency shall ensure that all surface water delivery systems within its boundaries are equipped with water measuring devices or water measuring methods of comparable effectiveness acceptable to the Secretary within five years of the date of contract execution, amendment, or renewal, and that any new surface water delivery systems installed within its boundaries on or after the date of contract renewal are so equipped. The contracting district or agency shall inform the Secretary and the State of California annually as to the monthly volume of surface water delivered within its boundaries.

(c) STATE AND FEDERAL WATER QUALITY STANDARDS. - All Central Valley Project water service or repayment contracts for agricultural, municipal, or industrial purposes that are entered into, renewed, or amended under any provision of Federal Reclamation law after the date of enactment of this title, shall provide that the contracting district or agency shall be responsible for compliance with all applicable State and Federal water quality standards applicable to surface and subsurface agricultural drainage discharges generated within its boundaries. This subsection shall not affect or alter any legal obligation of the Secretary to provide drainage services.

(d) WATER PRICING REFORM. - All Central Valley Project water service or repayment contracts for a term longer than three years for agricultural, municipal, or industrial purposes that are entered into, renewed, or amended under any provision of Federal Reclamation law after the date of enactment of this title shall provide that all project water subject to contract shall be made available to districts, agencies, and other contracting entities pursuant to a system of tiered water pricing. Such a system shall specify rates for each district, agency or entity based on an inverted block rate structure with the following provisions:

(1) the first rate tier shall apply to a quantity of water up to 80 percent of the contract total and shall not be less than the applicable contract rate;

(2) the second rate tier shall apply to that quantity of water over 80 percent and under 90 percent of the contract total and shall be at a level halfway between the rates established under paragraphs (1) and (3) of this subsection;

(3) the third rate tier shall apply to that quantity of water over 90 percent of the contract total and shall not be less than the full cost rate; and

(4) the Secretary shall charge contractors only for water actually delivered. The Secretary shall waive application of this subsection as it relates to any project water delivered to produce a crop which the Secretary determines will provide significant and quantifiable habitat values for water fowl in fields where the water is used and the crops are produced; Provided, That such waiver shall apply only if such habitat values can be assured consistent with the goals and objectives of this title through binding agreements executed with or approved by the Secretary.

(e) WATER CONSERVATION STANDARDS. - The Secretary shall establish and administer an office on Central Valley Project water conservation best management practices that shall, in consultation with the Secretary of Agriculture, the California Department of Water Resources, California academic institutions, and Central Valley Project water users, develop criteria for evaluating the adequacy of all water conservation plans developed by project contractors, including those plans required by section 210 of the Reclamation Reform Act of 1982.

(1) Criteria developed pursuant to this subsection shall be established within six months following enactment of this title and shall be reviewed periodically thereafter, but no less than every three years, with the purpose of promoting the highest level of water use efficiency reasonably achievable by project contractors using best available cost-effective technology and best management practices. The criteria shall include, but not be limited to agricultural water suppliers' efficient water management practices developed pursuant to California State law or reasonable alternatives.

(2) The Secretary, through the office established under this subsection, shall review and evaluate within 18 months following enactment of this title all existing conservation plans submitted by project contractors to determine whether they meet the conservation and efficiency criteria established pursuant to this subsection.

(3) In developing the water conservation best management practice criteria required by this subsection, the Secretary shall take into account and grant substantial deference to the recommendations for action specific to water conservation and drainage source reduction proposed in the Final Report of the San Joaquin Valley Drainage Program, entitled A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley (September 1990).

(f) INCREASED REVENUES. - All revenues received by the Secretary as a result of the increased repayment rates applicable to water transferred from irrigation use to municipal and industrial use under subsection 3405(a) of this section, and all increased revenues received by the Secretary as a result of the increased water prices established under subsection 3405(d) of this section, shall be covered to the Restoration Fund.

SEC. 3406. FISH, WILDLIFE AND HABITAT RESTORATION.

(a) AMENDMENTS TO CENTRAL VALLEY PROJECT AUTHORIZATIONS

-Act of August 26, 1937. -Section 2 of the Act of August 26, 1937 (chapter 832; 50 Stat. 850), as amended, is amended.

(1) in the second proviso of subsection (a), by inserting "and mitigation, protection, and restoration of fish and wildlife" after "Indian reservations,";

(2) in the last proviso of subsection (a), by striking "domestic uses;" and inserting "domestic uses and fish and wildlife mitigation, protection and restoration purposes;" and by striking "power" and inserting "power and fish and wildlife enhancement";

(3) by adding at the end the following: "The mitigation for fish and wildlife losses incurred as a result of construction, operation, or maintenance of the Central Valley Project shall be based on the replacement of ecologically equivalent habitat and shall take place in accordance with the provisions of this title and concurrent with any future actions which adversely affect fish and wildlife populations or their habitat but shall have no priority over them."; and,

(4) by adding at the end the following: "(e) Nothing in this title shall affect the State's authority to condition water rights permits for the Central Valley Project."

(b) FISH AND WILDLIFE RESTORATION ACTIVITIES. - The Secretary, immediately upon the enactment of this title, shall operate the Central Valley Project to meet all obligations under state and federal law, including but not limited to the federal Endangered Species Act, 16 U.S.C. s 1531, et seq., and all decisions of the California State Water Resources Control Board establishing conditions on applicable licenses and permits for the project. The Secretary, in consultation with other State and Federal agencies, Indian tribes, and affected interests, is further authorized and directed to:

(1) develop within three years of enactment and implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991; Provided, That this goal shall not apply to the San Joaquin River between Friant Dam and the Mendota Pool, for which a separate program is authorized under subsection 3406(c) of this title; Provided further, That the programs and activities authorized by this section shall, when fully implemented, be deemed to meet the mitigation, protection, restoration, and enhancement purposes established by subsection 3406(a) of this title; And provided further, That in the course of developing and implementing this program the Secretary shall make all reasonable efforts consistent with the requirements of this section to address other identified adverse environmental impacts of the Central Valley Project not specifically enumerated in this section.

(A) This program shall give first priority to measures which protect and restore natural channel and riparian habitat values through habitat restoration actions, modifications to Central Valley Project operations, and implementation of the supporting measures mandated by this subsection; shall be reviewed and updated every five years; and shall describe how the Secretary intends to operate the Central Valley Project to meet the fish, wildlife, and habitat restoration goals and requirements set forth in this title and other project purposes.

(B) As needed to achieve the goals of this program, the Secretary is authorized and directed to modify Central Valley Project operations to provide flows of suitable quality, quantity, and timing to protect all life stages of anadromous fish, except that such flows shall be provided from the quantity of water dedicated to fish, wildlife, and habitat restoration purposes under paragraph (2) of this subsection; from the water supplies acquired pursuant to paragraph (3) of this subsection; and from other sources which do not conflict with fulfillment of the Secretary's remaining contractual obligations to provide Central Valley Project water for other authorized purposes. Instream flow needs for all Central Valley Project controlled streams and rivers shall be determined by the Secretary based on recommendations of the U.S. Fish and Wildlife Service after consultation with the California Department of Fish and Game.

(C) The Secretary shall cooperate with the State of California to ensure that, to the greatest degree practicable, the specific quantities of yield dedicated to and managed for fish and wildlife purposes under this title are credited against any additional obligations of the Central Valley Project which may be imposed by the State of California following enactment of this title, including but not limited to increased flow and reduced export obligations which may be imposed by the California State Water Resources Control Board in implementing San Francisco Bay/Sacramento-San Joaquin Delta Estuary standards pursuant to the review ordered by the California Court of Appeals in U.S. v. State Water Resources Control Board, 182 Cal.App.3rd 82 (1986), and that, to the greatest degree practicable, the programs and plans required by this title are developed and implemented in a way that avoids inconsistent or duplicative obligations from being imposed upon Central Valley Project water and power contractors.

(D) Costs associated with this paragraph shall be reimbursable pursuant to existing statutory and regulatory procedures.

(2) upon enactment of this title dedicate and manage annually 800,000 acre-feet of Central Valley Project yield for the primary purpose of implementing the fish, wildlife, and habitat restoration purposes and measures authorized by this title; to assist the State of California in its efforts to protect the waters of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; and to help meet such obligations as may be legally imposed upon the Central Valley Project under state or federal law following the date of enactment of this title, including but not limited to additional obligations under the federal Endangered Species Act. For the purpose of this section, the term "Central Valley Project yield" means the delivery capability of the Central Valley Project during the 1928-1934 drought period after fishery, water quality, and other flow and operational requirements imposed by terms and conditions existing in licenses, permits, and other agreements pertaining to the Central Valley Project under applicable State or Federal law existing at the time of enactment of this title have been met.

(A) Such quantity of water shall be in addition to the quantities needed to implement paragraph 3406(d)(1) of this title and in addition to all water allocated pursuant to paragraph (23) of this subsection for release to the

Trinity River for the purposes of fishery restoration, propagation, and maintenance; and shall be supplemented by all water that comes under the Secretary's control pursuant to subsections 3406(b)(3), 3408(h)-(i), and through other measures consistent with subparagraph 3406(b)(1)(B) of this title.

(B) Such quantity of water shall be managed pursuant to conditions specified by the U.S. Fish and Wildlife Service after consultation with the Bureau of Reclamation and the California Department of Water Resources and in cooperation with the California Department of Fish and Game.

(C) The Secretary may temporarily reduce deliveries of the quantity of water dedicated under this paragraph up to 25 percent of such total whenever reductions due to hydrologic circumstances are imposed upon agricultural deliveries of Central Valley Project water; Provided, That such reductions shall not exceed in percentage terms the reductions imposed on agricultural service contractors; provided further, That nothing in this subsection or subsection 3406(e) shall require the Secretary to operate the project in a way that jeopardizes human health or safety.

(D) If the quantity of water dedicated under this paragraph, or any portion thereof, is not needed for the purposes of this section, based on a finding by the Secretary, the Secretary is authorized to make such water available for other project purposes.

(3) develop and implement a program in coordination and in conformance with the plan required under paragraph (1) of this subsection for the acquisition of a water supply to supplement the quantity of water dedicated to fish and wildlife purposes under paragraph (2) of this subsection and to fulfill the Secretary's obligations under paragraph 3406(d)(2) of this title. The program should identify how the Secretary intends to utilize, in particular the following options: improvements in or modifications of the operations of the project; water banking; conservation; transfers; conjunctive use; and temporary and permanent land fallowing, including purchase, lease, and option of water, water rights, and associated agricultural land.

(4) develop and implement a program to mitigate for fishery impacts associated with operations of the Tracy Pumping Plan. Such program shall include, but is not limited to improvement or replacement of the fish screens and fish recovery facilities and practices associated with the Tracy Pumping Plant. Costs associated with this paragraph shall be reimbursed in accordance with the following formula: 37.5 percent shall be reimbursed as main project features, 37.5 percent shall be considered a nonreimbursable Federal expenditure, and 25

percent shall be paid by the State of California. The reimbursable share of funding for this and other facility repairs, improvements, and construction shall be allocated among project water and power users in accordance with existing project cost allocation procedures.

(5) develop and implement a program to mitigate for fishery impacts resulting from operations of the Contra Costa Canal Pumping Plant No. 1. Such program shall provide for construction and operation of fish screening and recovery facilities, and for modified practices and operations. Costs associated with this paragraph shall be reimbursed in accordance with the following formula: 37.5 percent shall be reimbursed as main project features, 37.5 percent shall be considered a nonreimbursable Federal expenditure, and 25 percent shall be paid by the State of California.

(6) install and operate a structural temperature control device at Shasta Dam and develop and implement modifications in CVP operations as needed to assist in the Secretary's efforts to control water temperatures in the upper Sacramento River in order to protect anadromous fish in the upper Sacramento River. Costs associated with planning and construction of the structural temperature control device shall be reimbursed in accordance with the following formula: 37.5 percent shall be reimbursed as main project features, 37.5 percent shall be considered a nonreimbursable Federal expenditure, and 25 percent shall be paid by the State of California.

(7) meet flow standards and objectives and diversion limits set forth in all laws and judicial decisions that apply to Central Valley Project facilities, including, but not limited to, provisions of this title and all obligations of the United States under the "Agreement Between the United States and the Department of Water Resources of the State of California for Coordinated Operation of the Central Valley project and the State Water Project" dated May 20, 1985, as well as Pub. L. 99-546.

(8) make use of short pulses of increased water flows to increase the survival of migrating anadromous fish moving into and through the Sacramento-San Joaquin Delta and Central Valley rivers and streams.

(9) develop and implement a program to eliminate, to the extent possible, losses of anadromous fish due to flow fluctuations caused by the operation of any Central Valley Project storage or re-regulating facility. The program shall be patterned where appropriate after the agreement between the California Department of Water Resources and the California Department of Fish and Game with respect to the operation of the California State Water Project Oroville Dam complex.

(10) develop and implement measures to minimize fish passage problems for adult and juvenile anadromous fish at the Red Bluff Diversion Dam in a manner that provides for the use of associated Central Valley Project conveyance facilities for delivery of water to the Sacramento Valley National Wildlife Refuge complex in accordance with the requirements of subsection (d) of this section. Costs associated with implementation of this paragraph shall be reimbursed in accordance with the following formula: 37.5 percent shall be reimbursed as main project features, 37.5 percent shall be considered a nonreimbursable Federal expenditure, and 25 percent shall be paid by the State of California.

(11) rehabilitate and expand the Coleman National Fish Hatchery by implementing the U.S. Fish and Wildlife Service's Coleman National Fish Hatchery Development Plan, and modify the Keswick Dam Fish Trap to provide for its efficient operation at all project flow release levels and modify the basin below the Keswick Dam spillway to prevent the trapping of fish. Costs associated with implementation of this paragraph shall be reimbursed in accordance with the following formula: 50 percent shall be reimbursed as main project features and 50 percent shall be considered a nonreimbursable Federal expenditure.

(12) develop and implement a comprehensive program to provide flows to allow sufficient spawning, incubation, rearing, and outmigration for salmon and steelhead from Whiskeytown Dam as determined by instream flow studies conducted by the California Department of Fish and Game after Clear Creek has been restored and a new fish ladder has been constructed at the McCormick-Saeltzer Dam. Costs associated with channel restoration, passage improvements, and fish ladder construction required by this paragraph shall be allocated 50 percent to the United States as a nonreimbursable expenditure and 50 percent to the State of California. Costs associated with providing the flows required by this paragraph shall be allocated among project purposes.

(13) develop and implement a continuing program for the purpose of restoring and replenishing, as needed, spawning gravel lost due to the construction and operation of Central Valley Project dams, bank protection projects, and other actions that have reduced the availability of spawning gravel and rearing habitat in the Upper Sacramento River from Keswick Dam to Red Bluff Diversion Dam in the American and Stanislaus Rivers downstream from the Nimbus and Goodwin Dams, respectively. The program shall include preventive measures, such as re-establishment of meander belts and limitations on future bank protection activities, in order to avoid further losses of instream and riparian habitat. Costs associated with implementation of this paragraph shall be reimbursed in accordance with the following formula: 37.5 percent shall be reimbursed as main project features, 37.5 percent shall be considered a

nonreimbursable Federal expenditure, and 25 percent shall be paid by the State of California.

(14) develop and implement a program which provides for modified operations and new or improved control structures at the Delta Cross Channel and Georgiana Slough during times when significant numbers of striped bass eggs, larvae, and juveniles approach the Sacramento River intake to the Delta Cross Channel or Georgiana Slough. Costs associated with implementation of this paragraph shall be reimbursed in accordance with the following formula: 37.5 percent shall be reimbursed as main project features, 37.5 percent shall be considered a nonreimbursable Federal expenditure, and 25 percent shall be paid by the State of California.

(15) construct, in cooperation with the State of California and in consultation with local interests, a barrier at the head of Old River in the Sacramento-San Joaquin Delta to be operated on a seasonal basis to increase the survival of young outmigrating salmon that are diverted from the San Joaquin River to Central Valley Project and State Water Project pumping plants and in a manner that does not significantly impair the ability of local entities to divert water. The costs associated with implementation of this paragraph shall be reimbursed in accordance with the following formula: 37.5 percent shall be reimbursed as main project features, 37.5 percent shall be considered a nonreimbursable Federal expenditure, and 25 percent shall be paid by the State of California.

(16) establish, in cooperation with independent entities and the State of California, a comprehensive assessment program to monitor fish and wildlife resources in the Central Valley to assess the biological results and effectiveness of actions implemented pursuant to this subsection. 37.5 percent of the costs associated with implementation of this paragraph shall be reimbursed as main project features, 37.5 percent shall be considered a nonreimbursable Federal expenditure, and 25 percent shall be paid by the State of California.

(17) develop and implement a program to resolve fishery passage problems at the Anderson-Cottonwood Irrigation District Diversion Dam as well as upstream stranding problems related to Anderson-Cottonwood Irrigation District Diversion Dam operations. Costs associated with implementation of this paragraph shall be allocated 50 percent to the United States as a nonreimbursable expenditure and 50 percent to the State of California.

(18) if requested by the State of California, assist in developing and implementing management measures to restore the striped bass fishery of the Bay-Delta estuary. Such measures shall be coordinated with efforts to protect and restore native fisheries. Costs associated with implementation of this paragraph shall be allocated 50 percent to the United States and 50 percent to the State of

California. The United States' share of costs associated with implementation of this paragraph shall be nonreimbursable.

(19) reevaluate existing operational criteria in order to maintain minimum carryover storage at Sacramento and Trinity River reservoirs to protect and restore the anadromous fish of the Sacramento and Trinity Rivers in accordance with the mandates and requirements of this subsection and subject to the Secretary's responsibility to fulfill all project purposes, including agricultural water delivery.

(20) participate with the State of California and other federal agencies in the implementation of the on-going program to mitigate fully for the fishery impacts associated with operations of the Glenn-Colusa Irrigation District's Hamilton City Pumping Plant. Such participation shall include replacement of the defective fish screens and fish recovery facilities associated with the Hamilton City Pumping Plant. This authorization shall not be deemed to supersede or alter existing authorizations for the participation of other federal agencies in the mitigation program. Seventy-five percent shall be considered a nonreimbursable Federal expenditure, and 25 percent shall be paid by the State of California.

(21) assist the State of California in efforts to develop and implement measures to avoid losses of juvenile anadromous fish resulting from unscreened or inadequately screened diversions on the Sacramento and San Joaquin rivers, their tributaries, the Sacramento-San Joaquin Delta, and the Suisun Marsh. Such measures shall include but shall not be limited to construction of screens on unscreened diversions, rehabilitation of existing screens, replacement of existing non-functioning screens, and relocation of diversions to less fishery-sensitive areas. The Secretary's share of costs associated with activities authorized under this paragraph shall not exceed 50 percent of the total cost of any such activity.

(22) provide such incentives as the Secretary determines to be appropriate or necessary, consistent with the goals and objectives of this title, to encourage farmers to participate in a program, which the Secretary shall develop, under which such farmers will keep fields flooded during appropriate time periods for the purposes of waterfowl habitat creation and maintenance and for Central Valley Project yield enhancement; Provided, That such incentives shall not exceed $2,000,000 annually, either directly or through credits against other contractual payment obligations, including the pricing waivers authorized under subsection 3405(d) of this title; Provided further, That the holder of the water contract shall pass such incentives through to farmers participating in the program, less reasonable contractor costs, if any; And provided further, That such water may be transferred subject to section 3405(a) of this title only if the farmer waives all rights to such incentives. This provision shall terminate by the year 2002.

(23) in order to meet Federal trust responsibilities to protect the fishery resources of the Hoopa Valley Tribe, and to meet the fishery restoration goals of the Act of October 24, 1984, Pub. L. 98-541, provide through the Trinity River Division, for water years 1992 through 1996, an instream release of water to the Trinity River of not less than 340,000 acre-feet per year for the purposes of fishery restoration, propagation, and maintenance and,

(A) by September 30, 1996, the Secretary, after consultation with the Hoopa Valley Tribe, shall complete the Trinity River Flow Evaluation Study currently being conducted by the U.S. Fish and Wildlife Service under the mandate of the Secretarial Decision of January 14, 1981, in a manner which insures the development of recommendations, based on the best available scientific data, regarding permanent instream fishery flow requirements and Trinity River Division operating criteria and procedures for the restoration and maintenance of the Trinity River fishery; and

(B) not later than December 31, 1996, the Secretary shall forward the recommendations of the Trinity River Flow Evaluation Study, referred to in subparagraph (A) of this paragraph, to the Committee on Energy and Natural Resources and the Select Committee on Indian Affairs of the Senate and the Committee on Interior and Insular Affairs and the Committee on Merchant Marine and Fisheries of the House of Representatives. If the Secretary and the Hoopa Valley Tribe concur in these recommendations, any increase to the minimum Trinity River instream fishery releases established under this paragraph and the operating criteria and procedures referred to in subparagraph (A) shall be implemented accordingly. If the Hoopa Valley Tribe and the Secretary do not concur, the minimum Trinity River instream fishery releases established under this paragraph shall remain in effect unless increased by an Act of Congress, appropriate judicial decree, or agreement between the Secretary and the Hoopa Valley Tribe. Costs associated with implementation of this paragraph shall be reimbursable as operation and maintenance expenditures pursuant to existing law.

If the Secretary and the State of California determine that long-term natural fishery productivity in all Central Valley Project controlled rivers and streams resulting from implementation of this section exceeds that which existed in the absence of Central Valley Project facilities, the costs of implementing those measures which are determined to provide such enhancement shall become credits to offset reimbursable costs associated with implementation of this subsection.

(c) SAN JOAQUIN AND STANISLAUS RIVERS. - The Secretary shall, by not later than September 30, 1996:

(1) develop a comprehensive plan, which is reasonable, prudent, and feasible, to address fish, wildlife, and habitat concerns on the San Joaquin River, including but not limited to the streamflow, channel, riparian habitat, and water quality improvements that would be needed to reestablish where necessary and to sustain naturally reproducing anadromous fisheries from Friant Dam to its confluence with the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Such plan shall be developed in cooperation with the California Department of Fish and Game and in coordination with the San Joaquin River Management Program under development by the State of California; shall comply with and contain any documents required by the National Environmental Policy Act and contain findings setting forth the basis for the Secretary's decision to adopt and implement the plan as well as recommendations concerning the need for subsequent Congressional action, if any; and shall incorporate, among other relevant factors, the potential contributions of tributary streams as well as the alternatives to be investigated under paragraph (2) of this subsection. During the time that the Secretary is developing the plan provided for in this subsection, and until such time as Congress has authorized the Secretary to implement such plan, with or without modifications, the Secretary shall not, as a measure to implement this title, make releases for the restoration of flows between Gravelly Ford and the Mendota Pool and shall not thereafter make such releases as a measure to implement this title without a specific Act of Congress authorizing such releases. In lieu of such requirement, and until such time as flows of sufficient quantity, quality and timing are provided at and below Gravelly Ford to meet the anadromous fishery needs identified pursuant to such plan, if any, entities who receive water from the Friant Division of the Central Valley Project shall be assessed, in addition to all other applicable charges, a $4.00 per acre-foot surcharge for all Project water delivered on or before September 30, 1997; a $5.00 per acre-foot surcharge for all Project water delivered after September 30, 1997 but on or before September 30, 1999; and a $7.00 per acre-foot surcharge for all Project water delivered thereafter, to be covered into the Restoration Fund.

(2) in the course of preparing the Stanislaus River Basin and Calaveras River Water Use Program Environmental Impact Statement and in consultation with the State of California, affected counties, and other interests, evaluate and determine existing and anticipated future basin needs in the Stanislaus River Basin. In the course of such evaluation, the Secretary shall investigate alternative storage, release, and delivery regimes, including but not limited to conjunctive use operations, conservation strategies, exchange arrangements,

and the use of base and channel maintenance flows, in order to best satisfy both basin and out-of-basin needs consistent, on a continuing basis, with the limitations and priorities established in the Act of October 23, 1962 (76 Stat. 173). For the purposes of this subparagraph, "basin needs" shall include water supply for agricultural, municipal and industrial uses, and maintenance and enhancement of water quality, and fish and wildlife resources within the Stanislaus River Basin as established by the Secretary's June 29, 1981 Record of Decision; and "out-of-basin" needs shall include all such needs outside of the Stanislaus River Basin, including those of the San Francisco Bay/Sacramento-San Joaquin Delta Estuary and those of the San Joaquin River under paragraph (1) of this subsection.

(d) CENTRAL VALLEY REFUGES AND WILDLIFE HABITAT AREAS. - In support of the objectives of the Central Valley Habitat Joint Venture and in furtherance of the purposes of this title, the Secretary shall provide, either directly or through contractual agreements with other appropriate parties, firm water supplies of suitable quality to maintain and improve wetland habitat areas on units of the National Wildlife Refuge System in the Central Valley of California; on the Gray Lodge, Los Banos, Volta, North Grasslands, and Mendota state wildlife management areas; and on the Grasslands Resources Conservation District in the Central Valley of California.

(1) Upon enactment of this title, the quantity and delivery schedules of water measured at the boundaries of each wetland habitat area described in this paragraph shall be in accordance with Level 2 of the "Dependable Water Supply Needs" table for those habitat areas as set forth in the Refuge Water Supply Report and two-thirds of the water supply needed for full habitat development for those habitat areas identified in the San Joaquin Basin Action Plan/Kesterson Mitigation Action Plan Report prepared by the Bureau of Reclamation. Such water shall be provided through long-term contractual agreements with appropriate parties and shall be supplemented by the increment of water provided for in paragraph (1) of this subsection; Provided, That the Secretary shall be obligated to provide such water whether or not such long-term contractual agreements are in effect. In implementing this paragraph, the Secretary shall endeavor to diversify sources of supply in order to minimize possible adverse effects upon Central Valley Project contractors.

(2) Not later than ten years after enactment of this title, the quantity and delivery schedules of water measured at the boundaries of each wetland habitat area described in this paragraph shall be in accordance with Level 4 of the "Dependable Water Supply Needs" table for those habitat areas as set forth in the Refuge Water Supply Report and the full water supply needed for full habitat development for those habitat areas identified in the San Joaquin Basin

Action Plan/Kesterson Mitigation Action Plan Report prepared by the Bureau of Reclamation. The quantities of water required to supplement the quantities provided under paragraph (1) of this subsection shall be acquired by the Secretary in cooperation with the State of California and in consultation with the Central Valley Habitat Joint Venture and other interests in cumulating increments of not less than ten percent per annum through voluntary measures which include water conservation, conjunctive use, purchase, lease, donations, or similar activities, or a combination of such activities which do not require involuntary reallocations of project yield.

(3) All costs associated with implementation of paragraph (1) of this subsection shall be reimbursable pursuant to existing law. Incremental costs associated with implementation of paragraph (2) of this subsection shall be fully allocated in accordance with the following formula: 75 percent shall be deemed a nonreimbursable Federal expenditure; and 25 percent shall be allocated to the State of California for recovery through direct reimbursements or through equivalent in-kind contributions.

(4) The Secretary may temporarily reduce deliveries of the quantity of water dedicated under paragraph (1) of this subsection up to 25 percent of such total whenever reductions due to hydrologic circumstances are imposed upon agricultural deliveries of Central Valley Project water; Provided, That such reductions shall not exceed in percentage terms the reductions imposed on agricultural service contractors. For the purpose of shortage allocation, the priority or priorities applicable to the increment of water provided under paragraph (2) of this subsection shall be the priority or priorities which applied to the water in question prior to its transfer to the purpose of providing such increment.

(5) The Secretary is authorized and directed to construct or to acquire from non-Federal entities such water conveyance facilities, conveyance capacity, and wells as are necessary to implement the requirements of this subsection; Provided, That such authorization shall not extend to conveyance facilities in or around the Sacramento-San Joaquin Delta Estuary. Associated construction or acquisition costs shall be reimbursable pursuant to existing law in accordance with the cost allocations set forth in paragraph (3) of this subsection.

(6) The Secretary, in consultation with the State of California, the Central Valley Habitat Joint Venture, and other interests, shall investigate and report on the following supplemental actions by not later than September 30, 1997:

(A) alternative means of improving the reliability and quality of water supplies currently available to privately owned wetlands in the Central Valley and the need, if any, for additional supplies; and

(B) water supply and delivery requirements necessary to permit full habitat development for water dependent wildlife on 120,000 acres supplemental to the existing wetland habitat acreage identified in Table 8 of the Central Valley Habitat Joint Venture's "Implementation Plan" dated April 19, 1990, as well as feasible means of meeting associated water supply requirements.

(e) SUPPORTING INVESTIGATIONS. - Not later than five years after the date of enactment of this title, the Secretary shall investigate and provide recommendations to the Committee on Energy and Natural Resources of the Senate and the Committees on Interior and Insular Affairs and Merchant Marine and Fisheries of the House on the feasibility, costs, and desirability of developing and implementing each of the following, including, but not limited to, the impact on the project, its users, and the State of California:

(1) measures to maintain suitable temperatures for anadromous fish survival in the Sacramento and San Joaquin rivers and their tributaries, and the Sacramento-San Joaquin Delta by controlling or relocating the discharge of irrigation return flows and sewage effluent, and by restoring riparian forests;

(2) opportunities for additional hatchery production to mitigate the impacts of water development and operations on, or enhance efforts to increase Central Valley fisheries; Provided, That additional hatchery production shall only be used to supplement or to re-establish natural production while avoiding adverse effects on remaining wild stocks;

(3) measures to eliminate barriers to upstream and downstream migration of salmonids in the Central Valley, including but not limited to screening programs, barrier removal programs and programs for the construction or rehabilitation of fish ladders on tributary streams;

(4) installation and operation of temperature control devices at Trinity Dam and Reservoir to assist in the Secretary's efforts to conserve cold water for fishery protection purposes;

(5) measures to provide for modified operations and new or improved control structures at the Delta Cross Channel and Georgiana Slough to assist in the successful migration of anadromous fish; and

(6) other measures which the Secretary determines would protect, restore, and enhance natural production of salmon and steel-head trout in tributary streams of the Sacramento and San Joaquin Rivers, including but not limited to the

Merced, Mokelumne, and Calaveras Rivers and Battle, Butte, Deer, Elder, Mill, and Thomes Creeks.

(f) REPORT OF PROJECT FISHERY IMPACTS. - The Secretary, in consultation with the Secretary of Commerce, the State of California, appropriate Indian tribes, and other appropriate public and private entities, shall investigate and report on all effects of the Central Valley Project on anadromous fish populations and the fisheries, communities, tribes, businesses and other interests and entities that have now or in the past had significant economic, social or cultural association with those fishery resources. The Secretary shall provide such report to the Committee on Energy and Natural Resources of the Senate and the Committees on Interior and Insular Affairs and Merchant Marine and Fisheries of the House of Representatives not later than two years after the date of enactment of this title.

(g) ECOSYSTEM AND WATER SYSTEM OPERATIONS MODELS. - The Secretary, in cooperation with the State of California and other relevant interests and experts, shall develop readily usable and broadly available models and supporting data to evaluate the ecologic and hydrologic effects of existing and alternative operations of public and private water facilities and systems in the Sacramento, San Joaquin, and Trinity River watersheds. The primary purpose of this effort shall be to support the Secretary's efforts in fulfilling the requirements of this title through improved scientific understanding concerning, but not limited to, the following:

(1) a comprehensive water budget of surface and groundwater supplies, considering all sources of inflow and outflow available over extended periods;

(2) related water quality conditions and improvement alternatives, including improved temperature prediction capabilities as they relate to storage;

(3) surface-ground and stream-wetland interactions;

(4) measures needed to restore anadromous fisheries to optimum and sustainable levels in accordance with the restored carrying capacities of Central Valley rivers, streams, and riparian habitats;

(5) development and use of base flows and channel maintenance flows to protect and restore natural channel and riparian habitat values;

(6) implementation of operational regimes at State and Federal facilities to increase springtime flow releases, retain additional floodwaters, and assist in restoring both upriver and downriver riparian habitats;

(7) measures designed to reach sustainable harvest levels of resident and anadromous fish, including development and use of systems of tradeable harvest rights;

(8) opportunities to protect and restore wetland and upland habitats throughout the Central Valley;

(9) measures to enhance the firm yield of existing Central Valley Project facilities, including improved management and operations, conjunctive use opportunities, development of offstream storage, levee setbacks, and riparian restoration.

All studies and investigations shall take into account and be fully consistent with the fish, wildlife, and habitat protection and restoration measures required by this title or by any other state or federal law. Seventy-five percent of the costs associated with implementation of this subsection shall be borne by the United States as a nonreimbursable cost; the remaining 25 percent shall be borne by the State of California.

(h) The Secretary shall enter into a binding cost-share agreement with the State of California with respect to the timely reimbursement of costs allocated to the State in this title. Such agreement shall provide for consideration of the value of direct reimbursements, specific contributions to the Restoration Fund, and water, conveyance capacity, or other contributions in-kind that would supplement existing programs and that would, as determined by the Secretary, materially contribute to attainment of the goals and objectives of this title.

SEC. 3407. RESTORATION FUND.

(a) RESTORATION FUND ESTABLISHED. - There is hereby established in the Treasury of the United States the "Central Valley Project Restoration Fund" (hereafter "Restoration Fund") which shall be available for deposit of donations from any source and revenues provided under sections 3404(c)(3), 3405(f), 3406(c)(1), and 3407(d) of this title. Amounts deposited shall be credited as offsetting collections. Not less than 67 percent of all funds made available to the Restoration Fund under this title are authorized to be appropriated to the Secretary to carry out the habitat restoration, improvement and acquisition (from willing sellers) provisions of this title. Not more than 33 percent of all funds made available to the Restoration Fund under this title are authorized to be appropriated to the Secretary to carry out the provisions of paragraphs 3406(b)(4)-(6), (10)-(18), and (20)-(22) of this title. Monies donated to the Restoration Fund by non-Federal entities for specific purposes shall be expended for those purposes only and shall not be subject to appropriation.

(b) AUTHORIZATION OF APPROPRIATIONS. - Such sums as are necessary, up to $50,000,000 per year (October 1992 price levels), are authorized to be appropriated to the Secretary to be derived from the Restoration Fund to carry out programs, projects, plans, and habitat restoration, improvement, and acquisition provisions of this title. Any funds paid into the Restoration Fund by Central Valley Project water and power contractors and which are also used to pay for the projects and facilities set forth in section 3406(b), shall act as an offset against any water and power contractor cost share obligations that are otherwise provided for in this title.

(c) MITIGATION AND RESTORATION PAYMENTS BY WATER AND POWER BENEFICIARIES. -

(1) To the extent required in appropriation Acts, the Secretary shall assess and collect additional annual mitigation and restoration payments, in addition to the charges provided for or collected under sections 3404(c)(3), 3405(a)(1)(C), 3405(f), and 3406(c)(1) of this title, consisting of charges to direct beneficiaries of the Central Valley Project under subsection (d) of this section in order to recover a portion or all of the costs of fish, wildfish, and habitat restoration programs and projects under this title.

(2) The payment described in this subsection shall be established at amounts that will result in collection, during each fiscal year, of an amount that can be reasonably expected to equal the amount appropriated each year, subject to subsection (d) of this section, and in combination with all other receipts identified under this title, to carry out the purpose identified in subsection (b) of this section; Provided, That, if the total amount appropriated under subsection (b) of this section; Provided, That, if the total amount appropriated under subsection (b) of this section for the fiscal years following enactment of this title does not equal $50,000,000 per year (October 1992 price levels) on an average annual basis, the Secretary shall impose such charges in fiscal year 1998 and in each fiscal year thereafter, subject to the limitations in subsection (d) of this section, as may be required to yield in fiscal year 1998 and in each fiscal year thereafter total collections equal to $50,000,000 per year (October 1992 price levels) on a three-year rolling average basis for each fiscal year that follows enactment of this title.

(d) ADJUSTMENT AND ASSESSMENT OF MITIGATION AND RESTORATION PAYMENTS. -

(1) In assessing the annual payments to carry out subsection (c) of this section, the Secretary shall, prior to each fiscal year, estimate the amount that could be collected in each fiscal year pursuant to subparagraphs 2(A) and (B) of this subsection. The Secretary shall decrease all such payments on a proportionate basis from amounts contained in the estimate so that an aggregate amount is collected pursuant to the requirements of paragraph (c)(2) of this section.

(2) The Secretary shall assess and collect the following mitigation and restoration payments, to be covered to the Restoration Fund, subject to the requirements of paragraph (1) of this subsection:

(A) The Secretary shall require Central Valley Project water and power contractors to make such additional annual payments as are necessary to yield, together with all other receipts, the amount required under paragraph (c)(2) of this subsection; Provided, That such additional payments shall not exceed $30,000,000 (October 1992 price levels) on a three-year rolling average basis; Provided further, That such additional annual payments shall be allocated so as not to exceed $6.00 per acre-foot (October 1992 price levels) for agricultural water sold and delivered by the Central Valley Project, and $12.00 per acre-foot (October 1992 price levels) for municipal and industrial water sold and delivered by the Central Valley Project;

Provided further, that the charge imposed on agricultural water shall be reduced, if necessary, to an amount within the probable ability of the water users to pay as determined and adjusted by the Secretary no less than every five years, taking into account the benefits resulting from implementation of this title; Provided further, That the Secretary shall impose an additional annual charge of $25.00 per acre-foot (October 1992 price levels) for Central Valley Project water sold or transferred to any State or local agency or other entity which has not previously been a Central Valley Project customer and which contracts with the Secretary or any other individual or district receiving Central Valley Project water to purchase or otherwise transfer any such water for its own use for municipal and industrial purposes, to be deposited in the Restoration Fund; And Provided further, That upon the completion of the fish, wildlife, and habitat mitigation and restoration actions mandated under section 3406 of this title, the Secretary shall reduce the sums described in paragraph (c)(2) of this section to $35,000,000 per year (October 1992 price levels) and shall reduce the annual mitigation and restoration payment ceiling established under this subsection to $15,000,000 (October 1992 price levels) on a three-year rolling average basis. The amount of the mitigation and restoration payment made by Central Valley Project water and power users, taking into account all funds collected under this title, shall, to the greatest degree practicable, be assessed in the same proportion, measured over a ten-year rolling average, as water and power users' respective allocations for repayment of the Central Valley Project.

(e) FUNDING TO NON-FEDERAL ENTITIES. - If the Secretary determines that the State of California or an agency or subdivision thereof, an Indian tribe, or a non-profit entity concerned with restoration, protection, or enhancement of fish, wildlife, habitat, or environmental values is able to assist in implementing any action authorized by this title in an efficient, timely, and cost effective manner, the

Secretary is authorized to provide funding to such entity on such terms and conditions as he deems necessary to assist in implementing the identified action.

(f) RESTORATION FUND FINANCIAL REPORTS. - The Secretary shall, not later than the first full fiscal year after enactment of this title, and annually thereafter, submit a detailed report to the Committee on Energy and Natural Resources and the Committee on Appropriations of the Senate, and the Committee on Interior and Insular Affairs, the Committee on Merchant Marine and Fisheries, and the Committee on Appropriations of the House of Representatives. Such report shall describe all receipts to and uses made of monies within the Restoration Fund and the Restoration Account during the prior fiscal year and shall include the Secretary's projection with respect to receipts to and uses to be made of the finds during the next upcoming fiscal year.

SEC. 3408. ADDITIONAL AUTHORITIES.

(a) REGULATIONS AND AGREEMENTS AUTHORIZED. - The Secretary is authorized and directed to promulgate such regulations and enter into such agreements as may be necessary to implement the intent, purposes and provisions of this title.

(b) USE OF ELECTRICAL ENERGY. - Electrical energy used to operate and maintain facilities developed for fish and wildlife purposes pursuant to this title, including that used for groundwater development, shall be deemed as Central Valley Project power and shall, if reimbursable, be repaid in accordance with Reclamation law at a price not higher than the lowest price paid by or charged to other Central Valley Project contractors.

(c) CONTRACTS FOR ADDITIONAL STORAGE AND DELIVERY OF WATER. - The Secretary is authorized to enter into contracts pursuant to Reclamation law and this title with any Federal agency, California water user or water agency, State agency, or private non-profit organization for the exchange, impoundment, storage, carriage, and delivery of Central Valley Project and non-project water for domestic, municipal, industrial, fish and wildlife, and any other beneficial purpose, except that nothing in this subsection shall be deemed to supersede the provisions of section 103 of Pub. L. 99-546 (100 Stat. 3051).

(d) USE OF PROJECT FACILITIES FOR WATER BANKING. - The Secretary, in consultation with the State of California, is authorized to enter into agreements to allow project contracting entities to use project facilities, where such facilities are not otherwise committee or required to fulfill project purposes or other Federal obligations, for supplying carry-over storage of irrigation and other water for drought protection, multiple-benefit credit-storage operations, and other purposes. The use of such water shall be consistent with and subject to State law. All or a portion of the water provided for fish and wildlife under this title may be banked for fish and wildlife purposes in accordance with this subsection.

(e) LIMITATION ON CONSTRUCTION. - This title does not and shall not be interpreted to authorize construction of water storage facilities, nor shall it limit the Secretary's ability to participate in water banking or conjunctive use programs.

(f) ANNUAL REPORTS TO CONGRESS. - Not later than September 30 of each calendar year after the date of enactment of this title, the Secretary shall submit a detailed report to the Committee on Energy and Natural Resources of the Senate and the committee on Interior and Insular Affairs and the Committee on Merchant Marine and Fisheries of the House of Representatives. Such report shall describe all significant actions taken by the Secretary pursuant to this title and progress toward achievement of the intent, purposes and provisions of this title. Such report shall include recommendations for authorizing legislation or other measures, if any, needed to implement the intent, purposes and provisions of this title.

(g) RECLAMATION LAW. - This title shall amend and supplement the Act of June 17, 1902, and Acts supplementary thereto and amendatory thereof.

(h) LAND RETIREMENT. -

(1) The Secretary is authorized to purchase from willing sellers land and associated water rights and other property interests identified in paragraph (h)(2) which receives Central Valley Project water under a contract executed with the United States, and to target such purchases to areas deemed most beneficial to the overall purchase program, including the purposes of this title.

(2) The Secretary is authorized to purchase, under the authority of paragraph (h)(i), and pursuant to such rules and regulations as may be adopted or promulgated to implement the provisions of this subsection, agricultural land which, in the opinion of the Secretary -

(A) would, if permanently retired from irrigation, improve water conservation by a district, or improve the quality of an irrigation district's agricultural wastewater and assist the district in implementing the provisions of a water conservation plan approved under section 210 of the Reclamation Reform Act of 1982 and agricultural wastewater management activities developed pursuant to recommendations specific to water conservation, drainage source reduction, and land retirement contained in the final report of the San Joaquin Valley Drainage Program (September, 1990); or

(B) are no longer suitable for sustained agricultural production because of permanent damage resulting from severe drainage or agricultural wastewater management problems, groundwater withdrawals, or other causes.

(i) WATER CONSERVATION. -

(1) The Secretary is authorized to undertake, in cooperation with Central Valley Project irrigation contractors, water conservation projects or measures needed to meet the requirements of this title. The Secretary shall execute a cost-sharing agreement for any such project or measure undertaken. Under such agreement, the Secretary is authorized to pay up to 100 percent of the costs of such projects or measures. Any water saved by such projects or measures shall be governed by the conditions of subparagraph 3405(a)(1)(A) and (J) of this title, and shall be made available to the Secretary in proportion to the Secretary's contribution to the total cost of such project or measure. Such water shall be used by the Secretary to meet the Secretary's obligations under this title, including the requirements of paragraph 3406(b)(3). Such projects or measures must be implemented fully by September 30, 1999.

(2) There are authorized to be appropriated through the end of fiscal year 1998 such sums as may be necessary to carry out the provisions of this subsection. Funds appropriated under this subsection shall be nonreimbursable Federal expenditure.

(j) PROJECT YIELD INCREASE. - In order to minimize adverse effects, if any, upon existing Central Valley Project water contractors resulting from the water dedicated to fish and wildlife under this title, and to assist the State of California in meeting its future water needs, the Secretary shall, not later than three years after the date of enactment of this title, develop and submit to the Congress, a least-cost plan to increase, within fifteen years after the date of enactment of this title, the yield of the Central Valley Project by the amount dedicated to fish and wildlife purposes under this title. The plan authorized by this subsection shall include, but shall not be limited to a description of how the Secretary intends to use the following options:

(1) improvements in, modification of, or additions to the facilities and operations of the project;

(2) conservation;

(3) transfers;

(4) conjunctive use;

(5) purchase of water;

(6) purchase and idling of agricultural land; and

(7) direct purchase of water rights.

Such plan shall include recommendations on appropriate cost-sharing arrangements and shall be developed in a manner consistent with all applicable State and Federal law.

(k) Except as specifically provided in this title, nothing in this title is intended to alter the terms of any final judicial decree confirming or determining water rights.

SEC. 3409. ENVIRONMENTAL REVIEW.

Not later than three years after the date of enactment of this title, the Secretary shall prepare and complete a programmatic environmental impact statement pursuant to the National Environmental Policy Act analyzing the direct and indirect impacts and benefits of implementing this title, including all fish, wildlife, and habitat restoration actions and the potential renewal of all existing Central Valley Project water contracts. Such statement shall consider impacts and benefits within the Sacramento, San Joaquin, and Trinity River basins, and the San Francisco Bay/Sacramento-San Joaquin River Delta Estuary. The cost of the environmental impact statement described in this section shall be treated as a capital expense in accordance with Reclamation law.

SEC. 3410. AUTHORIZATION OF APPROPRIATIONS.

There are authorized to be appropriated such sums as may be necessary to carry out the provisions of this title. Funds appropriated under this title shall remain available until expended without fiscal year limitation.

SEC. 3411. COMPLIANCE WITH STATE WATER LAW AND COORDINATED OPERATIONS AGREEMENT.

(a) Notwithstanding any other provision of this title, the Secretary shall, prior to the reallocation of water from any purpose of use or place of use specified within applicable Central Valley Project water rights permits and licenses to a purpose of use or place of use not specified within said permits or licenses, obtain a modification in those permits and licenses, in a manner consistent with the provisions of applicable State law, to allow such change in purpose of use or place of use.

(b) The Secretary, in the implementation of the provisions of this title, shall fully comply with the United States' obligations as set forth in the "Agreement Between the United States of America and the Department of Water Resources of the State of California for Coordinated Operation of the Central Valley Project and the State Water Project: dated May 20, 1985, and the provisions of Pub. L. 99-546; and shall take no action which shifts an obligation that otherwise should be borne by the Central Valley Project to any other lawful water rights permittee or licensee.

SEC. 3412. EXTENSION OF THE TEHAMA-COLUSA CANAL SERVICE AREA.

The first paragraph of section 2 of the Act of September 26, 1950 (64 Stat. 1036), as amended by the Act of August 19, 1967 (81 Stat. 167), and the Act of December 22, 1980 (94 Stat. 3339), authorizing the Sacramento Valley Irrigation Canals, Central Valley Project, California, is further amended by striking "Tehama, Glenn, and Colusa Counties, and those portions of Yolo County within the boundaries of the Colusa County, Dunnigan, and Yolo-Zamora water districts or" and inserting "Tehama, Glenn, Colusa, Solano, and Napa Counties, those portions of Yolo County within the boundaries of Colusa Water District, Dunnigan Water-District, Yolo-Zamora Water District, and Yolo County Flood Control and Water Conservation District, or".

ATTACHMENT B

DISTRIBUTION OF DRAFT PEIS

Attachment B

DISTRIBUTION OF DRAFT PEIS*

Cooperating Agencies

CA Department of Fish & Game*
CA Department of Water Resources*
CA State Water Resources Control Board*
Hoopa Valley Tribal Council*
National Marine Fisheries Service*
U.S. Army Corps of Engineers*
U.S. Environmental Protection Agency*
U.S. Fish & Wildlife Service*
Western Area Power Administration*

Consulting Agencies

Natural Resources Conservation Service*
U.S. Bureau of Indian Affairs**
U.S. Geological Survey*

Other Federal State Agencies/Organizations

Bay Conservation & Development Commission
CA Air Resources Board
CA Coastal Commission
CA Coastal Conservancy
CA Department of Boating and Waterways
CA Department of Food & Agriculture
CA Department of Forestry & Fire Protection
CA Department of Health Services
CA Department of Parks & Recreation
CA Energy Commission
CA Environmental Protection Agency
CA Regional Water Quality Control Boards (9)
CA Resources Agency*
CA State Clearinghouse**
CA State Parks & Recreation
CA Water Commission
CALFED Bay-Delta Program*
Colorado River Board of CA
Council of Environmental Quality
Delta Protection Commission
Department of Pesticide Regulation
Federal Emergency Management Agency
Legislative Counsel Bureau
Native American Heritage Commission
National Park Service*
Office of Legislative Council
Office of Metro Water Planning
Office of Planning & Research
Reclamation Board
Regional Water Quality Control Board*
Sacramento National Wildlife Refuge
State Lands Commission
State of Nevada
U.S. Bureau of Land Management*
U.S. Department of Agriculture
U.S. Department of Energy
U.S. Department of the Interior

Elected Officials*

CA Assembly, Committee on Agriculture
CA Assembly, Committee on Natural Resources
CA Assembly, Committee on Utilities and Commerce
CA Assembly, Committee on Water, Parks and Wildlife
CA Senate, Committee on Energy, Utilities and Communications
CA Senate, Committee on Natural Resources and Wildlife
CA Senate, State Appropriations Committee
Office of the Governor, State of California
U.S. House of Representatives (California Delegation)
U.S. House of Representatives, Committee on
Appropriations, Energy & Water Development
U.S. House of Representatives, Committee on Resources
U.S. Senate, Committee on Agriculture & Water
U.S. Senate, Committee on Energy & Natural Resources
U.S. Senate, Senators Barbara Boxer & Diane Feinstein

Other Interested Parties

American Farmland Trust
American Whitewater Affiliation Parties
Association of CA Water Agencies
Audubon Society*
Baker, Manock & Jenson
Bank of America
Battelle Pacific Northwest Laboratory*
Bay Conservation & Development Commission
Bay Institute of San Francisco*
CA Advisory Committee Salmon & Steelhead Trout
CA Farm Bureau Federation
CA Farm Water Coalition*
CA Municipal Utilities Association
CA Striped Bass Association
Calaveras County*
California Trout
California Urban Water Agencies*
California Waterfowl Association
California Wildlife Foundation
Central Delta Water Agency*
Central Sierra Planning Council
Central Valley Project Water Users Association*
Cherokee Ranch
Citizens for Cloverdale*
City and County of San Francisco*
City of Folsom
City of Fresno Public Utilities*
City of Mendota

***Asterisk indicates organization was sent the Draft PEIS. Others listed received the Executive Summary. Not listed are other organizations and individuals who have specifically requested the document. Reclamation has also distributed the PEIS to other organizations and individuals who have specifically requested the document.**

Other Interested Parties (Continued)

City of Modesto
City of Redding
City of Redding Electric Department*
City of Sacramento*
City of San Diego Water Department*
City of Stockton*
Contra Costa County Department of Agriculture*
Contra Costa Water District
County of Sacramento
County of Santa Cruz*
CVP Customer Technical Committee
De Cuir & Somach*
Delta Protection Commission*
Dooley and Herr*
Downey, Brand, Seymour & Rohwer*
EA Engineering, Science and Technology
East Bay Municipal Utility District*
East Palo Alto Historical & Agricultural*
El Dorado County Water Agency*
El Dorado County Trail Users of the Divide
Endangered Species Recovery Program
Environmental Defense Fund*
Environmental Law Foundation
Friant Water Users Authority*
Friends of Navarro Watershed
Frost, Krup & Atlas*
Gagen, McCoy, McMahon & Armstrong*
Glenn County*
Golden Gate Angling & Casting Club
Golden West Women Fly Fishers
Griffith, Masuda & Godwin
JFK University School of Law
Kahn Soares & Conway*
Kronick Moskovitz*
Lasher, Holzapfel, Sperry & Ebberson*
Law Offices of Barry Epstein*
League of Women Voters*
Los Angeles Department of Water and Power*
Los Angeles County Department of Public Works*
Lower Tule River Irrigation District
Martinez & Curtis, P.C.*
Mehlaff, Hay & Swingle*
Mendocino County
Mendocino County Courthouse
Mendota Unified School District
Metropolitan Water District of Southern California
Morongo Band of Mission Indians*
Murray, Burns & Kienlen
Native American Heritage Commission*
Natural Heritage Institute
Natural Resources Defense Council*
Neumiller & Beardslee*
Nevada County Farm Bureau*
NORCAL Fishing Guides & Sportmens*
Northern California Council Federation of Fly Fishers
Northern California Power Agency
Northern California Water Association
Northwestern University*
Oak Ridge National Laboratory*
Orange County Planning Department*
Orangevale Water Company
Pacific Coast Federation of Fisherman's Association*
Pacific Fishery Management Council
Patterson Water District*
Placer County Water Agency
Redding - Electric
Resource Management International
Rural Water Impact Network
Sacramento City and County Office of Water Planning
Sacramento Municipal Utility District
Sacramento River Council
Sacramento River Water Contractors Association
Sacramento Valley Landowners Association
Salmon Trollers Marketing Association
San Francisco Bay Regional Water Board*
San Francisco Estuary Project
Sanger Chamber of Commerce
San Joaquin County
San Luis & Delta-Mendota Water Authority*
Santa Clara County*
Santa Clara Valley Water District
Save the San Francisco Bay Association
Share the Water
Shasta County Farm Bureau
Sierra Club*
Siskiyou County Farm Bureau
Solano Irrigation District
South Delta Water Agency*
Sportsmen Council of Northern California
Stanislaus Area Association of Governments*
State Lands Commission*
State Water Contractors*
Stockton East Water District
Sutter Mutual Water Company
Tehama Fly Fishers Preservation Trust
Tehama Sportsman Club
Tehama-Colusa Canal Authority*
The Nature Conservancy
The Public Trustee*
Tribal Environmental Protection Agency*
Trinity County
Trinity County Natural Resources*
Trinity County Public Utilities District
Trout Unlimited of California
Tuolumne County*
Turlock Irrigation District
United Anglers of California
Van Ruiten Bros.
Westlands Water District**

Libraries*

Alum Rock Library
Alturas Public Library
Amador County Library
Auburn-Placer County Library
Bakersfield Library
Burbank Public Library
Butte County Library
Calaveras County Library
California State Library
College of the Redwoods
Colusa County Free Library
Concord Library

Libraries (Continued)

Contra Costa County Library
CSU - Chico, Meriam Library-Government Publications
CSU - Long Beach, Library-Government Documents
CSU - Stanislaus
Del Norte County Library District
Dixon Unified School District Library
E.P. Foster and H.P. Wright Library
El Dorado County Library
Fresno County Public Library
Grass Valley-Sierra County Library
Humboldt County Library
Kern County Public Library
Kings County Library
Lake County Library
Lassen County Free Library
Lodi Public Library
Los Angeles Public Library
Los Banos City Library
Madera County Library
Marin County Civic Center Library
Mariposa County Library
Mendocino County Library
Merced Library
Modesto City Library
Monterey County Free Library
Napa City and County Library
Nevada City Library
Oakland Public Library
Orange County Public Library
Plumas County Library
Red Bluff City Library
Redwood City-San Mateo County Library
Riverside City and County Library
Sacramento County Library
Sacramento Public Library
San Benito County Free Library
San Bernadino County Library
San Diego Public Library
San Diego State University
San Francisco Public Library
San Jose State University
San Luis Obispo City and County Library
San Rafael Civic Center Library
Santa Barbara Public Library
Santa Cruz Public Library
Shasta County Library
Siskiyou County Library
Solano County Library
Sonoma County Library
Stanford University Libraries
Stanislaus County Free Library
Stockton City Library
Stockton-San Joaquin County Public Library
Sutter County Library
Tehama County Library
Trinity County Library
Tulare County Free Library
Tulare Public Library
Tuolumne County Library
U.C. Berkeley Library
U.C. Davis Library
U.C., Hastings College of Law
U.C. Los Angeles, University Research Library
U.C. San Diego, Government Documents/Maps Department
U.C. Santa Barbara, Library-Government Publications Section
U.C. Water Resources Center
Willows Public Library
Yolo County Library
Yuba County Library

ATTACHMENT C

LIST OF PREPARERS

Attachment C

LIST OF PREPARERS

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role in Preparation
Bureau of Reclamation			
Rick Breitenbach	M.S., Biological Conservation B.S., Biology 22 Years	Environmental Planning Regulatory Compliance	Project Planning Alternative Development
John "Chip" Bruss	B.S., Wildlife Biology 17 Years	Natural Resource Management Native American Issues	Vegetation and Wildlife and Indian Trust Assets Review
Alan Candlish	B.S., Civil Engineering 24 Years	Water Resource Planning Project Management	Project Management Review
Randy Christopherson	M.S., Agribusiness Management B.S., Agricultural Economics 15 Years	Agricultural Economist Resource Manager Resource Economist	Project Planning
Thomas Dang	B.S., Electrical Engineering 10 Years	Hydropower Modeling Power Operations and Planning FERC Licensing	Power Impact Analysis Power Review Analytical Tools
Merv de Haas	M.S., Agricultural Economics Business Management B.S., Agricultural Economics 27 Years	Repayment Contract Administration Economics	Project Planning Analytical Tools
Marian Echeverria	M.B.A. B.A., Latin American Studies 6 Years	Public Involvement Facilitation Dispute Resolution	Public Involvement
Rosalie Faubion	M.S., Education B.S., Biology 30 Years	Fish and Wildlife Biology	Vegetation and Wildlife Review
John Fields	B.S., Environmental Toxicology 17 Years	Water Quality and Toxicology	Public Health - Delta as a Source of Drinking Water Review
Kurt Flynn	B.S., Biology 13 Years	NEPA ESA	Vegetation and Wildlife Review
Gale Heffler-Scott	30 Years	Repayment Contract Administration Water Rights	Water Transfer Review
Buford Holt	Ph.D., Botany and Plant Pathology B.S., Botany 28 Years	Plant Ecology and Population Biology Environmental Assessment mineral resource management and water resource management	Vegetation and Wildlife Review
John Johannis	B.S., Civil Engineering 19 Years	Hydraulic Modeling Power Planning Water Operations Hydrology	Project Planning Project Management Review
Will Keck	M.S., International Relations B.S., Political Science 20 Years	Outdoor Recreation Planning Special Projects Coordinator	Recreation Review

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role in Preparation
Tammy Kendrick	30 Years	Acreage Limitations of Reclamation Law Environmental Compliance	Project Planning No Action Alternative
Doug Kleinsmith	M.S., Biology B.A., Biology 18 Years	Biology Environmental Compliance	NEPA Coordination Visual Resources Review
Sue Kristoff	B.S., Civil Engineering 7 Years	Hydraulic Engineering	Project Planning Analytical Tools
Ken Lentz	M.S., Fisheries Biology B.S., Fisheries Biology 25 Years	Fisheries Aquatic Biology	Fisheries Review
Peggy Manza	B.S., Hydrologic Sciences	Hydrologic Modeling	Surface Water Review
Frank Michny	M.S., Fish and Wildlife Biology B.S., Biology 23 Years	Fish and Wildlife Biology Environmental Compliance	ESA NEPA Compliance Review
David Moore	M.S., Geology B.S., Geology 16 Years	Geology and Hydrogeology	Groundwater Review
Betty Riley-Simpson	B.S., Business Administration 20 Years	Repayment Contract Administration	Review
Kirk Rodgers	24 Years	Project Management Program Management ESA	Program Manager Project Plannining
Ted Roefs	M.S., Civil Engineering B.S., Civil Engineering 40 Years	Hydrology Systems Analysis	Surface Water Review
Jeff Sandberg	M.A., Geography B.A., Geography 7 Years	Hydrologic Modeling Water Rights	Surface Water Review
Chuck Solomon	M.S., Environmental Science M.S., Biology B.A., Biology 26 Years	Terrestrial Ecology Habitat Modeling Wildlife Management	Vegetation and Wildlife Review
Craig Stroh	M.A., Economics B.A., Economics 27 Years	Economics	Economics and Social Analysis Review
Bernice Sullivan	2 Years College 35 Years Experience	Administrative Management Technical Writer/Editor Resource Management Environmental Planning Watershed Program Management/Coordination	Review
Ramona Swafford	B.A., Statistics	Hydrology	Surface Water Review
Lenore Thomas	Post Graduate - Civil Engineering M.S., Water Resources Management B.S., Biology B.S., Secondary Education 28 Years	Hydraulic Engineer	Technical Review
Don Treasure	B.S., Wildlife Management 22 Years	Fish and Wildlife Biology Environmental Compliance	NEPA Compliance Review

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role in Preparation
Robert Turner	B.S., Geology 26 Years	Geology and Hydrogeology	Groundwater and Geology and Soils Review
Patrick Welch	B.A., Chemistry 21 Years	Cultural Resources/Archeology	Cultural Resources Review
G. James West	Ph.D. 25 Years	Cultural Resources/Archeology	Cultural Resources Review
Fish and Wildlife Service			
Jerry Bielfeldt	B.S., Biology 10 Years	Fish and Wildlife Biology	PEIS Document Review Vegetation and Wildlife Review
Roger Guinee	B.S., Wildlife Biology 22 Years	Fish and Wildlife Biology	Fisheries Review
Andrew Hamilton	M.S., Aquatic Ecology B.A., Comparative Literature 19 Years	Fish and Wildlife Biology	Fisheries Review
Derek Hilts	M.S., Water Resources B.S., Civil Engineering 15 Years	CVP/SWP Operations Computer Programming Hydrology	Surface Water Review
Michael Hoover	B.S., Biology 18 Years	Fish and Wildlife Biology Environmental Compliance	Project Planning PEIS Document Review Vegetation and Wildlife Review NEPA Compliance
Patrick Leonard	M.S., Animal Behavior B.A., Anthropology 10 Years	Fish and Wildlife Biology ESA Issues	PEIS Document Review Vegetation and Wildlife Review
Joel Miller	B.S., Wildlife Biology 27 Years	Wildlife Biology Refuge Management	Vegetation and Wildlife Review Refuge Water Supply
Steven Schoenberg	Ph.D., Biology/Ecology M.S., Biology/Ecology B.S., Biology 20 Years	Fish and Wildlife Biology Aquatic Ecology	Fisheries Review
James G. Smith	B.S., Fisheries Post Graduate Work 22 Years	Fisheries Biology	Fisheries Review
Marie Sullivan	M.S., Natural Science B.S., Environmental Planning 10 Years	Fish and Wildlife Biology	Vegetation and Wildlife Review (b) (1) “other” Program Review
Western Area Power Administration			
P. Nannette Engelbrite	B.S., Electrical Engineering 13 Years	Power Engineering	Power Impact Analysis
Phil House	B.S., Civil Engineering 28 Years	Power Resource Planning	Power Impact Analysis
Montgomery Watson			
F. Phillip Sharpe	Post Graduate- Economics/Statistics M.S., Biology/Statistics B.S., Fishery Science 39 years	Fisheries Biologist	Project Manager

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role in Preparation
Gwendolyn M. Buchholz	M.S., Civil-Environmental Engineering B.S., Physics 20 years	Environmental Engineer/Planner	Deputy Project Manager
David Alderete	B.S., Civil Engineering 2 years	Civil Engineer	Municipal and Industrial Land Use and Demographics, Surface Water Supplies and Facilities Operations
Michael Cornelius	M.S., Environmental Engineering B.S., Geology 7 years	Geology and Hydrogeology	Groundwater, Soils and Geology
Sarah Holmgren	M.S., Conservation Ecology B.S., Environmental Health Science 2 years	Ecology	Municipal and Industrial Land Use and Demographics
Carol Howe	B.S., Planning 23 years	Water Quality and Aquatic Habitat	Municipal and Industrial Land Use and Demographics
Robert Morrow	B.S., Biology 13 years	Fisheries	Fisheries
Vanessa Nishikawa	M.S., Environmental Engineering B.S., Bioengineering 2 years	Environmental Engineer	Surface Water Supplies and Facilities Operations, PROSIM M/M
Roger Putty	M.S., Water Resources Engineering and Hydrology B.S., Civil Engineering 9 years	Environmental Engineer/ Hydrogeology	Groundwater, Surface Water Supplies and Facilities Operations, CVGSM M/M
Kevan Samsam	B.S., Civil Engineering 1 year	Civil Engineer	Groundwater, CVGSM M/M
Sandra Siems	B.S., Agriculture Business 10 years	Economist/Planner	Soils and Geology, Social
Anne Sienko	B.A., Ecology and Evolution 2 years	Ecology	Public Health: The Delta as a Source of Drinking Water
William Swanson	B.S., Civil Engineering 13 years	Environmental Engineer/Hydrology	Surface Water Supplies and Facilities Operations, Air Quality, Public Health: Mosquitoes, Indian Trust Assets, Visual Resources, SANJASM M/M
Ali Taghavi	Ph.D., Civil Engineering 15 years	Environmental Engineer/ Hydrogeologist	Groundwater, CVGSM M/M
Robert Tull	M.S.E., Environmental Engineering B.S., Environmental Planning 9 years	Environmental Engineer/ Hydrologist	Surface Water Supplies and Facilities Operations, PROSIM M/M
Paul Wisheropp	M.S., Civil Engineering 15 years	Water Resources Engineer	PROSIM M/M
Derrick Wong	M.S., Environmental Engineering B.S., Civil Engineering 3 years	Environmental Engineer/ Hydrologist	Surface Water Supplies and Facilities Operations, SANJASM M/M
CH2M HILL			
Loren Bottorff	M.S., Civil Engineering 20 years	Water Resources Engineer	Development of Alternatives
Earl Byron	M.S., Biology 15 years	Fisheries	Fisheries
Rhonda Detherage	12 Years	Desktop Publisher	Desktop Publisher

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role in Preparation
Neal Dixon	Ph.D., Water Resources 35 years	Water Resources Engineer	Surface Water Supplies and Facilities Operations
Tim Hamaker	B.S., Biology 15 years	Fisheries Biologist	Fisheries
Steve Hatchett	Ph.D., Agricultural Economics M. Admin., Environmental Administration B.S., Forestry 17 Years	Agricultural and Resources Economist	Agricultural Economics, CVPM M/M, Water Transfer Opportunities, CVPTM M/M
Allan Highstreet	M.S., Agricultural Economics B.S., Agricultural Business Management 19 years	Agricultural and Resources Economist	Agricultural Economics and Land Use, CVPM M/M, Municipal Water Costs, Water Transfer Opportunities
Wendy Haydon	M.S., Recreation B.S., Environmental Studies 8 years	Environmental Planner	Public Health: Mosquitoes, Visual Resources
Umesh Laliwani	Ph.D., Environmental Engineering 5 years	Environmental Engineer	Groundwater
Roger Mann	Ph.D., Agricultural and Resource Economics M.S., Agricultural and Resource Economics B.S., Resource Economics 16 years	Agricultural and Resources Economist	Municipal Water Costs, Water Transfer Opportunities
Pamela Vanderbilt		Air Quality	Air Quality
Melissa Williams	B.S., Biology	Environmental Planner	Public Health: Mosquitoes, Air Quality, Visual Resources
Phylis Williams		Agricultural and Resources Economist	Agricultural Economics and Land Use
Bing Zhang	Ph.D., Agricultural Economics M.S., Agricultural Economics B.S., Agricultural Economics 10 years	Agricultural and Resources Economist	Agricultural Economics and Land Use, Municipal Water Costs, Water Transfer Opportunities, CVPTM M/M
Jones & Stokes Associates, Inc.			
Edward Beedy	Ph.D., M.A., B.S., Zoology 20 years	Zoologist	Vegetation and Wildlife
Russ Brown	Ph.D., Civil Engineering, Water Resources M.S., Ocean Engineering B.S., Civil and Environmental Engineering 16 years	Environmental Engineer	Fish Habitat Water Quality and Fish Habitat Water Quality M/M
Roberta Childres	B.A., Political Science 5 years	Publications Specialist, Technical Editor	Cultural Resources; Fisheries; Fish Habitat Water Quality; Fish, Wildlife, and Recreation Economics; Recreation; Vegetation and Wildlife
Gregg Ellis	B.A., Geography 2 years	Environmental Compliance	Cultural Resources; Fisheries; Fish Habitat Water Quality; Fish, Wildlife, and Recreation Economics; Recreation; Vegetation and Wildlife
Mary Engbring	16 years	Graphics Artist	Graphics
Matt Gause	B.S., Botany 5 years	Botanist	Vegetation and Wildlife

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role in Preparation
Steve Holl	M.S., Vertebrate Biology B.S., Wildlife and Fisheries Biology 18 years	Wildlife Biologist	Vegetation and Wildlife and Vegetation and Wildlife M/M
Dana McGowan	M.A., Anthropology B.A., Anthropology 11 years	Anthropologist	Cultural Resources
Tim Messick	M.A., Biology B.A., Botany 13 years	Botanist, Graphic Artist	Vegetation and Wildlife
Rick Oestman	M.S., Fisheries B.A., Fisheries 7 years	Fisheries Biologist	Fisheries
Jane Palik	6 years	Word Processing Operator	Word Processing
Gerrit Platenkamp	Ph.D., Ecology M.S., Animal and Plant Ecology B.S., Biology 12 years	Ecologist	Vegetation and Wildlife; Vegetation and Wildlife M/M
Tim Rimpo	M.S., Economics (Natural Resource and Environmental Specialization) B.A., Economics 9 years	Natural Resource Economist	Recreation
Gregg Roy	B.S., Political Economy of Natural Resources 13 years	Economist	Recreation and Recreation M/M
Warren Shaul	M.S., Fisheries B.S., Biology 17 years	Fisheries Biologist	Fisheries
Todd Sloat	B.S., Wildlife and Fisheries Biology 3 years	Wildlife Biologist	Vegetation and Wildlife
Alan Solbert	M.S., Wildlife Sciences and Ecology B.S., Biology and Zoology 17 years	Environmental Compliance	Cultural Resources; Fisheries; Fish Habitat Water Quality; Fish, Wildlife, and Recreation Economics; Recreation; Vegetation and Wildlife
Craig Stevens	B.S., Renewable Natural Resources 12 years	Environmental Compliance	Cultural Resources; Fisheries; Fish Habitat Water Quality; Fish, Wildlife, and Recreation Economics; Recreation; Vegetation and Wildlife
Stephanie Theis	M.S., Applied Ecology and Conservation Biology (pending) B.S., Fisheries Biology 4 years	Ecologist	Fisheries
Roger Trott	M.S., Agricultural Economics B.A., Economics 10 years	Economist	Fish, Wildlife, and Recreation Economics
Thomas Wegge	M.S., Environmental Economics B.A., Urban Studies 17 years	Economist	Fish, Wildlife, and Recreation Economics and Fish, Wildlife, and Recreation Economics M/M; Recreation M/M
Ray Weiss	B.A., Economics 2 years	Economist	Recreation; Fish, Wildlife, and Recreation Economics
Michael Wolanek	M.S., Forest Hydrology B.S., Forest Management 8 years	Hydrologist, Fisheries Habitat	Fisheries

Preparers	Degree(s)/Years of Experience	Experience and Expertise	Role in Preparation
Andy Wones	M.S., General Science B.S., Biology 10 years	Biologist	Fisheries
Public Affairs Management			
Bonnie Nixon	B.A., Communication 15 years	Environmental and Government Policy	Public Involvement
Charles Gardiner	B.S., Chemistry and Political Science 15 years	Environmental and Government Policy	Public Involvement
Bradd Shinn	B.S., Agricultural Business 11 years	Environmental and Government Policy	Public Involvement
Northwest Economics Associates			
Duane Paul	Ph.D., Agricultural Economics M.S., Agricultural Economics B.S., Agricultural Business 23 years	Regional Economist	Regional Economics
R.W. Beck , Inc.			
Peter J. Robertshaw	B.A.Sc., Civil Engineering 13 Years	Computer Modeling Electric Utilities	Power Impact Analysis
Paul G. Scheuerman	B.S., Electrical Engineering 31 Years	Power Systems Electric Utilities	Power Impact Analysis

ATTACHMENT D

GLOSSARY OF TERMS, ACRONYMS, ABBREVIATIONS, METRIC CONVERSIONS, AND READER'S GUIDE TO EXCEEDENCE CURVES

Attachment D

GLOSSARY OF TERMS, ACRONYMS, ABBREVIATIONS, METRIC CONVERSIONS, AND READER'S GUIDE TO EXCEEDENCE CURVES

GLOSSARY OF TERMS

A

Acre-foot—The quantity of water required to cover 1 acre to a depth of 1 foot. Equal to 1,233.5 cubic meters (43,560 cubic feet).

Affected environment—Existing biological, physical, social, and economic conditions of an area subject to change, both directly and indirectly, as a result of a proposed human action.

Air quality—Measure of the health-related and visual characteristics of the air, often derived from quantitative measurements of the concentrations of specific injurious or contaminating substances.

Alternatives—Courses of action which may meet the objectives of the proposal at varying levels, including the most likely future without the project or action. An environmental assessment or an environmental impact statement identifies and objectively evaluates and analyzes all reasonable alternatives including a no action alternative.

Anthropogenic—Human-created.

Anadromous—In general, this term is used to refer to fish, such as salmon or steelhead trout, that hatch in fresh water, migrate to and mature in the ocean, and return to freshwater as adults to spawn. Section 3403(a) of the CVPIA defines anadromous as "those stocks of salmon (including steelhead), striped bass, sturgeon, and American shad that ascend the Sacramento and San Joaquin rivers and their tributaries and the Sacramento-San Joaquin Delta to reproduce after maturing in San Francisco Bay or the Pacific Ocean".

Anadromous Fish Restoration Program (AFRP)—A program authorized by the CVPIA to address anadromous fish resource issues in Central Valley streams that are tributary to the Delta. This program is lead by the U.S. Fish and Wildlife Service (Service).

Applied Water (AW)**—**The quantity of water delivered to the intake to a city's water system and the farm headgate, the amount of water supplied to a marsh or other wetland, either directly or by incidental drainage flows.

Aquatic—Living or growing in or on the water.

Aquifer—An underground geologic formation in which water can be stored.

Artificial propagation/production—As defined in Section 3403(b) of the CVPIA, "spawning, incubating, hatching, and rearing fish in a hatchery or other facility constructed for fish production".

Authorization—An act by the Congress of the United States which authorizes use of public funds to carry out a prescribed action.

B

Baseload—Minimum load of a power system over a given time period.

Basin Irrigation Efficiency—Evapotranspiration of applied water divided by the net diversion.

Bay-Delta Plan Accord—In December 1994, representatives of the state and federal governments and urban, agricultural and environmental interests agreed to the implementation of a Bay-Delta protection plan through the SWRCB, in order to provide ecosystem protection for the Bay-Delta Estuary. The Draft Bay-Delta Water Control Plan, released in May 1995, superseded D-1485.

Beneficial use—Those uses of water as defined in the State of California Water Code (Chapter 10 of Part 2 of Division 2), including but not limited to agricultural, domestic, municipal, industrial, power generation, fish and wildlife, recreation, and mining.

Benthic—Bottom of rivers, lakes, or oceans; organisms that live on the bottom of water bodies.

Biological opinion—Document issued under the authority of the Endangered Species Act stating the Service and/or the National Marine Fisheries Service (NMFS) finding as to whether a Federal action is likely to jeopardize the continued existence of a threatened or endangered species or result in the destruction or adverse modification of critical habitat. This document may include:

***Critical habitat*—**A description of the specific areas with physical or biological features essential to the conservation of a listed species and which may require special management considerations or protection. These areas have been legally designated via Federal Register notices.

***Jeopardy opinion*—**The Service or NMFS opinion that an action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. The finding includes reasonable and prudent alternatives, if any.

No jeopardy opinion—U.S. Fish and Wildlife Service or NMFS finding that an action is not likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat.

C

CALFED—Joint federal and state program to address water-related issues in the Sacramento-San Joaquin rivers Delta.

Candidate species—Plant or animal species not yet officially listed as threatened or endangered, but which is undergoing status review by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

Carryover storage—That water remaining in storage at the end of the water year.

Catch—At a recreational fishery, refers to the number of fish captured.

Central Valley Habitat Joint Venture—As defined by Section 3403(c) of the CVPIA, "the association of Federal and State agencies and private parties established for the purpose of developing and implementing the North American Waterfowl Management Plan as it pertains to the Central Valley of California".

Central Valley Project (CVP)—As defined by Section 3403(d) of the CVPIA, "all Federal reclamation projects located within or diverting water from or to the watershed of the Sacramento and San Joaquin rivers and their tributaries as authorized by the Act of August 26, 1937 (50 Stat. 850) and all Acts amendatory or supplemental thereto, ...".

Central Valley Project service area—As defined by Section 3403(e) of the CVPIA, "that area of the Central Valley and San Francisco Bay Area where water service has been expressly authorized pursuant to the various feasibility studies and consequent congressional authorizations for the Central Valley Project".

Central Valley Project water—As defined by Section 3403(f) of the CVPIA, "all water that is developed, diverted, stored, or delivered by the Secretary in accordance with the statutes authorizing the Central Valley Project in accordance with the terms and conditions of water rights acquired pursuant to California law".

Central Valley Project water service contractor—Water users that have contracted with the U.S. Bureau of Reclamation for water.

Channel—Natural or artificial watercourse, with a definite bed and banks to confine and conduct continuously or periodically flowing water.

Confined aquifer—An aquifer bounded above and below by impermeable or confining layers of distinctly lower permeability than the aquifer itself.

Confluence—The flowing together of two or more streams; the place of meeting of two streams.

Conjunctive use—The planned use of groundwater in conjunction with surface water in overall management to optimize water resources.

Conserved water—That water resulting from the contractor operations and practices that results in less use of the allocated supply.

Conveyance capacity—The rate at which water can be transported by a canal, aqueduct, or ditch. In this document, conveyance capacity is generally measured in cubic feet per second.

Conveyance losses—Evaporation, evapotranspiration and seepage losses in major conveyance canals.

Cooperating agency—This is defined as an agency that meets the following criteria: (1) is included in 40 CFR Chapter V, Council on Environmental Quality (CEQ) Rules and Regulations, Appendix 1 - Federal and Federal-State agency National Environmental Policy Act (NEPA) contacts; and/or (2) has study area-wide jurisdiction by law or special expertise on environmental quality issues; (3) has been invited by the lead agency to participate as a cooperating agency; and (4) has made a commitment of resources (staff and/or funds), for regular attendance at meetings, participation in workgroups, in actual preparation of portions of the programmatic environmental impact statement (PEIS), and in providing review and comment on activities associated with the PEIS as it progresses. The role of the cooperating agency is documented in a formal memorandum of agreement with the lead agency.

Cost-of-service water rates—The water rate charged to recover all operating and capital costs, and individual contractor operating deficits, associated with the providing of water service. Components of operation and maintenance (O&M) and capital cost vary by contractor depending on services required for water delivery. Differs from full cost in that no charge for interest on capital is included.

Cubic feet per second—A measure of the volume rate of water movement. As a rate of streamflow, a cubic foot of water passing a reference section in 1 second of time. One cubic foot per second equals 0.0283 m^3/s (7.48 gallons per minute). One cubic foot per second flowing for 24 hours produces approximately 2 acre-feet.

D

Decision -1485 (D-1485)—The SWRCB decision specifying water quality standards for the Sacramento-San Joaquin Delta and Suisun Marsh.

Dedicated Water—Refers to the 800,000 acre feet of CVP yield identified in Section 3406(b)(2) of the CVPIA that the Secretary must dedicate and manage for the primary purpose of implementing the fish and wildlife purposes and measures of the act, to help California protect the Bay-Delta estuary, and to help meet legal obligations imposed on the CVP under state and federal law, including the Federal Endangered Species Act (ESA).

Deep Percolation—Percolation of applied water and precipitation below the root zone of plants.

Deficiencies—Reductions in deliveries of contracted firm water. The amount of these reductions is expressed as the percent of full annual supply delivered.

Delta—A low, nearly flat alluvial tract of land formed by deposits at or near the mouth of a river. In this report, delta usually refers to the delta formed by the Sacramento and San Joaquin Rivers.

Density—The mass of a substance per unit of volume of that substance; i.e., the density of water changes with changes in temperature.

Depletion—Represents water consumed in a service area or no longer available as a source of supply.

Depletion study area—An analysis unit defined by the California Department of Water Resources for water resources planning investigations. Defined as the division of large drainage areas into smaller drainage and service areas from which water supplies and demands can be easily evaluated.

Dissolved oxygen (D.O.)—A commonly employed measure of water quality.

Dry-farmed—Crop production without the use of applied water.

E

Endangered species—Any species or subspecies of bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion of its range. Federally endangered species are officially designated by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service and published in the Federal Register.

Endemism—Native or limited to a certain region (endemic).

Enhancement—Measures which develop or improve the quality or quantity of existing conditions or resources beyond a condition or level that would have occurred without an action; i.e., beyond compensation.

Entrainment—The drawing of fish and other aquatic organisms into water diversions.

Environmental consequences—The impacts to the Affected Environment that are expected from implementation of a given alternative.

Environmental Impact Statement (EIS)—An analysis required by the National Environmental Policy Act (NEPA) for all major federal actions, which evaluates the environmental risks of alternative actions.

Escapement—Number of salmon that actually return to a stream to spawn.

Estuary—A water passage where the tide meets a river current; an arm of the sea at the lower end of a river.

Evaporation—The change of a substance from the solid or liquid phase to the gaseous (vapor) phase.

Evapotranspiration (ET)—Water evaporated from plant and soil surfaces or transpired by plant tissues.

Evapotranspiration of Applied Water (ETAW)—Portion of the evapotranspiration provided by the applied water.

Exotic species—Introduced species not native to the place where they are found.

Extirpated species—A species which has become extinct in a given area.

F

Fallowed land—Cultivated land that lies idle during a growing season.

Field Irrigation Efficiency—The efficiency of water application. Computed by dividing the evapotranspiration of applied water by applied water and converting the result to a percentage. Efficiency may be computed at three levels: farm, district, or basin.

Firm water supplies—Non-interruptible water supplies guaranteed by the supplier to be available at all times except for reasons of uncontrollable forces or continuity of service provisions.

Fish ladders—A series of ascending pools constructed to enable salmon or other fish to swim upstream around or over a dam.

Fish passage facilities—Features of a dam that enable fish to move around, through, or over without harm. Generally an upstream fish ladder or a downstream bypass system.

Flow—The volume of water passing a given point per unit of time.

***Instream flow requirements*—**Amount of water flowing through a stream course needed to sustain instream values.

***Minimum flow*—**Lowest flow in a specified period of time.

***Peak flow*—**Maximum instantaneous flow in a specified period of time.

***Return flow*—**Portion of water previously diverted from a stream and subsequently returned to that stream or to another body of water.

Fry—Life stage of fish between the egg and fingerling stages.

Full cost water rates—Adds an interest component to the cost-of-service water rates to recover costs of financing the construction of irrigation facilities placed in service. The interest component is calculated in accordance with the Reclamation Reform Act of 1982.

Full cost—As defined by Section 3403(g) of the CVPIA, "the meaning given such term in paragraph (3) of section 202 of the Reclamation Reform Act of 1982". As defined by Section 202(3)(A) of the Reclamation Reform Act of 1982, "an annual rate as determined by the Secretary that shall amortize the expenditures for construction properly allocable to irrigation facilities in service, including all operation and maintenance deficits funded, less payments, over such periods as may by required under Federal Reclamation law or applicable contract provisions, with interest on both accruing from the date of enactment of the Act on costs outstanding at that date, or from the date incurred in the case of costs arising subsequent to the date of enactment of this Act: Provided that operation, maintenance and replacement charges required under Federal reclamation law, including this title, shall be collected in addition to the full cost charge".

G

Groundwater—Water stored underground in pore spaces between rocks and in other alluvial materials and in fractures of hard rock occurring in the saturated zone.

Groundwater level—Refers to the water level in a well, and is defined as a measure of the hydraulic head in the aquifer system.

Groundwater overdraft—A condition of a groundwater basin in which the amount of water withdrawn by pumping exceeds the amount of water that recharges the basin over a period of years, during which water supply conditions approximate average.

Groundwater pumping—Quantity of water extracted from groundwater storage.

Groundwater table—The upper surface of the zone of saturation, except where the surface is formed by an impermeable body.

H

Habitat—Area where a plant or animal lives.

I

Indicator species—Organism, species, or community which indicates presence of certain environmental conditions.

Interest group—This is defined as an agency/entity that has expressed an interest, verbally or in writing, in becoming more intensely involved in the development of the PEIS.

Irrigation water—Water made available from the project which is used primarily in the production of agricultural crops or livestock, including domestic use incidental thereto, and the watering of livestock. Irrigation water does not include water used for domestic uses such as the watering of landscaping or pasture for animals (e.g., horses) which are kept for personal enjoyment. It generally does not include water delivered to landholdings operated in units of fewer than 2 acres, unless the contractor establishes to the satisfaction of the contracting officer that the use of the water delivered to any such landholding is a use within this definition.

J

Juvenile—Young fish older than 1 year but not having reached reproductive age.

L

Land classification—An economic classification of variations in land reflecting its ability to sustain long-term agricultural production.

Land retirement—Permanent or long-term removal of land from agricultural production.

Level 2—A term used to refer to refuge water supply deliveries. The 1989 and 1992 Refuge Water Supply Studies define Level 2 refuge water supplies as the average amount of water the refuges received between 1974 and 1983.

Level 4—A term used to refer to refuge water supply deliveries. Level 4 refuge water supplies are defined in the 1989 and 1992 Refuge Water Supply Studies as the amount of water for full development of the refuges based upon management goals developed in the 1980s.

Limnology—Scientific study of the physical characteristics and biology of lakes, streams, and ponds.

Long-term contract—Contracts with terms of more than 10 years.

M

Mainstem—The main course of a stream.

Mitigation—One or all of the following: (1) Avoiding an impact altogether by not taking a certain action or parts of an action; (2) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (3) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (4) reducing or eliminating an impact over time by preservation and maintenance operations during the life of an action; and (5) compensating for an impact by replacing or providing substitute resources or environments.

Model—A tool used to mathematically represent a process which could be based upon empirical or mathematical functions. Models can be computer programs, spreadsheets, or statistical analyses.

N

Natural production—As defined by Section 3403(h) of the CVPIA, "fish produced to adulthood without direct human intervention in the spawning, rearing, or migration processes".

Net Water Diversion—Amount of water needed in a depletion study area to meet requirements, less reuse (recoverable service loss and deep percolation).

Nonconsumptive water use—Water uses including swimming, boating, waterskiing, fishing, maintenance of stream-related fish and wildlife habitat, hydropower generation, and other uses that do not substantially deplete water supplies.

Non-Recoverable Loss—Losses to salt sinks, or evaporation and evapotranspiration in conveyance and drainage canals. Expressed as a percentage of evapotranspiration of applied water.

O

Operating non-Federal entity—A Non-Federal entity that operates and maintains Federal facilities pursuant to an agreement with the United States.

P

Percolation—In the context of this report, the downward movement of water through the soil or alluvium to the ground-water table.

Place of use—The geographic area specified in a water right permit or license issued by the California State Water Resources Control Board, wherein the water may be used.

Point of diversion—The point along a river or stream that a water right permit or license specifies water may be diverted to areas away from the river.

Programmatic environmental impact statement—EIS prepared prior to a Federal agency's decision regarding a major program, plan, or policy. It is usually broad in scope and followed by subsequent more narrowly focused NEPA compliance documents such as site-specific environmental assessments and environmental impact statements.

Project repayment—The return to the Treasury of the reimbursable funds expended to construct, operate, maintain, and replace project facilities under the terms and conditions authorized by Congress plus other costs assigned by Congress.

Proposed action—Plan that a Federal agency intends to implement or undertake and which is the subject of an environmental analysis. Usually, but not always, the proposed action is the agency's preferred alternative for a project. The proposed action and all reasonable alternatives are evaluated against the no action alternative.

Public involvement—Process of obtaining citizen input into each stage of the development of planning documents. Required as a major input into any EIS.

R

Range—Geographic region in which a given plant or animal normally lives or grows.

Reasonableness criteria—Parameters established by the AFRP for determining the "reasonableness" of restoration actions. These parameters include: consideration of potential adverse economic and social impacts, public sentiment, the magnitude of benefits, the certainty that an action will achieve projected benefits, and the authority established by existing laws and regulations.

Recharge—The processes of water filling the voids in an aquifer, which causes the piezometric head or water table to rise in elevation.

Reclamation laws—As defined by Section 3403(I) of the CVPIA, "the Act of June 17, 1902 (82 Stat. 388) and all Acts amendatory thereof or supplemental thereto".

Record of Decision (ROD)—Concise, public, legal document which identifies and publicly and officially discloses the responsible official's decision on the alternative selected for implementation. It is prepared following completion of an EIS.

Redd—Depression in river or lake bed dug by fish for the deposition of eggs.

Refuge Water Supply Report—As defined by Section 3403(j) of the CVPIA, "the report issued by the Mid-Pacific Region of the Bureau of Reclamation of the U.S. Department of the Interior entitled Report on Refuge Water Supply Investigations, Central Valley Hydrologic Basin, California (March 1989)".

Repayment contract—As defined by Section 3403(k) of the CVPIA, "the same meaning as provided in sections 9(d) and 9(e) of the Reclamation Project Act of 1939 (53 Stat. 1187, 1195), as amended". See water service contract.

Reservoir—Artificially impounded body of water.

Reservoir storage capacity—Reservoir capacity normally usable for storage and regulation of reservoir inflows to meet established reservoir operating requirements.

***Flood control storage capacity*—**Reservoir capacity reserved for the purpose of regulating flood inflows to reduce flood damage downstream.

Restoration Fund—As defined in Section 3403(l) of the CVPIA, "the Central Valley Project Restoration Fund established by this title".

Return flows—That water returned to the natural surface water system after use by the water user.

Riparian—Areas along or adjacent to a river or stream bank whose waters provide soil moisture significantly in excess of that otherwise available through local precipitation.

S

Salmonids—Fish of the family Salmonidae, such as salmon, trout (including steelhead), and whitefish.

Scoping—The process of defining the scope of a study, primarily with respect to the issues, geographic area, and alternatives to be considered. The term is typically used in association with environmental documents prepared under the National Environmental Policy Act.

Secretary—As defined by Section 3403(m) of the CVPIA, "the Secretary of the Interior".

Seepage—Water that escapes control through canal lining, stream banks, or other holding or conveyance systems.

Shasta Criteria—Establishes when a water year is considered critical, based on inflow to Shasta Lake. When inflows to Shasta Lake fall below the defined thresholds, the water year is defined as critical, and water deliveries to Sacramento River Water Rights and San Joaquin River Exchange Contractors may be reduced up to 25 percent. A year is critical when the full natural inflow to Shasta Lake for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year) is equal to or less than 3.2 million acre-feet. This is considered a single-deficit. A year is also critical when the accumulated difference (deficiency) between 4 million acre-feet and the full natural inflow to Shasta Lake for successive previous years, plus the forecasted deficiency for the current water year, exceeds 800,000 acre-feet.

Short-term contract—Contracts with a term of more than 5 years but less than 10 years.

Semi-confined Aquifer—A condition where the movement of groundwater is restricted sufficiently to cause differences in head between different depth zones of the aquifer during periods of heavy pumping, but during periods of little draft the water levels recover to a level coincident with the water table.

Smolt—A juvenile salmon or steelhead migrating to the ocean and undergoing physiological changes to adapt its body from a freshwater to a saltwater environment.

Spawning—The releasing and fertilizing of eggs by fish.

Spill—Water released from reservoirs to comply with flood control criteria.

Spillway—Overflow structure of a dam.

Stream—Natural water course.

Ephemeral stream**—**Flows briefly only in direct response to precipitation.

Intermittent or seasonal stream**—**Stream on or in contact with the groundwater table that flows only at certain times of the year when the groundwater table is high.

Perennial stream**—**Flows continuously throughout the year.

Subsidence—A local mass movement that involves principally the gradual downward settling or sinking of the earth's surface with little or no horizontal motion. It may be due to natural geologic processes or mass activity such as removal of subsurface solids, liquids, or gases, ground water extraction, and wetting of some types of moisture-deficient loose or porous deposits.

Supplemental analyses—Alternatives analyses conducted in addition to the five main alternatives. Examples of supplemental analyses include: 1A, 2A, 3A, 4A, and 5A.

Surface water diversion—Total quantity of water removed from a stream.

Surface Water Return Flow (SWRF)—Percent of water that directly returns by surface to the stream.

T

Tailwater—Water immediately downstream of a dam.

Target Flows—Flow goals used in development of the Draft PEIS alternatives. The goals were based upon preliminary information developed for the AFRP Restoration Plan. The target flows were developed in a iterative process.

Temporary contract—Contract with a term of less than 5 years.

Threatened species—Legal status afforded to plant or animals species that are likely to become endangered within the foreseeable future throughout all or a significant portion of their range, as determined by the U.S. Fish and Wildlife Service or the National Marine Fisheries Service.

Tiering—Procedure which allows an agency to avoid duplication of paperwork through incorporation by reference of the general discussions and relevant specific discussions from an EIS of broader scope into a subsequent EIS of narrower scope.

Total supply—Total water supply available to area (surface water plus groundwater).

Transfers, sales, and exchanges—A transfer or sale is a one way transaction to another contractor usually on an annual basis, but could be on a permanent basis. An exchange is a two way transaction wherein a contractor transfers water to another contractor to be returned at a later date. CVP contractors may transfer, sell and exchange to other contractors their contractual water supply only with written consent from the United States.

Tributary—A stream feeding into a larger stream or a lake.

Turn outs—The physical structures along main canal systems for distribution of water.

W

Water acquisition—The purchase of water from willing sellers.

Water rights—California recognizes riparian and appropriative water rights.

***Riparian water rights*—**Exists for lands which abut a waterway, or which overly an underground stream. Generally, there is no riparian right to diffused surface waters or swamps. The extent of the frontage along a waterway in no way governs the quantity of the water right. Use of water through riparian rights must be on riparian land and within the watershed of the stream. Riparian rights may not be lost as a result of nonuse.

Appropriative water rights—Water rights based upon the principle of prior appropriations, or "first in time, first in right". In order to maintain appropriative water rights, the right to any water must be put to beneficial use. Nonuse of appropriative water rights may result in the loss of those water rights. In a conflict between a riparian water user and an upstream appropriator, the riparian user has priority, provided that the water is being used in a reasonable and beneficial manner.

Watershed—A region or area bounded peripherally by a water parting and draining ultimately to a particular watercourse or body of water.

Water year—Usually when related to hydrology, the period of time beginning October 1 of one year and ending September 30 of the following year and designated by the calendar year in which it ends.

Wetland—A zone periodically or continuously submerged or having high soil moisture, which has aquatic and/or riparian vegetation components, and is maintained by water supplies significantly in excess of those otherwise available through local precipitation.

Wildlife habitat—An area that provides a water supply and vegetative habitat for wildlife.

Willing sellers—A term used to describe individuals who would be interested in selling water supplies under transfer guidelines established by SWRCB and other regulatory agencies.

X

X2—Salinty criteria of two parts per thousand (2ppt) which must be maintained in Suisun Bay during the February through June spring runoff period.

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AAQS	Ambient Air Quality Standards
AB	Assembly Bill
ACHP	Advisory Council on Historic Preservation
ACID	Anderson Cottonwood Irrigation District
ACWD	Alameda County Water District
AEAWT	Authorization for Environmental Analysis of Water Transfers
af	acre-foot (feet)
af/yr	acre-feet per year
AFRP	Anadromous Fish Restoration Program
AIRFA	American Indian Religious Freedom Act
ANOVA	analysis of variance
APCD	Air Pollution Control District
APE	area of potential effect
AQAP	Air Quality Attainment Plan
AQMD	Air Quality Management District
ARB	Air Resources Board (California)
ARP	acreage reduction percentage
AUM	Animal Unit Month
AW	applied water
BAAQMD	Bay Area Air Quality Management District
BAP	San Joaquin Basin Action Plan
BAT	best available technology
Bay	San Francisco Bay
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin Delta
Bay-Delta Region	San Francisco Bay/Sacramento-San Joaquin Delta
Bay/Delta Study	Delta Outflow/San Francisco Bay Study
BIA	U.S. Bureau of Indian Affairs
BLM	U.S. Bureau of Land Management
BMP	Best Management Practice
B.P.	Before Present
BPA	Bonneville Power Administration
BTI	*Bacillus thuringiensis israelensis*
CAAQS	California Ambient Air Quality Standard
CAC	County Agricultural Commissioner
Caltrans	California Department of Transportation
CAP	Clean Air Plan
CCAA	California Clean Air Act
CCTS	Central California Taxonomic System
CCWD	Contra Costa Water District
CDEC	California Data Exchange Center
Census	U.S. Bureau of the Census
CEQA	California Environmental Quality Act

CES	University of California Cooperative Extension Service
cf	cubic feet
cfs	cubic feet per second
CIMIS	California Irrigation Meteorologic Information System
CNPS	California Native Plant Society
CO	carbon monoxide
COA	Coordinated Operating Agreement
COE	U.S. Army Corps of Engineers
CPFV	commercial passenger-carrying fishing vessel
CRHR	California Register of Historic Resources
CRW	Colorado River Water
CSU	California State University
CT	In disinfection operations, the concentration of a disinfectant multiplied by its time of contact with the water.
CUWA	California Urban Water Agency
CVGSM	Central Valley Groundwater - Surface Water Simulation Model
CVHJV	Central Valley Habitat Joint Venture
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVPM	Central Valley Production Model
CVP-OCAP	Central Valley Project Operations Criteria and Plan
CVPTM	Central Valley Production and Transfer Model
CVRWQCB	Central Valley Regional Water Quality Control Board
CWA	Clean Water Act
CWD	Chowchilla Water District
D-1485	Decision 1485 (State Water Resources Control Board)
DAU	Detailed Analysis Unit
DBP	disinfection by-product
DCAA	dichloroacetic acid
D/DBP	disinfectant/disinfection by-product
DCC	Delta Cross Channel
DDE	dichloro-diphenyl-dichloroethylene
DDT	dicholoro-diphenyl-trichloroethane
Delta	Sacramento-San Joaquin River Delta
Delta Plan	Delta Water Quality Control Plan
DFA	California Department of Food and Agriculture
DFF	California Department of Forestry and Fire Protection
DFG	California Department of Fish and Game
DHS	California Department of Health Services
DMC	Delta-Mendota Canal
DO	dissolved oxygen
DOC	California Department of Conservation
DOF	California Department of Finance
DPR	California Department of Parks and Recreation
DWR	California Department of Water Resources

EA	environmental assessment
EBMUD	East Bay Municipal Utility District
EC	electrical conductivity
EDD	Employment Development Department
EDF	Environmental Defense Fund
EID	El Dorado Irrigation District
EIR	environmental impact report
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESWTR	Enhanced Surface Water Treatment Rule
ET	evapotranspiration
ETAW	evapotranspiration of applied water
FCAA	Federal Clean Air Act
FERC	Federal Energy Regulatory Commission
FIP	Federal Implementation Plan
FIRE	Finance, insurance, and real estate
FLPMA	Federal Land Policy and Management Act of 1976
FONSI	Finding of No Significant Impact
FWCA	Fish and Wildlife Coordination Act
GAC	granular activated carbon
GATT	General Agreement on Tariffs and Trade
GCID	Glen Colusa Irrigation District
GIS	geographic information system
GRCD	Grasslands Resource Conservation District
HAA	haloacetic acids
HC	Hydrocarbons
HCl	Hydrochloric Acid
I	Interstate
I-5	Interstate 5
IAG	Interagency Group Meetings
IEP	Interagency Ecological Program
IFIM	instream flow incremental methodology
IGM	Interested Group Meetings
IID	Imperial Irrigation District
IMPLAN	regional economic input-output model
Interior	U.S. Department of the Interior
IRF	Intermediate Regional Flood
ITA	Indian Trust Asset
KCWA	Kern County Water Agency
KMZ	Klamath Management Zone
kW	kilowatt
LLNL	Lawrence Livermore National Laboratory
M&I	municipal and industrial
MAD	Mosquito Abatement District

MBF	million board feet
MBUAPCD	Monterey Bay Unified Air Pollution Control District
MCL	maximum contaminant level
MCLGs	Maximum Contaminant Level Goals
mg/l	milligrams per liter
MID	Modesto Irrigation District
M/M	Methodology/Modeling
MMWD	Marin Municipal Water District
MOU	memorandum of understanding
mph	miles per hour
MRDL	Maximum Residual Disinfectant Level
MSA	Metropolitan Statistical Area
msl	mean sea level
mS/cm	millisiemens per centimeter
MVCD	Mosquito and Vector Control District
MWD	Municipal Water District of Southern California; Metropolitan Water District
MWT	mid-water trawl
NAAQS	National Ambient Air Quality Standard
NAGPRA	Native American Graves Protection Repatriation Act
NAHC	Native American Heritage Commission
NAWMP	North American Waterfowl Management Plan
NCCAB	North Central Coast Air Basin
NCRWQCB	North Coast Regional Water Quality Control Board
NDDB	Natural Diversity Database
NEPA	National Environmental Policy Act
NHL	National Historic Landmark
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Services
NO_X	Nitrogen Oxides
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NPDWR	National Primary Drinking Water Regulations
NPS	National Park Service
NRA	National Recreation Area
NRHP	National Register of Historic Places
NSDWR	National Secondary Drinking Water Regulations
NSVAB	Northern Sacramento Valley Air Basin
NTU	nephelometric turbidity units
NWR	National Wildlife Refuge
NWS	National Weather Service
O_3	Ozone
O&M	Operations and Maintenance
OHV	off-highway vehicle
OID	Oakdale Irrigation District

OPR	California Office of Planning and Research
ORV	off-road vehicle
P_b	Lead
PA	Programmatic Agreement
PCBs	polychlorinated biphenyls
PDA	Public Domain Allotment
PEIS	Programmatic Environmental Impact Statement
PFMC	Pacific Fishery Management Council
PG&E	Pacific Gas and Electric Company
PHABSIM	Physical Habitat Simulation
PM	particulate matter
PM_{10}	PM of 10 microns in aerometric diameter or less
POW	Place of work
ppb	parts per billion
ppm	parts per million
ppt	parts per trillion; parts per thousand
PROSIM	Project Simulation Model
PSA	planning subarea
psi	pounds per square inch
PSMFC	Pacific States Marine Fisheries Commission
RBDD	Red Bluff Diversion Dam
RCD	Resource Conservation District
Reclamation	U.S. Bureau of Reclamation
Reg-Neg	Regulatory Negotiations
RGO	resident, government, and other demands
RM	river mile
ROD	Record of Decision
ROG	reactive organic gases
ROP	Record of Progress
RVD	recreational visitor day
RWQCB	California Regional Water Quality Control Board
SANJASM	San Joaquin Area Simulation Model
SBA	South Bay Aqueduct
SCAB	South Coast Air Basin
SCAG	Southern California Association of Governments
SCAQMD	South Coast Air Quality Management District
SCCAB	South Central Coast Air Basin
SCS	U.S. Department of Agriculture Soil Conservation Service
SCVWD	Santa Clara Valley Water District
SCWA	Sacramento County Water District
SDAB	San Diego Air Basin
SDWA	Safe Drinking Water Act
Secretary	Secretary of the Interior
Service	U.S. Fish and Wildlife Service
SF	San Felipe

SFBAAB	San Francisco Bay Area Air Basin
SFSA	San Felipe Service Area
SFWD	San Francisco Water District
SIP	State Implementation Plan
SHPO	California State Historic Preservation Officer
SJRMP	San Joaquin River Management Program
SJVAB	San Joaquin Valley Air Basin
SJVDP	San Joaquin Valley Drainage Program
SJVUAPCD	San Joaquin Valley Unified Air Pollution Control District
SLOCAPCD	San Luis Obispo County Air Pollution Control District
SMAQMD	Sacramento Metropolitan Air Quality Management District
SMUD	Sacramento Municipal Utility District
SNA	Significant Natural Area
SO_X	Oxides of Sulfur
SO_2	Sulfur Dioxide
SPF	Standard Project Flood
SPW	State Project Water
SR	State Route
SRA	shaded riverine aquatic
SRBT model	Sacramento River Basin Temperature model
SS	suspended solids
SSJID	South San Joaquin Irrigation District
SSWD	South Sutter Water District
SVAB	Sacramento Valley Air Basin
SWP	State Water Project
SWRCB	State Water Resources Control Board
SWRF	Surface Water Return Flow
SWTR	Surface Water Treatment Rule
SYMVCD	Sacramento-Yolo Mosquito and Vector Control District
TAC	Toxic Air Contaminants
taf	thousand acre-feet
TCC	Tehama-Colusa Canal
TCD	temperature control device
TCPs	traditional cultural properties
TCR	total coliform rule
TDS	total dissolved solids
TFPC	total trihalomethane formation potential carbon
THAAs	total haloacetic acids
THM	trihalomethane
THMFP	trihalomethane formation potential
TID	Turlock Irrigation District
TNC	The Nature Conservancy
TNS	toe net survey
TOC	total organic carbon
TOG	Total Organic Gases

TOX	total organic halogen
TRH	Trinity River Hatchery
TSP	Total Suspended Particulates
TTHMFP	total trihalomethane formation potential
USDA	U.S. Department of Agriculture
USDI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation
VAR	Magnetic or inductive power
VCAPCD	Ventura County Air Pollution Control District
VELB	valley elderberry longhorn beetle
VMT	Vehicle Miles of Travel
VOC	Volatile Organic Compound
VMS	Visual Management System
VRM	Visual Resource Management
Western	Western Area Power Administration
WHR	wildlife habitat relationships
WMA	Wildlife Management Area
WMP	Water Management Plan
WR	water rights
WUA	weighted usable area
WWD	Westlands Water District
WY	water year
X2	isocline
YCWA	Yuba County Water Agency
YSAPCD	Yolo-Solano Air Pollution Control District
Zone 7	Zone 7 of the Alameda County Flood Control and Water Conservation District
μS/cm	microsiemens per centimeter
$^\circ$F	degrees Fahrenheit

CONVERSION TABLES

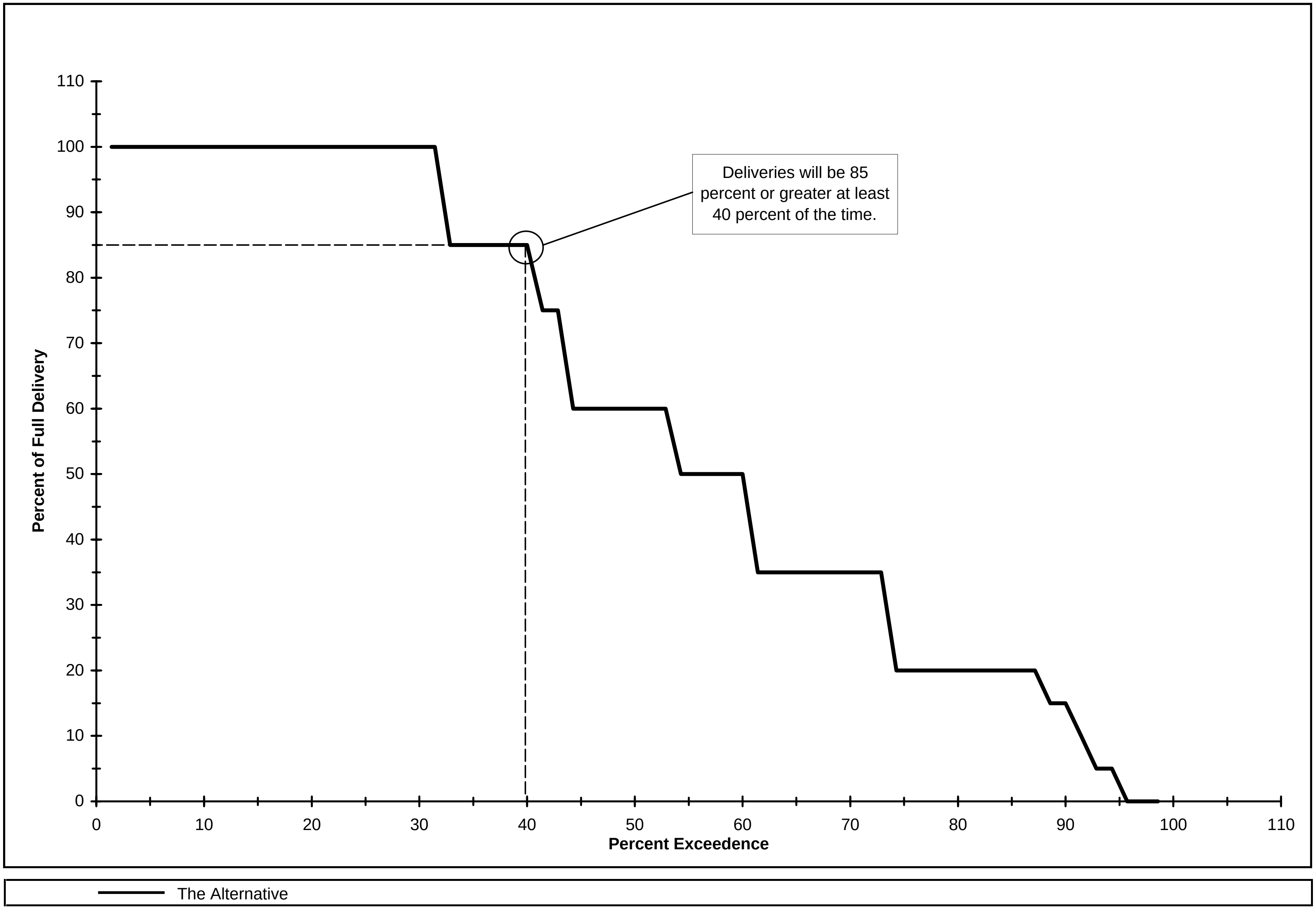
U.S. CUSTOMARY TO METRIC

Multiply	By	To Obtain
inches (in)	25.4	millimeters
inches (in)	2.54	centimeters
feet (ft)	0.3048	meters
miles (mi)	1.609	kilometers
square feet (ft^2)	0.0929	square kilometers
acres (ac)	0.4047	hectares
square miles (mi^2)	2.590	square kilometers
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02832	cubic meters
acre-feet (af)	1,233.0	cubic meters
pounds (lb)	0.4536	kilograms
tons (ton)	0.9072	metric tons

Temperature in degrees Fahrenheit (°F) can be converted to degrees Celsius (°C) as follows:
°C = 5/9 (°F - 32)

OTHER USEFUL CONVERSION FACTORS

Multiply	By	To Obtain
acre-feet (af)	43,560	cubic-feet
acre-feet (af)	325,851	gallons
cubic feet per second (cfs)	1.9835	acre-feet per day
cubic feet per second (cfs)	724.0	acre-feet per year



READER'S GUIDE TO EXCEEDENCE CURVES

ATTACHMENT E

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Attachment E

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ATTACHMENT F

NON-FLOW ACTIONS CONSIDERED IN DRAFT PEIS ALTERNATIVES

Attachment F

NON-FLOW ACTIONS CONSIDERED IN DRAFT PEIS ALTERNATIVES

Preliminary information from the AFRP was used in the development of the Draft PEIS alternatives. The non-flow actions presented in the December 1995 Draft Restoration Plan were included in all of the Draft PEIS alternatives. Programmatic cost estimates were developed for these actions to determine an order of magnitude costs for use of the Restoration Fund for non-flow actions. The cost estimates are presented in Chapter II of the Draft PEIS. The non-flow actions included in all of the Draft PEIS alternatives and anticipated benefits are included in Table F-1.

TABLE F-1
NON-FLOW FISH MANAGEMENT ACTIONS UNDER ANADROMOUS FISH RESTORATION PROGRAM

WATERSHED	ACTION	ANTICIPATED BENEFITS
Upper and Middle Sacramento River and Tributaries		
	Shasta Temperature Device	Increase survival of spawning, incubation and rearing chinook salmon and steelhead trout lifestages
	Correct fish passage problem at ACID diversion	Increase survival of migrating adult and juvenile chinook salmon and steelhead trout due to reduced delay and entrainment
	Red Bluff Diversion Dam fish passage	Increase survival of migrating adult and juvenile chinook salmon and steelhead trout due to reduced delay and entrainment
	Screen unscreened or inadequately screened diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Spawning gravel restoration	Increase spawning success and productivity of adult chinook salmon and steelhead trout
	Correct problems at Glenn-Colusa ID diversion	Increase outmigrant survival of juvenile chinook salmon and steelhead trout due to reduced entrainment loss
	Evaluate a meander belt from Keswick to Colusa to provide gravel recruitment, large woody debris, moderate air temperatures, and nutrient input to the biotic system	Increase survival of rearing and outmigrant juvenile chinook salmon and steelhead trout
Lower Sacramento River and Tributaries		
	Colusa Basin Drain Outfall Exclusion Device at Knights Landing	Increase survival of juvenile chinook salmon
Clear Creek		
	Channel restoration, sediment removal, and fish passage at McCormick - Saeltzer Dam	Increase survival and spawning success of adult chinook salmon and steelhead trout
	Restrict gravel mining and restore degraded channel	Improved instream and riparian habitat, Increase survival of juvenile chinook salmon and steelhead trout
	Restore gravel and spawning habitat	Increase spawning success of adult chinook salmon and steelhead trout
	Prevent habitat degradation due to sedimentation and urbanization	Increase survival of incubating and rearing lifestages of chinook salmon and steelhead trout

TABLE F-1. CONTINUED

WATERSHED	ACTION	ANTICIPATED BENEFITS
Cow Creek		
	Screen diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Fence riparian corridors to exclude livestock	Increase survival of salmon and steelhead trout
	Provide passage, spawning, and rearing flows for fall run	Reduce delay of migrating and increase productivity of adult chinook salmon and steelhead trout
	Improve upstream passage at diversions dams	Reduce delay of migrating adult chinook salmon and steelhead trout
Cottonwood Creek		
	Limit instream gravel mining, and protect and enhance spawning gravel recruitment	Increase survival and spawning success of chinook salmon and steelhead trout
	Restore stream channel at ACID siphon and avoid the barrier	Improve passage of migrating adult chinook salmon and steelhead trout
	Improve land use practices-improve habitat, reduce siltation of existing gravels	Improve instream and riparian habitat and survival of rearing fry and juvenile chinook salmon and steelhead trout
	Eliminate attraction flows or provide adult barrier at Crowley Gulch	Reduce delay and straying of adult chinook salmon and steelhead trout
Bear Creek		
	Install fish screens on unscreened diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Provide instream flows for adult and juvenile passage in spring and early fall	Improved instream conditions for adult and juvenile chinook salmon and steelhead trout during the spawning and rearing lifestages

TABLE F-1. CONTINUED

WATERSHED	ACTION	ANTICIPATED BENEFITS
Battle Creek		
	Install fish screen on Orwick diversion	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Screen 6 unscreened hydropower diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Construct barrier gates at Gover diversion and adult waste gates for chinook salmon	Improved passage and reduce delay of migrating adult chinook salmon and steelhead trout
	Improve Fish passage at Eagle Canyon	Improved passage and reduce delay of migrating adult chinook salmon and steelhead trout
	Install adult barrier at tailrace of Coleman powerhouse	Improved passage and reduce delay of migrating adult chinook salmon and steelhead trout
	Continue to allow adult spring-run and steelhead trout passage above Coleman National Fish Hatchery weir and screen intakes #2 and #3	
Paynes Creek		
	Provide instream flows for adult and juvenile passage in spring and early fall	Improve instream conditions for adult and juvenile steelhead trout during critical life stages
	Restore and enhance spawning gravel	Increase spawning success for survival of adult steelhead trout
Antelope Creek		
	Provide instream flows for adult and juvenile passage in spring and early fall	Improve instream conditions for adult and juvenile chinook salmon and steelhead trout during critical life stages

TABLE F-1. CONTINUED

WATERSHED	ACTION	ANTICIPATED BENEFITS
Mill Creek		
	Improve spawning areas in lower Mill Creek	Increase spawning success for chinook salmon and steelhead trout
	Establish, restore, and maintain riparian habitat along lower Mill Creek	Increase survival of rearing fry and juvenile chinook salmon and steelhead trout
	Preserver habitat productivity through cooperative watershed management	Increase survival of spawning, incubating, rearing and outmigrant life stages of chinook salmon and steelhead trout through improved instream and riparian conditions
Deer Creek		
	Improve instream flows to provide passage over 3 diversions	Reduced delay in migration and improved spawning success of adult chinook salmon and steelhead
	Improve spawning areas in lower Deer Creek	Increase spawning success of chinook salmon and steelhead
	Restore and preserve riparian habitat along lower reaches in Deer Creek	Increase survival of rearing and outmigrant lifestages of chinook salmon and steelhead trout
	Develop a watershed management plan to preserve chinook salmon and steelhead habitat	Increase survival of all life stages of chinook salmon and steelhead trout through improved instream
	Flood management activities with the least damage to fish and habitat	Improve instream and riparian conditions and increased survival of adult and rearing juvenile chinook salmon and steelhead trout
Elder Creek		
	Adopt an erosion control ordinance to minimize sediment input	Increase survival of spawning, incubating, and rearing lifestages of chinook salmon and steelhead trout
Thomes Creek		
	Modify gravel mining methods	Increase survival for chinook salmon and steelhead trout
	Modify timber harvest practices	Increase survival for chinook salmon and steelhead trout
	Modify grazing practices	Increase survival for chinook salmon and steelhead trout
	Improve fish passage at diversions	Increase migration survival due to reduced delay of adult chinook salmon and steelhead trout

TABLE F-1. CONTINUED

WATERSHED	ACTION	ANTICIPATED BENEFITS
Bear Creek		
	Install fish screens on unscreened diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Provide instream flows for adult and juvenile passage in spring and early fall	Improve for adult and juvenile chinook salmon and steelhead trout during the spawning and rearing
Big Chico Creek		
	Relocate M & T Ranch diversion	Increase survival by reduced entrainment of juvenile chinook salmon and steelhead
	Replenish spawning gravel in flood control channels	Increase spawning success of adult fall-run chinook salmon
	Protect summer holding areas for spring-run chinook salmon	Increase survival of adult spring-run chinook salmon
	Revegetate stream reaches, maintain protected riparian habitat	Increase rearing success of juvenile chinook salmon and steelhead trout
	Repair Iron Canyon fish ladder	Increase survival provided by reduced delay of adult chinook salmon and steelhead trout
	Repair Lindo Channel weir and fishway at 5-mile diversion	Increase survival provided by reduced delay of adult chinook salmon and steelhead trout
	Improve cleaning at One-Mile Pool	Increase survival of juvenile chinook salmon and steelhead trout
	Develop a watershed management plan to preserve chinook salmon and steelhead habitat	Increase survival of all life stages of chinook salmon and steelhead trout through improved instream

TABLE F-1. CONTINUED

WATERSHED	ACTION	ANTICIPATED BENEFITS
Butte Creek		
	Replace Western Canal Siphon	Increase survival of adult and juvenile lifestages of chinook salmon and steelhead trout
	Remove McPherrin and McGowan diversion dams	Increase survival by reduced delay of adult chinook salmon and steelhead trout outmigration
	Adams Dam screens and ladders	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Gorille Dam screens and ladders	Increase survival of migrating adult and juvenile chinook salmon and steelhead trout
	Durham Mutual Dam screens and ladders	Increase survival by reduced delay in migration of adult chinook salmon and steelhead trout
	White Mallard Dam screen and ladder	Increase survival by reduced delay in migration of adult chinook salmon and steelhead trout
	Little Dry Creek diversion channel pumps with screens	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Eliminate salmon stranding at White Mallard Duck Club outfall	Increase survival of juvenile chinook salmon and steelhead trout
	Renovate and maintain existing culvert and riser at Drumheller Slough outfall	Increase survival of juvenile chinook salmon and steelhead trout
	Restore, maintain, and protect riparian habitat through land use plans and buffer zones	Increase survival of spring-run chinook salmon
	Parrott-Phelan screens and ladders	Increase survival of migrating adult and juvenile chinook salmon and steelhead trout
Yuba River		
	Install fish screens at three diversions	Increase survival due to reduced entrainment of outmigrant juvenile chinook salmon and steelhead trout
	Purchase streambank conservation easements	Increase survival of rearing chinook salmon and steelhead trout
	Modify ladders at Daguerre Point Dam	Reduced delay providing improved spawning success of chinook salmon and steelhead trout
	Modify Daguerre Point Dam to facilitate outmigration	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Improve fish bypasses at diversion dams	Increase survival due to reduced delay of migrating adult chinook salmon and steelhead trout

TABLE F-1. CONTINUED

WATERSHED	ACTION	ANTICIPATED BENEFITS
Bear River		
	Screen all diversions	Increase survival of outmigrant juvenile steelhead trout
	Remove culvert or modify crossing at Patterson Sand and Gravel	Reduce delay and blockage of migrating adult steelhead trout
American River		
	Improve fish screen at Fairbairn diversion	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Replenish spawning gravel and/or restore existing spawning grounds and riparian habitat	Increase survival provided by improved instream habitat conditions for spawning chinook salmon and steelhead trout
	Develop riparian corridor management plan: improve and protect habitat and instream cover	Increase survival provided by improved instream habitat conditions for rearing and juvenile chinook salmon and steelhead trout
	Terminate current programs that remove woody debris from the river channels	Increase survival provided by improved instream habitat conditions for rearing and juvenile chinook salmon and steelhead trout
	Reconfigure Folsom release shutters for better temperature control	Increase survival provided by improved instream temperatures for spawning, rearing and juvenile adult chinook salmon and steelhead trout
Mokelumne River		
	Screen all diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Screen smaller diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Replenish gravels suitable for salmonid spawning habitat	Increase spawning success of adult chinook salmon and steelhead trout through improved instream habitat conditions
	Cleanse spawning gravel of fine sediments	Increase spawning success of adult chinook salmon and steelhead trout through improved instream habitat conditions
	Eliminate or restrict gravel mining operations	Increase spawning success of adult chinook salmon and steelhead trout through improved instream habitat conditions
	Enhance and maintain riparian corridor: improve streambank and channel rearing for juvenile salmonids	Increase survival provided by improved instream and riparian habitat conditions of rearing and juvenile chinook salmon and steelhead trout
	Establish and enforce new water quality standards	Increase survival provided by instream habitat

TABLE F-1. CONTINUED

WATERSHED	ACTION	ANTICIPATED BENEFITS
Cosumnes River		
	Screen Diversions and enforce prohibition of unlicenced dams	Increase survival of outmigrant juvenile chinook salmon
	Establish riparian corridor protection zone: preserve existing salmonids habitat from incompatible land use and moderate water temperature	Watershed management coordination and improved instream and riparian conditions provide increased survival for all lifestages of chinook salmon and steelhead trout
	Rehabilitate damaged areas: Remedy incompatible land use practices that have increased sedimentation of the river and elevate water temperatures	Improve instream and riparian conditions affecting the survival of all lifestages of chinook salmon
Calaveras River		
	Facilitate passage of adult and juvenile chinook salmon at existing diversion dams	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Screen diversions	Reduced migration delay provides an increased spawning success of migrating adult chinook salmon and steelhead
Merced River		
	Screen diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Establish streamwatch program and improve watershed management program	Watershed management coordination and improved instream and riparian conditions provide increased survival for all lifestages of chinook salmon and steelhead trout
Tuolumne River		
	Screen Diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Establish streamwatch program and improve watershed management program	Watershed management coordination and improved instream and riparian conditions provide increased survival for all lifestages
	Support Tuolumne River Interpretive Center and coordinate efforts with Riparian and Recreation Improvement Fund	Increase spawning success for chinook salmon and steelhead trout

TABLE F-1. CONTINUED

WATERSHED	ACTION	ANTICIPATED BENEFITS
Stanislaus River		
	Screen diversions	Increase survival of outmigrant juvenile chinook salmon and steelhead trout
	Replenish spawning gravel	Increase spawning success for chinook salmon and steelhead trout
	Improve watershed management program	Watershed management coordination and improved instream and riparian conditions provide increased survival for all lifestages of chinook salmon and steelhead trout
San Joaquin River		
	Install fish protective device at Banta-Carbona ID	Reduced entrainment provides increased survival of outmigrants
	Install fish protective device at West Stanislaus ID	Reduced entrainment provides increased survival of outmigrants
	Install fish protective device at Patterson ID	Reduced entrainment provides increased survival of outmigrants
	Install fish protective device at El Solyo ID	Reduced entrainment provides increased survival of outmigrants
	Screen small riparian diversions	Reduced entrainment to increased survival of outmigrants
Sacramento-San Joaquin Delta		
	Improve Tracy Pumping Plant fish protection facilities	Increase survival due to reduced entrainment of outmigrant juvenile chinook salmon and steelhead trout
	Improve Contra Costa Pumping Plant fish protection facilities	Increase survival due to reduced entrainment of outmigrant juvenile chinook salmon and steelhead trout
	Install fish barrier at Georgiana Slough	Increase survival due to reduced entrainment of outmigrant juvenile chinook salmon and steelhead trout
	Install fish barrier at head of Old River	Increase survival due to reduced delay in migration route for outmigrant juvenile chinook salmon and steelhead trout
	Reduce predation at SWP and CVP fish salvage facilities	Increase survival due to reduced predation of outmigrant juvenile chinook salmon and steelhead trout
	Screen or relocate riparian diversions in the Delta	Increase survival due to reduced entrainment of outmigrant juvenile chinook salmon and steelhead trout

Attachment G1

Biological Priorities for Flow Actions

Attachment G1

BIOLOGICAL PRIORITIES FOR FLOW ACTIONS

One of the purposes of the CVPIA was to develop and implement the Anadromous Fish Restoration Program (AFRP). The purpose of the AFRP is to develop reasonable efforts to ensure that by the Year 2002, natural production of anadromous fish in the Central Valley rivers and streams would be sustainable on a long-term basis at levels not less than twice the average levels attained during the period of 1967 through 1991. The AFRP is being developed to: 1) attain the best available scientific and commercial data; 2) develop a long-term Restoration Plan that identifies the general approaches and actions to attain the goal; and 3) develop short-term implementation plans as tiers to the Restoration Plan. The tiered implementation plans would be revised at least every 3 to 5 years. The AFRP also will be reviewed and updated as needed every 5 years.

Information used in the AFRP was collected from available reports, input from stakeholders, and input from the scientific community. The objective of AFRP is to meet the anadromous fisheries goals, including the doubling goals, of CVPIA, if possible. Based on current information, Interior believes that doubling goals can be achieved for some species and discrete runs on some streams. In almost all cases, Interior believes that improvement can occur even if doubling goals are not achieved. Monitoring will be used extensively to provide crucial information about ecosystem responses to specific project implementation. Information from the monitoring program will be used with Adaptive Management to modify the actions. In addition, Interior would use partnerships with other Federal, state, and private entities to meet the overall goals.

The AFRP goals were based upon best available scientific information to provide a platform on which participating agencies and the public could develop reasonable actions. In December 1995, the Service prepared a Draft Restoration Plan. The purpose of this plan was to identify general approaches and actions to attain the goals and objectives of AFRP. The Draft Restoration Plan was reviewed by the public and interested agencies and groups. The Revised Draft Restoration Plan was released in June 1997. The Revised Draft Restoration Plan included actions based upon scientific knowledge and the following reasonableness criteria.

- The intent, technical, and legal basis of the actions must be reasonable
- Interior or supportive partners must have the authority to implement the actions
- Potential partners that would be required to implement actions must be supportive

The AFRP was implemented in the Draft PEIS alternatives through the instream and Delta habitat and flow improvements. The habitat improvements were included in the Draft and Revised Draft Restoration Plans as "ACTIONS" to be completed in each watershed (a list is included in Attachment F of the PEIS).

The flow improvements were developed based upon information developed by the Service in October 1996. The preliminary information used scientific data to develop long-term goals that could be achieved using the three tools provided by the CVPIA: 1) Reoperation in accordance with Section 3406(b)(1)(B) of the CVPIA; 2) Dedication of 800,000 acre-feet of CVP water in accordance with Section 3406(b)(2) (also known as "(b)(2) Water"); and Water Acquisitions in accordance with Section 3406(b)(3).

In October 1996, the Service developed two memoranda. One of the memos included Draft Guidelines for Allocation of Acquired Water for Each Central Valley Stream Tributary to the Delta. These guidelines are included in Attachment G4. For each stream, historic flow patterns were reviewed and compared to the needs of the species that used the stream for appropriate life stages. Minimum flows under existing standards were identified and used to develop hydrographs. Then, incremental minimum flow recommendations were developed based upon existing reports and scientific data. The incremental flow recommendations were translated into blocks of water that could be acquired through normal water operations or acquisitions. The blocks of water were prioritized based upon biological criteria. The memo did not identify any specific targets within the prioritized blocks of water. It was anticipated that as more water became available through the Reoperation, (b)(2) water management, or acquisition programs, that the higher priorities would be met and more benefits would be realized. Prioritized flow schedules were developed for multiple year types for each river. The overall goal of the prioritization method was to attempt to increase flows in the rivers towards conditions that occurred in wetter years for all water year types.

In the other memo, the Service identified preliminary flow and water quality goals for CVP-controlled streams. This memo is provided in Attachment G5. Both of these memoranda were presented in October 1996 as preliminary in nature to obtain public input. Comments on this information will be used in the development of the Long-Term Water Management Plan and the Long-Term Water Acquisition Program. However, information was required to complete the impact assessment in the Draft PEIS and was utilized to develop alternatives as described in Attachments G2 and G3.

Attachment G2

Development of Reoperation And (B)(2) Water Management Methodology

ATTACHMENT G2

DEVELOPMENT OF REOPERATION AND (b)(2) WATER MANAGEMENT METHODOLOGY

INTRODUCTION

Water management provisions were developed to utilize two of the tools provided by CVPIA, 3406(b)(1)(B) Re-operation and 3406(b)(2) Water Management, toward meeting the target flows for chinook salmon and steelhead trout in the CVP-controlled streams in the Delta. In the PEIS, the term "(b)(2) Water Management" is used to indicate the integrated use of 3406(b)(1)(B) Re-operation and 3406(b)(2) Water Management.

The goal of the PEIS (b)(2) Water Management analysis was to develop a simplified strategy for use in the analysis of the PEIS Alternatives. The PEIS analysis was purposely limited to a planning level evaluation, due to the many uncertainties associated with the prioritization, allocation, and accounting of (b)(2) water. The approach consisted of development of preliminary prescriptions designed to attempt to meet the target flows on CVP-controlled streams and in the Delta as developed by the Service and presented in Attachment G-5 of the PEIS. It is recognized that this simplified analysis is for the purposes of the PEIS only. An ongoing formal Water Management Plan (WMP) process, involving the U.S. Bureau of Reclamation (Reclamation) and the U.S. Fish and Wildlife Service (Service), will provide a detailed evaluation of the use of (b)(2) water.

This attachment summarizes (b)(2) Water Management in the PEIS as developed in Alternatives 1 and 4 and Supplemental Analysis 1a.

METHODOLOGY

The first priority for the use of (b)(2) water was in the Delta to meet the Bay-Delta Plan Accord requirements in the May 1995 Draft Water Quality Control Plan. This Bay-Delta Plan Component is included in all Alternatives and Supplemental Analyses. Next, instream (b)(2) Water Management actions were added to the No-Action Alternative, which includes the Bay-Delta Plan Accord, based on the target flows and operational priorities. The strategy attempted to meet the target flows in all years, without violating existing operational criteria. This instream component is included in all Alternatives and Supplemental Analyses. Needs for (b)(2) water use were evaluated on each of the CVP controlled rivers, as compared to the No-Action Alternative. In addition, Alternative 4 and Supplemental Analysis 1a include the use of (b)(2) water to attempt to meet fishery objectives in the Delta, as well as on CVP-controlled streams.

Operational rules were developed that integrate the target flow objectives with No-Action Alternative CVP project operations to create a (b)(2) Water Management strategy for Alternative 1. To provide an estimate of the total use of (b)(2) water in the Alternative or Supplemental

Analysis, a No Bay-Delta Plan Accord (D-1485) base scenario, at a 2022 level of development, was required for comparative purposes. This base scenario was needed because the No-Action Alternative includes use of (b)(2) water to meet the Bay-Delta Plan Accord requirements. The reduction in CVP deliveries between the base scenario and the (b)(2) Water Management component of the Alternative or Supplemental Analysis provides a measure of the total amount of (b)(2) water used. Due to the programmatic nature of the PEIS, reductions in CVP deliveries were evaluated on an average annual basis for the 1922-1990 simulation period. (b)(2) Water Management cannot adversely impact non-CVP water rights holders (including the SWP), Sacramento River Water Rights Contractors, or San Joaquin River Exchange Contractors as compared to the No-Action Alternative.

In addition to long-term average conditions, average annual impacts to deliveries were evaluated for seven hydrologic periods within the simulation period, ranging from wet to critical dry, to show the range of possible impacts under varying hydrologic conditions. The potential use of (b)(2) water in any given year may vary significantly between wet and dry hydrologic year types. For example, in many wet years, reservoir storages and inflows are adequate to meet full deliveries and all target flows without additional releases, thereby limiting the amount of (b)(2) water required. However, in many dry periods, CVP reservoir releases for target flows may be limited by the need to use remaining reservoir storage to meet the Biological Opinion, Delta water quality, or water rights requirements. Therefore, a number of different hydrologic periods were selected to evaluate the average annual delivery impacts of the use of (b)(2) water under wet, above normal, below normal, and dry hydrologic conditions. The 1976 - 1977 period was not selected as a period of evaluation because it is an extremely dry period, and it is assumed that under such a condition, Reclamation and the Service would reconsult to determine appropriate operations. Table G2-1 shows the hydrologic periods selected for analysis.

TABLE G2-1
HYDROLOGIC PERIODS OF EVALUATION
FOR PEIS (b)(2) WATER MANAGEMENT

Contract Years Included in Simulation Period			Period Type
1928	-	1934	Dry
1944	-	1950	Below Normal
1951	-	1957	Above Normal
1959	-	1962	Below Normal
1967	-	1971	Wet
1978	-	1980	Above Normal
1987	-	1990	Dry

The following guidelines were established for the PEIS (b)(2) Water Management.

- Proposed management actions could not interfere with existing operational requirements, including the Winter-Run Biological Opinion and the Bay-Delta Plan Accord. In comparison to the No-Action Alternative simulation, increases in the number of violations of Winter-Run Biological Opinion temperature criteria in the Sacramento River were not allowed.

- Proposed management actions should produce a feasible operational scenario.

- Management actions would not include modifications to existing reservoir flood control rules.

- The primary goal of (b)(2) Water Management was to provide water for salmon and steelhead target flows.

PEIS (b)(2) WATER MANAGEMENT IN ALTERNATIVE 1

To develop an initial (b)(2) Water Management strategy, CVP-controlled river flow conditions in the No-Action Alternative simulation were compared to target flows. This comparison was used to identify rivers where target flows were not met, and to develop operational objectives to meet the target flows where possible. The actions on each CVP-controlled river were evaluated, using the PROSIM and SANJASM models, to determine the specific (b)(2) water needs and possible operational constraints on each river. The actions on all of the CVP-controlled rivers were then integrated into a combined simulation to analyze the overall system wide impacts of (b)(2) Water Management.

CLEAR CREEK OPERATIONS

The operational criteria for minimum flow requirements on Clear Creek in the No-Action Alternative are based on a modified version of Reclamation's 1963 Whiskeytown Dam release schedule. Reclamation's release schedule was developed and implemented (but never formalized) in conjunction with the Service to enhance fishery and recreational values for the Whiskeytown National Recreation Area. As developed by Reclamation, the minimum flows on Clear Creek are:

- Jan. 1 through Oct. 31: 50 cfs (normal year) or 30 cfs (critical year); and
- Nov 1 through Dec. 31: 100 cfs (normal year) or 70 cfs (critical year).

In the No-Action Alternative simulation, both normal and critical year minimum flow requirements are 50 cfs from January 1 through October 31.

The target flows developed by the Service on Clear Creek were based on an instream flow study (DWR, 1986) and hydrologic data at Whiskeytown Dam for the period 1923 to 1994. Flows were prescribed for fall/late-fall chinook salmon and steelhead, as well as spring-run salmon. The Clear Creek flow targets are prescribed for every month of the year, based on the Shasta Index water year-type. Target flows are 200 cfs from October through May (regardless of water year type) and 150 cfs for the remainder of the year (variable spring-time releases depending on water year type). During drought conditions, a 25 percent reduction in instream flow is allowed.

The No-Action Alternative simulation flows meet the target flows in less than 10 percent of the months in the 69-year PEIS simulation period. However, several factors, including limited inflows and reservoir storage capacity, constrain the ability to re-operate water and use (b)(2) water during dry periods. In critically dry years, inflow to Whiskeytown Lake is insufficient to support the target flows.

Monthly inflows to Whiskeytown Lake and target flows for the critical dry period 1928-1934 are presented in Figure G2-1. Inflows in winter and spring months often exceed the releases needed to meet the target flows. The limited storage of 241,000 acre-feet in Whiskeytown Lake makes it difficult to store this water for use in subsequent dry months when inflows are significantly less than the releases needed to meet target flows. In many years, the volume of spring inflow that can be stored in excess of target flows is not sufficient to meet target flows in later summer months. During these dry periods, water diversions from the Trinity River Basin are reduced to maintain minimum Clair Engle Lake storage. Outside of the critical dry period, inflows and Trinity River diversions to Whiskeytown Lake provide enough water to meet target flows.

Because it would not be possible to meet the target flows in all years, priorities for re-operation and use of (b)(2) water were established. The flow objectives in critical dry years were reduced to 30 percent of the target flow value and the revised objectives were used in the (b)(2) Water Management simulation. As a result of this adjustment, target flows are met in all but critical dry years, thereby maintaining minimum storage levels in Clair Engle and Whiskeytown lakes for temperature control purposes.

SACRAMENTO RIVER OPERATIONS

The operational criteria included in the No-Action Alternative for the Sacramento River below Keswick are in accordance with the 1993 Winter-Run Biological Opinion, as summarized below.

- Maintain minimum carryover (end-of-September) storage of 1.9 million acre-feet in Shasta Lake, except in the driest ten percent of years.
- Maintain temperature control below Keswick Dam from April 1 through September 30.
- Maintain minimum flow of 3,250 cfs below Keswick Dam from October 1 through April 30.

The target flows developed by the Service on the Sacramento River at Keswick Dam were based on historical operations of Shasta Lake and existing operational criteria. The target flows were developed to balance instream flow needs for habitat with carryover storage needs for temperature control. Flow stability, for winter-run chinook salmon rearing and spring/fall-run chinook spawning, was a primary consideration. The minimum flow requirement at Keswick for October through April is based on the October 1 storage in Shasta Lake. A storage target of between 3.0 and 3.2 million acre-feet is set for April 30 to maintain enough water for summer temperature control releases. The storage-based target flows are presented in Table G2-2.

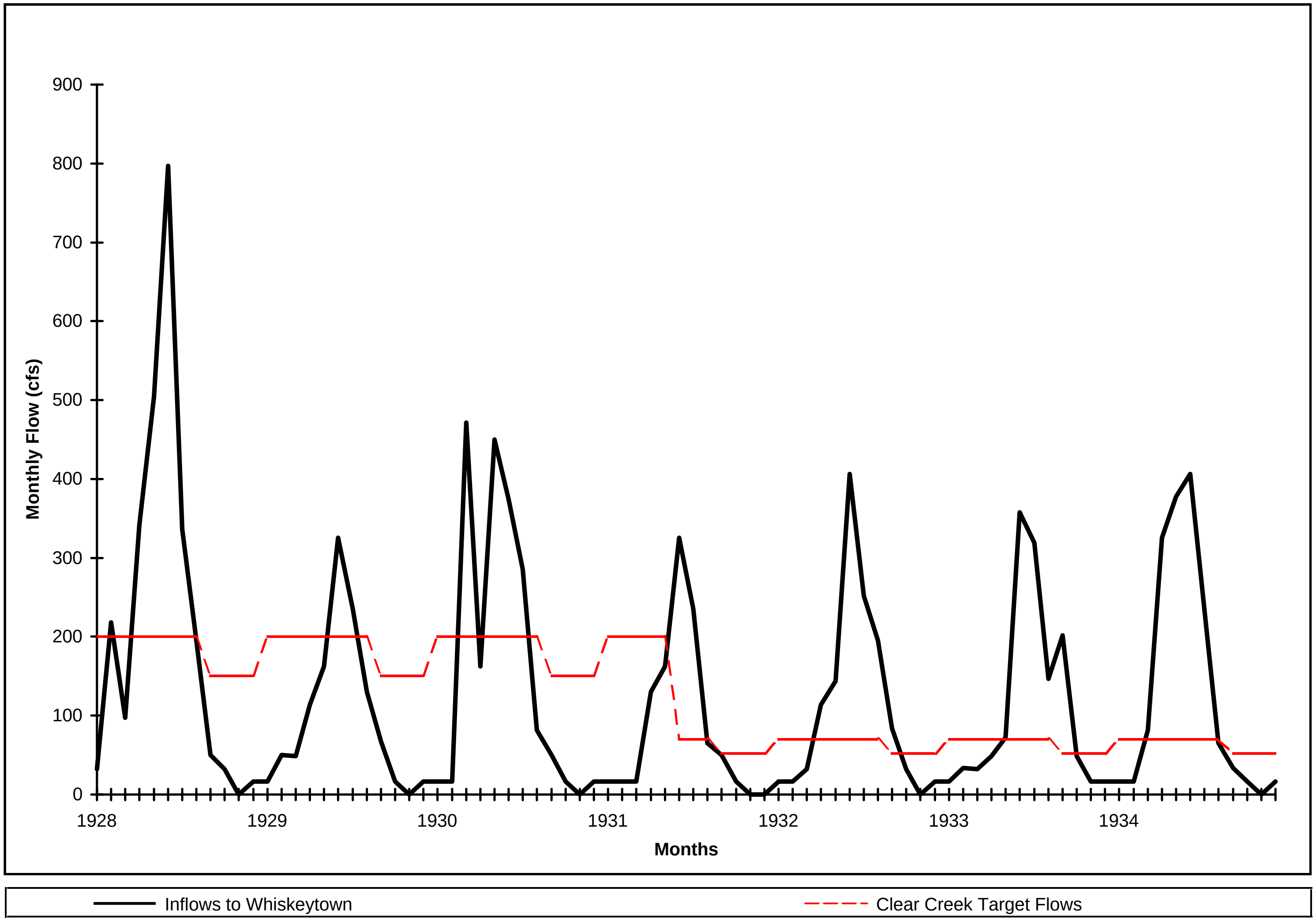

FIGURE G2-1

COMPARISON OF ESTIMATED MONTHLY INFLOWS TO WHISKEYTOWN AND TARGET FLOWS ON CLEAR CREEK

TABLE G2-2
MINIMUM SACRAMENTO RIVER TARGET FLOWS AT KESWICK DAM FOR THE PERIOD OCTOBER 1 THROUGH APRIL 30

Carryover Storage (in million af)	Keswick Dam Release (in cfs)	Carryover Storage (in million af)	Keswick Dam Release (in cfs)
1.9	3,250	2.5	4,250
2.0	3,250	2.6	4,500
2.1	3,250	2.7	4,750
2.2	3,500	2.8	5,000
2.3	3,750	2.9	5,250
2.4	4,000	3.0	5,500

NOTES:
Based on October 1 carryover storage in Shasta Lake and critically dry runoff conditions (driest decile runoff of 2.5 million af) to produce a target April 30 Shasta Lake storage of 3.0 to 3.2 million af for temperature control.

In the No-Action Alternative simulation, these target flows are met in nearly all months during October through April in wet years, but only in about 50 percent of the months in dry years. This indicates that the need for the use of (b)(2) water is primarily in drier years.

In the (b)(2) Water Management simulation, the October through April target flows are based on October 1 storage in Shasta Lake and are therefore achieved in 100 percent of the months. This revised operation utilizes Shasta Lake storage to increase October through April river flows. In all but critical low runoff years which follow wet years, operations under the storage/flow relationship result in April 30 Shasta Lake storage levels between 3.0 and 3.2 million acre-feet. When Shasta Lake storage on October 1 is high (near or at flood control), minimum required releases are also high. If subsequent reservoir inflow is critically low, it may not be sufficient to meet the target flows and the April 30 storage target, so the resulting storage may be below the target.

The end-of-water year storage targets, as set in the Winter-Run Biological Opinion, can be met in all but some dry and critical dry years. The target cannot be met in some critical years because reservoir inflows are extremely low and spring and summer reservoir releases are required for temperature control and water rights deliveries. Although deliveries to agricultural water service contractors may be reduced to zero, releases for temperature control, water rights, M&I contractors, and Exchange and Water Rights contractors must still be made. In these extreme dry years, Reclamation would reconsult with the National Marine Fisheries Service (NMFS) to determine appropriate actions under the Winter Run Biological Opinion.

Operation under (b)(2) Water Management results in reduced Shasta Lake releases for CVP water users in the spring and summer months, to provide additional fall and winter releases to meet flow targets. This shift in Shasta Lake releases is limited by the need to make spring and summer releases to meet Winter Run Biological Opinion temperature control requirements. The modeling conducted for the PEIS provides a general indication of how much summer releases can be reduced without negatively impacting the ability to meet winter run temperature requirements. The minimum average monthly release required to meet the 56 degree minimum temperature threshold varies and is a function of ambient air temperature, the volume and temperature of downstream accretions, and the volume and temperature of cold water storage in Shasta Lake. Based on PEIS monthly temperature modeling analyses, it appears that during the hot summer months of June through August there needs to be a minimum release of about 10,000 to 12,000 cfs to meet the biological opinion temperature requirements during this critical winter run salmon mortality period.

In most dry and critical dry years Shasta Lake Reservoir releases are governed by water rights and fisheries objectives including the target flows, Winter Run Biological Opinion, and Delta water quality requirements. During these periods, CVP Delta exports are limited to incidental Delta inflows resulting from upstream releases for fisheries, and return flows from water rights diversions.

AMERICAN RIVER OPERATIONS

Operational criteria included in the No-Action Alternative are summarized below.

- Maintain COE (Corps of Engineers) 400 fixed Folsom flood control requirements.

- Maintain American River minimum streamflow requirements based on recent operational practices which attempt to meet some of the requirements of California State Water Resources Control Board (SWRCB) Decision 1400 with minimum flow requirements per SWRCB Decision 893.

Under Alternative 1, target flows are prescribed for the lower American River for the entire reach downstream of Nimbus Dam to provide adequate flow for the fall/winter spawning and incubation of chinook salmon and steelhead trout. A September 30 Folsom Lake storage target of 610,000 acre-feet is also included to attempt to provide a sufficient volume of water to maintain increased stable spawning and incubation flows during the fall and winter months. The target flows for the American River, by year-type, are presented in Table G2-3.

The No-Action Alternative simulation flows meet the target flows on the American River below Nimbus Dam in 60 percent of the months in wet years and in 20 percent of the months in critical dry years, based on the 40-30-30 year type index. During the critical spawning and incubation period of October through February, target flows are only met in 10 percent of the above normal years and in zero percent of the dry and critical dry years. The Folsom Lake September 30 storage target of 610,000 acre-feet is met in 40 percent of the years. This indicates the need to use (b)(2) water is primarily in dry to above normal year types.

TABLE G2-3
AMERICAN RIVER MINIMUM FLOW OBJECTIVES

Month	Flow for Each of Four Year Types (in cfs)			
	Wet	**Normal**	**Dry/Critical**	**Critical Relaxation**
October	2,500	2,000	1,750	800
November - February	2,500	2,000	1,750	1,200
March - May	4,500	3,000	2,000	1,500
June	4,500	3,000	2,000	500
July	2,500	2,500	1,500	500
August	2,500	2,000	1,000	500
September	2,500	1,500	500	500

NOTES:
A multi-agency and interested party management team should be formed to review and adjust flows in consideration of carryover storage and hydrologic conditions as needed to provide for the long-term needs of anadromous fish.

Year types should be based on an American River index, or on consideration of carryover storage and hydrologic conditions in the American River watershed.

The use of (b)(2) water on the American River is limited by extremely variable inflow hydrology, the limited storage capacity of Folsom Lake, and the high level of M&I demands along the river. Annual inflows to Folsom Lake are highly variable, as shown in Figure G2-2, ranging from less than 1 acre-feet to greater than 6 million acre-feet over the 69-year PEIS simulation period. In wet years, inflows to Folsom Lake often exceed the releases needed to meet the target flows, but the limited storage capacity of 972,000 acre-feet in Folsom Lake prevents storage of this water for use in subsequent dry years when inflows may be significantly less than the releases needed to meet target flows. In addition, COE flood control restrictions further limit fall storage to about 600,000 acre-feet in November.

M&I demands along the American River also limit the ability to re-operate and use (b)(2) water. Between the projected 1995 and 2022 levels of development, M&I demands along the American River are projected to increase from 240,000 acre-feet to 510,000 acre-feet. Over 90 percent of this increase, approximately 250,000 acre-feet, is attributable to water rights contractors which are not subject to any CVP shortage criteria. The remaining 10 percent, approximately 20,000 acre-feet, is attributable to CVP M&I contractors, which are subject to a maximum shortage of 25 percent. This water must be released for water rights and M&I contractors on a monthly pattern which does not necessarily coincide with the target flows. Thus, the majority of the increase in American River demand cannot be reduced substantially to provide water toward meeting target flows.

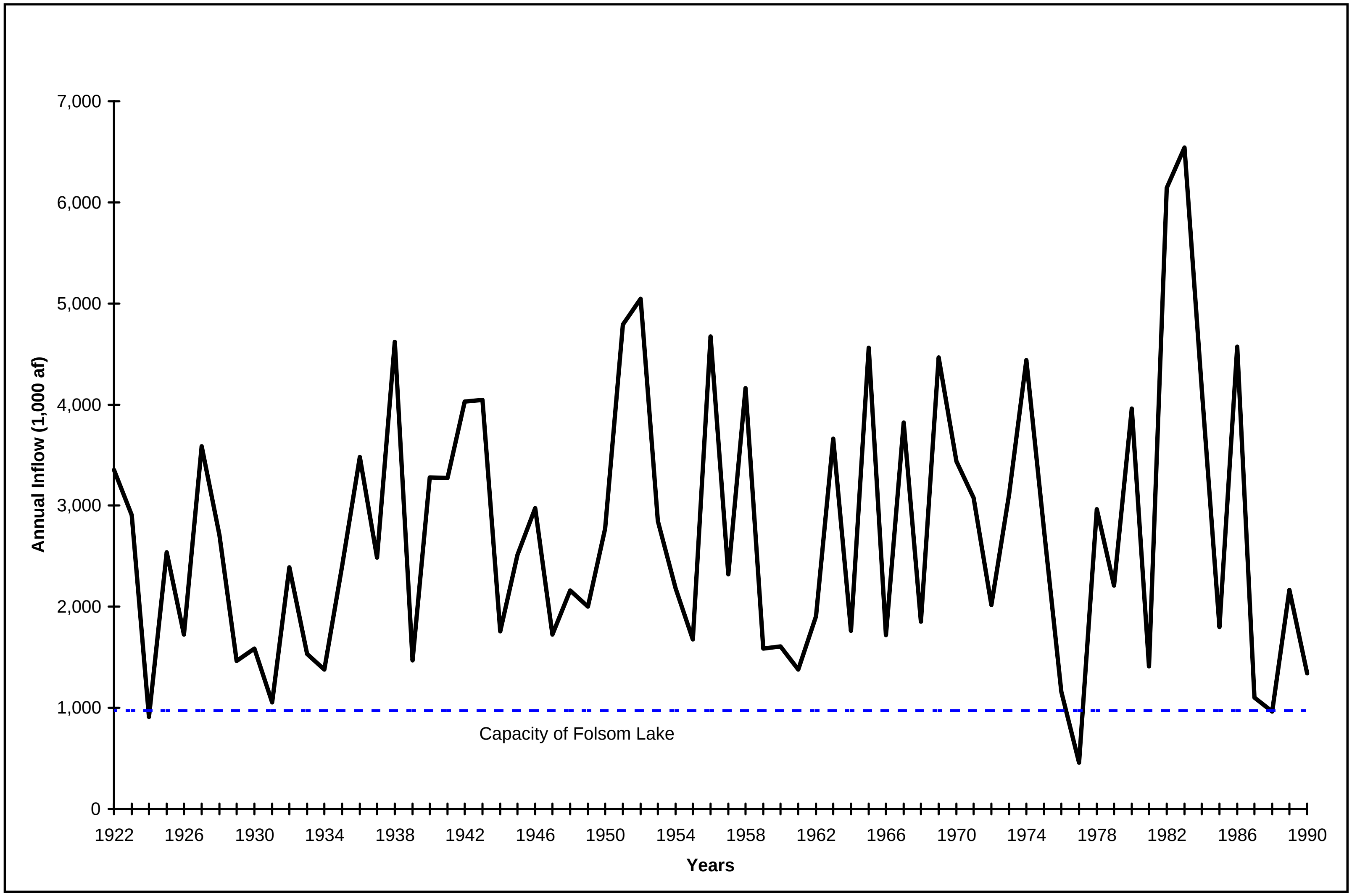

FIGURE G2-2

SIMULATED ANNUAL INFLOW TO FOLSOM RESERVOIR 1922 - 1990

Because it would not be possible to meet all target flows on the lower American River, priorities for use of (b)(2) water were established. The Service assigned the highest biological priorities to maintenance of stable fall and winter flows October through February and increasing Folsom Lake end-of-month September storage. The year-type flow requirements were transformed into reservoir storage/inflow based flow requirements to allow additional operational flexibility during dry and critical years. The reach of the American River over which the target flows were prescribed was limited to the section from Nimbus Dam to the "H" Street bridge.

The revised PEIS American River (b)(2) water target flows for the October through February period are based on October 1 storage in Folsom Lake. Flow targets for the remaining months, March through September, are determined by the previous month's storage and remaining water year projected inflow. The spring pulse flows in the March through June months are considered by the Service to be a lower priority than the October through February target flows. The storage/inflow based flow relationship developed for PEIS (b)(2) Water Management on the American River is presented in Table G2-4.

TABLE G2-4
STORAGE-BASED FLOW RELATIONSHIP DEVELOPED FOR (b)(2) WATER MANAGEMENT ON THE AMERICAN RIVER AT NIMBUS DAM

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Criteria and Flow	**S**	**W**	**W**	**W**	**W**	**S + I**	**S + I**	**S + I**	**S + I**	**S + I**	**S + I**	**S + I**
Criteria (1,000 af)	600	600	600	600	600	2,850	2,450	2,050	1,550	1,250	1,200	1,150
Flow (cfs)	2,500	2,500	2,500	2,500	2,500	4,500	4,500	4,500	4,500	2,500	2,500	2,500
Criteria (1,000 af)	500	500	500	500	500	2,600	2,250	1,875	1,425	1,150	875	850
Flow (cfs)	2,000	2,500	2,500	2,250	2,000	3,750	3,750	3,750	3,750	2,500	2,250	2,000
Criteria (1,000 af)	410	410	410	410	410	2,350	2,050	1,700	1,300	1,050	750	700
Flow (cfs)	2,000	2,000	2,000	2,000	2,000	3,000	3,000	3,000	3,000	2,500	2,000	1,500
Criteria (1,000 af)	350	350	350	350	350	1,500	1,350	1,200	850	700	550	500
Flow (cfs)	1,500	2,000	2,000	1,750	1,500	2,500	2,500	2,500	2,250	1,875	1,500	1,000
Criteria (1,000 af)	300	300	300	300	300	1,300	1,150	1,000	750	600	500	0
Flow (cfs)	800	1,500	1,500	1,250	1,250	1,500	1,500	1,500	1,500	1,250	1,000	500
Criteria (1,000 af)	250	250	250	250	250	1,100	1,000	900	650	500	0	
Flow (cfs)	500	1,000	1,000	1,000	1,000	1,250	1,250	1,250	1,250	1,000	500	
Criteria (1,000 af)	0	0	0	0	0	900	700	600	500	0		
Flow (cfs)	500	500	500	500	500	750	750	750	500	500		
Criteria (1,000 af)						0	0	0	0			
Flow (cfs)						250	250	250	250			

NOTES:

American River at Nimbus Dam storage-based flow relationship developed for PEIS PROSIM runs

S = end-of-previous month's Folsom Lake storage

W = beginning of water year's Folsom Lake storage (end-of-September Folsom Reservoir storage, previous water year)

I = inflow to Folsom Lake (current month + all months until end of water year)

In comparison to the No-Action Alternative simulation, the Folsom Lake releases in the (b)(2) water simulation are shifted from the spring and summer months to the fall and winter months, in accordance with the prioritized target flows. For the October through February period, the original Year type target flows are achieved in 100 percent of the October through February periods of wet, above normal, and below normal years. For the same period, target flows are met in 80 percent of the dry years and 40 percent of critically dry years. In addition, the flow reductions during spring and summer months increase end-of-September storage by an average of 80,000 acre-feet. The Folsom Lake September storage target is met in 50 percent of the years simulated.

The (b)(2) Water Management on the American River results in reductions in spring and summer releases from Folsom Lake, which consequently decrease American River flows entering the Delta. This reduction in American River inflow to the Delta requires that additional water be released from Shasta Lake to meet Delta water rights and water quality requirements. These additional Shasta Lake releases limit some of the CVP's flexibility to maintain spring and summer cold water storage in Shasta Lake for Winter Run Biological Opinion temperature control requirements. This loss of flexibility is partially offset by increased fall and winter Folsom Lake releases that reduce the need to make Shasta Lake releases during that period to meet Delta water quality requirements or supply water for Tracy Pumping Plant exports.

STANISLAUS RIVER OPERATIONS

Target flows for the Stanislaus River below Goodwin Dam are presented in Table G2-5. The flows are intended to supplement instream flow releases made pursuant to the 1987 agreement between Reclamation and DFG, described in the Affected Environment.

TABLE G2-5
TARGET FLOWS ON THE STANISLAUS RIVER BELOW GOODWIN DAM

	Requirement by Water Year Type (cfs)				
	Wet	**Above Normal**	**Below Normal**	**Dry**	**Critical**
October	350	350	250	250	200
November-March	400	350	300	275	250
April	1,500	1,500	300/1,500 (1)	300/1,500 (2)	300/1,500 (3)
May	1,500	1,500	1,500/300 (1)	1,500/300 (2)	1,500/300 (3)
June	1,500	800	250	200	200
July-September	300	300	250	200	200

NOTES:
(1) In a below normal water year, April-May flow would be maintained for 45 days at 1,500 cfs and 16 days at 300 cfs.
(2) In a dry water year, April-May flow would be maintained for 30 days at 1,500 cfs and 31 days at 300 cfs.
(3) In a critical water year, April-May flow would be maintained for 30 days at 1,500 cfs and 31 days at 300 cfs.
(4) Based on the San Joaquin Valley 60-20-20 water year type classification.

In the No-Action Alternative, target flows would be met in approximately 50 percent of the months in the summer, fall, and winter . Spring pulse flows would be met only in very wet conditions, when releases are made to maintain flood control storage. Re-operation of New Melones Reservoir and (b)(2) Water Management on the Stanislaus River focused on these two objectives and was accomplished in two steps.

The first step included operation of New Melones to meet the target flows in July through March of non-critical years. Because this would result in lower storage in New Melones, operational targets were initially reduced in April through June in order to maintain minimum New Melones storage criteria. Due to the limited water supplies, no increase in the instream flows would be made in critical year types.

The second step applied (b)(2) Water Management to CVP contracts. In years when target flows would not be met, CVP contractors would not receive deliveries. The water would be stored in New Melones Reservoir and released toward meeting the target flows, primarily in April through June. In addition, where possible, flood control ramping releases in the summer and fall would be released earlier in the year, primarily in April through June to help meet target flows.

SUMMARY OF (b)(2) WATER MANAGEMENT IN ALTERNATIVE 1

The (b)(2) Water Management component of Alternative 1 incorporates an integrated package of target flows for all CVP-controlled rivers in the Central Valley. As described previously, the measure of (b)(2) water use in the PEIS is based on the reduction in CVP average annual deliveries as compared to a No Bay-Delta Plan Accord base condition, at a 2022 level of development. The average annual reduction in CVP deliveries, as a result of the use of (b)(2) water in Alternative 1, is presented in Table G2-6 for each of the hydrologic periods selected for evaluation. A negative value indicates a reduction in average annual CVP deliveries due to the use of (b)(2) water during that simulated hydrologic period. A positive value indicates an increase in average annual deliveries.

In each hydrologic period of evaluation, (b)(2) water is used to meet the Bay-Delta Plan Accord requirements and to help meet the target flows. The greatest amount of (b)(2) water is used during dry and below normal hydrologic periods when natural river flows and CVP reservoir releases are at their lowest. In wet and above normal periods, the (b)(2) water component is less than during below normal and dry periods. This is because target flows may be satisfied by reservoir flood control releases, spills, and other CVP operations during wetter periods and no additional releases of water may be necessary to meet the target flows.

It should be noted that the average annual reduction in CVP deliveries does not reach 800,000 acre-feet during any of the hydrologic periods. This is because the CVP is over-constrained due to the multiple needs and operational criteria that govern operations. The (b)(2) water is measured as reductions in deliveries to CVP water service contractors north and south of the Delta. However, many CVP operational criteria take priority before deliveries are made to CVP water service contractors and, therefore, use of (b)(2) water is limited. These operational priorities include water rights, the Winter Run Biological Opinion, flood control operations, and water quality requirements. These operational criteria, in combination with limited water availability, often constrain the amount of water which may be used towards (b)(2) Water Management objectives.

TABLE G2-6
CVP DELIVERY IMPACTS OF THE INSTREAM (b)(2) WATER MANAGEMENT COMPONENT OF ALTERNATIVE 1 AS COMPARED TO THE 2022 D-1485 BASE SCENARIO

Hydrologic Period	Period Type	Simulated Average Annual CVP Deliveries (in 1,000 af)		Change in Average Annual CVP Deliveries (in 1,000 af)
		2022 D-1485 Base Scenario	Simulation with Instream (b)(2) Water Management	
1922 - 1990	Simulation Period	5,890	5,530	-360
1928 - 1934	Dry	4,900	4,340	-560
1944 - 1950	Below Normal	5,900	5,410	-490
1951 - 1957	Above Normal	6,300	6,100	-200
1959 - 1962	Below Normal	5,890	5,360	-530
1967 - 1971	Wet	6,310	6,120	-190
1978 - 1980	Above Normal	6,320	6,190	-130
1987 - 1990	Dry	5,330	4,590	-740

Note: Does not include CVP refuge deliveries

The impacts to SWP deliveries, resulting from (b)(2) Water Management in Alternative 1, are presented in Table G2-7. A negative value indicates that SWP deliveries are reduced as a result of (b)(2) Water Management. A positive value indicates that SWP deliveries are increased as a result of (b)(2) Water Management.

The table shows that SWP deliveries generally increase as a result of (b)(2) Water Management actions included in Alternative 1. This is because Delta inflow increases during the fall and winter due to greater upstream CVP reservoir releases for target flows. In many years, these inflows exceed the capacity of the CVP's Tracy Pumping Plant. Under the current Coordinated Operations Agreement (COA) assumptions used for the PEIS analysis, this excess Delta inflow may be pumped by the SWP when capacity is available at Banks Pumping Plant, reducing the need for Lake Oroville releases.

As stated above, the impacts to the CVP and SWP are a function of the COA assumptions used to represent the coordinated operations of the two projects at a 2022 level of development. It must be recognized that the impacts to SWP deliveries could vary substantially under a different set of Delta water quality requirements and/or COA sharing assumptions. It is also possible that wheeling agreements could be negotiated with the SWP to pump excess CVP water, above the Tracy Pumping Plant capacity, to CVP water users south of the Delta.

TABLE G2-7
SWP DELIVERY IMPACTS OF INSTREAM
(b)(2) WATER MANAGEMENT COMPONENT OF THE ALTERNATIVE 1

Hydrologic Period	Period Type	Simulated Average Annual SWP Deliveries (in 1,000 af): 2022 D-1485 Base Scenario	Simulated Average Annual SWP Deliveries (in 1,000 af): Simulation with Instream (b)(2) Water Management	Change in Average Annual SWP Deliveries (in 1,000 af)
1922 - 1990	Simulation Period	3,400	3,460	+60
1928 - 1934	Dry	2,380	2,200	-180
1944 - 1950	Below Normal	3,300	3,450	+150
1951 - 1957	Above Normal	3,950	3,830	-120
1959 - 1962	Below Normal	3,130	3,080	-50
1967 - 1971	Wet	4,050	4,140	+90
1978 - 1980	Above Normal	4,080	4,220	+140
1987 - 1990	Dry	1,930	2,140	+210

PEIS (b)(2) WATER MANAGEMENT IN SUPPLEMENTAL ANALYSIS 1a

The operational criteria for the Delta in the No-Action Alternative and Alternative 1 include the Bay-Delta Plan Accord, the COA with assumptions to allow use with the SWRCB's May 1995 Draft Water Quality Control Plan, and the 1993 Winter-Run Biological Opinion as amended in 1995 by NMFS. In addition to using (b)(2) water to help meet fishery target flow goals on CVP-controlled streams, Supplemental Analysis 1a also includes the Delta (b)(2) water component to attempt to meet fishery objectives in the Delta. As is the case with Alternative 1, a simplified version of the (b)(2) Water Management in the Delta was developed for the PEIS analysis. The Delta (b)(2) actions evaluated in Supplemental Analysis 1a are based on preliminary actions proposed by the Service in February 1996.

In Supplemental Analysis 1a, the assumptions regarding the COA are particularly important since many of the proposed (b)(2) Delta actions assume cooperative implementation by both the CVP and SWP. The relative impacts to the CVP and SWP described under Supplemental Analysis 1a are a function of the associated COA assumptions.

DELTA OPERATIONS

Delta actions to benefit anadromous fish include operational targets and supplemental actions (Delta (b)(2) actions). The operational targets are recommendations to the Operations Coordination Group (Ops Group) that do not involve costs to water supply in excess of the Bay-Delta Plan Accord. The Delta (b)(2) actions include changes in operations that extend beyond the authority of the Ops Group and that further contribute to meeting the goals. Delta (b)(2) actions are limited by the water available through the management of the 800,000 acre-feet of

CVP yield as defined in Section 3406(b)(2) of CVPIA. These Delta (b)(2) actions are intended to be consistent and supportive of the Bay-Delta Plan Accord.

The simplified analysis used for the PEIS focuses on the use of major (b)(2) actions for the protection of anadromous fish, assuming that the SWP would cooperate by reducing exports during specified periods and making releases to contribute to additional levels of Delta protection. As shown in Alternative 1, the SWP would gain some limited export benefits at Banks Pumping Plant as a result of reservoir releases for (b)(2) water purposes on CVP streams. It is assumed for Supplemental Analysis 1a, that any negative impact to the SWP due to this cooperation would not exceed the benefits shown in Alternative 1. Therefore, there would be no net impact to SWP deliveries as compared to the No-Action Alternative. The resulting reductions in deliveries estimated based on this simplified analysis do not include the potential for SWP pumping of CVP water in fall and winter months to make up water costs associated with (b)(2) actions for Delta purposes earlier in the year.

The Delta (b)(2) actions incorporated into Supplemental Analysis 1a, in addition to the instream (b)(2) Water Management described in Alternative 1, are listed below.

- Maintain a 1,500 cfs maximum for total CVP/SWP exports during the 30-day pulse flow period from April 15 through May 15. The 1,500 cfs maximum pumping limit approximates the Service's desired San Joaquin River pulse flow export/inflow ratio under each of the different water year types.

- Increase level of protection targeted by the May and June X2 requirement to a 1962 level of development. This represents an increase in the number of days when X2 would be required at Chipps Island in Table A of the SWRCB May 1995 Water Quality Control Plan, as shown in Table G2-8.

- Reduce CVP Tracy Pumping Plant exports in November and December to decrease the fall Delta export/inflow ratio. This action is intended to reduce the direct and indirect entrainment effects of export pumping on migrating juvenile chinook salmon.

SUMMARY OF (b)(2) WATER MANAGEMENT SUPPLEMENTAL ANALYSIS 1a

The reduction in deliveries due to the Delta (b)(2) actions in Supplemental Analysis 1a are presented in Table G2-9, for each of the hydrologic periods of evaluation. If the average annual change in deliveries is negative, then (b)(2) water is used during that period.

In each hydrologic period of evaluation, (b)(2) water would be used to meet the Bay-Delta Plan Accord requirements, instream target flows, and Delta (b)(2) actions. During dry and below normal periods, the greatest amount of (b)(2) water is used. In many instances, this is because the greatest need for (b)(2) water occurs during dry periods when reservoir releases are lowest. During none of the periods does the average annual (b)(2) water component reach 800,000 acre-feet. As described under Alternative 1, operational criteria such as biological opinion temperature requirements, reservoir flood control, water rights demands, and Delta water quality requirements often limit the amount of (b)(2) water which may be used. Delta (b)(2) actions were also limited to prevent negative impacts to SWP deliveries as compared to the No-Action Alternative.

TABLE G2-8
INCREASE IN X2 DAYS FOR 1962 LEVEL OF DEVELOPMENT

	1962 Level of Development		May 1995 Water Quality Control Plan	
Previous Month Index	**May**	**June**	**May**	**June**
500	0	0	0	0
750	0	0	0	0
1000	0	0	0	0
1250	0	0	0	0
1500	0	0	0	0
1750	1	0	0	0
2000	4	0	1	0
2250	13	1	3	0
2500	24	3	11	1
2750	29	7	20	2
3000	30	12	27	4
3250	31	18	29	8
3500	31	23	30	13
3750	31	26	31	18
4000	31	28	31	23
4250	31	29	31	25
4500	31	29	31	27
4750	31	30	31	28

TABLE G2-9
CVP DELIVERY IMPACTS OF THE INSTREAM AND DELTA (b)(2) WATER MANAGEMENT COMPONENTS OF THE SUPPLEMENTAL ANALYSIS 1a

		Simulated Average Annual CVP Deliveries (in 1,000 af)		
Hydrologic Period	**Period Type**	**2022 D-1485 Base Scenario**	**Instream and Delta (b)(2) Water Management**	**Average Annual Change in Deliveries (in 1,000 af)**
1922 - 1990	Simulation Period	5,890	5,430	-460
1928 - 1934	Dry	4,900	4,270	-630
1944 - 1950	Below Normal	5,900	5,310	-590
1951 - 1957	Above Normal	6,300	5,980	-320
1959 - 1962	Below Normal	5,890	5,360	-530
1967 - 1971	Wet	6,310	6,000	-310
1978 - 1980	Above Normal	6,320	6,020	-300
1987 - 1990	Dry	5,330	4,570	-760
Note: Does not include refuge deliveries				

The (b)(2) water component would be less in wet and above normal periods, than during below normal and dry periods. In many instances, this is because the target flows would already be met with existing reservoir releases and no additional releases or use of (b)(2) water would be necessary.

The impact to SWP deliveries resulting from (b)(2) Water Management in Supplemental Analysis 1a is presented in Table G2-10. If the SWP Impact of (b)(2) Water Management is a negative value, SWP deliveries would be reduced as a result of (b)(2) Water Management. If the SWP Impact of (b)(2) Water Management is a positive value, SWP deliveries would be increased as a result of (b)(2) Water Management.

TABLE G2-10
SWP DELIVERY IMPACTS OF INSTREAM AND DELTA (b)(2) WATER MANAGEMENT COMPONENTS OF SUPPLEMENTAL ANALYSIS 1a

Hydrologic Period	Period Type	Simulated Average Annual SWP Deliveries (in 1,000 af)		Average Annual Change in Deliveries (in 1,000 af)
		2020 D-1485 Base Scenario	Instream and Delta (b)(2) Water Management	
1922 - 1990	Simulation Period	3,400	3,410	+10
1928 - 1934	Dry	2,380	2,230	-150
1944 - 1950	Below Normal	3,300	3,360	+60
1951 - 1957	Above Normal	3,950	3,860	-90
1959 - 1962	Below Normal	3,130	3,080	-50
1967 - 1971	Wet	4,050	4,100	+50
1978 - 1980	Above Normal	4,080	4,080	0
1987 - 1990	Dry	1,930	2,190	+260
Note: Does not include refuge deliveries				

During the fall and winter months, Delta inflows are increased because of greater upstream CVP reservoir releases for target flows. In many years, these inflows exceed the capacity of the Tracy Pumping Plant. In many of these years, excess pumping capacity is available at Banks Pumping Plant so the SWP is able to export additional water in some of the fall and winter months, and increase deliveries. The ability of the SWP to increase deliveries is dependent upon several operational constraints, including pumping capacity at the Banks Pumping Plant, the COA, Delta water quality requirements, and SWP San Luis Reservoir operations.

PEIS (b)(2) WATER MANAGEMENT IN ALTERNATIVE 4

The operational criteria for the Delta in the No-Action Alternative and Alternative 1 include the Bay-Delta Plan Accord, the COA with assumptions to allow use with the SWRCB's May 1995 Draft Water Quality Control Plan, and the 1993 Winter-Run Biological Opinion as amended in 1995 by NMFS. As in Supplemental Analysis 1a, Alternative 4 includes the Delta (b)(2) water component to attempt to meet fishery objectives on CVP-controlled streams and in the Delta. In contrast to the proposed preliminary February 1996 Delta (b)(2) actions that were evaluated in Supplemental Analysis 1a, the Delta (b)(2) actions evaluated in Alternative 4 were developed based on preliminary information released by the Service in October 1996, which is presented in Attachment G-5 of the PEIS. The Delta (b)(2) actions outlined in this Alternative are a refinement of the preliminary potential actions originally proposed in February 1996, and evaluated in Supplemental Analysis 1a.

As in Supplemental Analysis 1a, the assumptions regarding the COA are particularly important since the proposed (b)(2) Delta actions assume cooperative implementation by both the CVP and SWP. The relative potential impacts to the CVP and SWP described under Alternative 4 are a function of the associated COA assumptions.

DELTA OPERATIONS

A simplified version of (b)(2) Water Management was developed that integrated the nine proposed Delta (b)(2) water actions into Alternative 4. These actions are listed below according to priority, **as developed by the Service**. The highest priority action is assigned the number 1.

1. Limit CVP/SWP April and May exports to a percent of San Joaquin River at Vernalis flow based on water year type.

2. Head of Old River barrier in place April through May.

3. Increase level of May and June X2 requirement to 1962 level of development.

4. Provide 13,000 cfs at the “I” Street Bridge and 9,000 cfs at Knights Landing on the Sacramento River in May.

5. Ramp total CVP/SWP export/inflow ratio levels April 1 to April 15 and May 15 through May 31.

6. Close Delta Cross Channel Gates November 1 through January 31.

7. Limit CVP/SWP exports to 35 percent of Delta inflow in July.

8. Establish conditions for a late fall run smolt survival experiment.

9. Limit CVP/SWP total exports to 35 percent of Delta inflow in November through January.

The same methodology described under Alternative 1 was used for the analysis of the combined instream and Delta (b)(2) water actions integrated into CVP operations in Alternative 4. The simplified analysis used for the PEIS focuses on the major Delta (b)(2) actions for the protection of anadromous fish, assuming that the SWP would cooperate with implementation of the actions by reducing exports during specified periods and making releases to contribute to additional levels of Delta protection. As shown in Alternative 1, the SWP would gain some limited export benefits at Banks Pumping Plant as a result of reservoir releases for (b)(2) water purposes on CVP streams. It is assumed that any negative impacts to the SWP, due to this cooperation in Alternative 4, would not exceed the benefits shown in Alternative 1. Therefore, there would be no net impact to average annual SWP deliveries as compared to the No-Action Alternative. The resulting reductions in deliveries estimated based on this simplified analysis do not include the potential for SWP pumping of CVP water in fall and winter months to make up water costs associated with (b)(2) actions for Delta purposes earlier in the year.

The potential impacts of all nine Delta (b)(2) actions could not be assessed in the model simulations conducted for the PEIS. The simulations were programmatic in nature and did not have the capability to assess the specific changes that might occur as a result of the implementation of actions 2, 5, and 8. Although the models did not allow quantification of the potential impacts, some general assessments were made where possible.

Delta actions 1 and 3 were met throughout the simulation, regardless of year type (40-30-30 year type index). Delta action 6 was met in wet and above normal years only. In Delta action 4, the minimum flows at the "I" Street Bridge and Knights Landing in Sacramento were met in 59 and 22 percent of the months of May, respectively, during the simulation period. Delta action 7 was met in 56 percent of the months of July during the simulation period. Delta action 9 was met in 32 percent of the months of November, 38 percent of the months of December, and 57 percent of the months of January during the simulation period.

SUMMARY OF (b)(2) WATER MANAGEMENT IN ALTERNATIVE 4

The reduction in deliveries due to the Delta (b)(2) actions in Alternative 4 are presented in Table G2-11, for each of the hydrologic periods of evaluation. If the average annual change in deliveries is negative, then (b)(2) water is used during that period.

TABLE G2-11
CVP DELIVERY IMPACTS OF THE INSTREAM AND DELTA (b)(2) WATER MANAGEMENT COMPONENT OF ALTERNATIVE 4

Hydrologic Period	Period Type	Simulated Average Annual CVP Deliveries (in 1,000 af)		Average Annual Change in CVP Deliveries (in 1,000 af)
		2022 D-1485 Base Scenario	Simulation with Instream and Delta (b)(2) Water Management	
1922 - 1990	Simulation Period	5,890	5,410	-480
1928 - 1934	Dry	4,900	4,280	-620
1944 - 1950	Below Normal	5,900	5,290	-610
1951 - 1957	Above Normal	6,300	5,950	-350
1959 - 1962	Below Normal	5,890	5,310	-580
1967 - 1971	Wet	6,310	6,060	-250
1978 - 1980	Above Normal	6,320	6,020	-300
1987 - 1990	Dry	5,330	4,460	-770

Note: Does not include refuge deliveries

In each hydrologic period of evaluation, (b)(2) water would be used to meet the Bay-Delta Plan Accord requirements, instream target flows, and Delta (b)(2) actions. During dry and below normal periods, the greatest amount of (b)(2) water is used. In many instances, this is because the greatest need for (b)(2) water occurs during dry periods when reservoir releases are lowest. As described under Alternative 1, operational criteria such as biological opinion temperature requirements, reservoir flood control, water rights demands, and Delta water quality requirements often limit the amount of (b)(2) water which may be used. Delta (b)(2) actions were limited primarily by the need to prevent negative impacts to SWP deliveries as compared to the No-Action Alternative.

The (b)(2) water component would be less in wet and above normal periods, than during below normal and dry periods. In many instances, this is because the target flows would already be met with existing reservoir releases and no additional releases or use of (b)(2) water would be necessary.

The impact to SWP deliveries resulting from (b)(2) Water Management in Alternative 4 is presented in Table G2-12. If the SWP Impact of (b)(2) Water Management is a negative value, SWP deliveries are reduced as a result of (b)(2) Water Management. If the SWP Impact of (b)(2) Water Management is a positive value, SWP deliveries are increased as a result of (b)(2) Water Management. The table shows primarily negative numbers indicating a reduction in SWP deliveries due to the use of (b)(2) water. This reduction is caused by a combination of Delta (b)(2) actions and the Delta actions in the Bay-Delta Plan Accord that are included in the (b)(2) analysis as compared to the 2022 No Bay-Delta Plan Accord (2022 D-1485) simulation that is used as the basis for measurement of impacts. In the comparisons in previous Alternatives, the incidental benefits to the SWP of the use of (b)(2) water on CVP controlled rivers offset the impacts of the Bay-Delta Plan Accord.

TABLE G2-12
SWP DELIVERY IMPACTS OF THE INSTREAM AND DELTA (b)(2) WATER MANAGEMENT COMPONENTS OF ALTERNATIVE 4

Hydrologic Period	Period Type	Simulated Average Annual SWP Deliveries (in 1,000 af)		Average Annual Change in SWP Deliveries (in 1,000 af)
		2022 D-1485 Base Scenario	Simulation with Instream and Delta (b)(2) Water Management	
1922 - 1990	Simulation Period	3,400	3,320	-80
1928 - 1934	Dry	2,380	2,050	-330
1944 - 1950	Below Normal	3,300	3,270	-30
1951 - 1957	Above Normal	3,950	3,830	-120
1959 - 1962	Below Normal	3,130	2,970	-160
1967 - 1971	Wet	4,050	4,100	+50
1978 - 1980	Above Normal	4,080	4,080	0
1987 - 1990	Dry	1,930	1,930	0

Attachment G3

Development of Water Acquisition Methodology

Attachment G3

DEVELOPMENT OF WATER ACQUISITION METHODOLOGY

Water would be acquired from willing sellers in Alternatives 2, 3, and 4 and the associated Supplemental Analyses. Water was acquired to increase the instream flows towards the target flows identified for chinook salmon and steelhead in Attachment G4. The amount of water to be acquired would be limited by the willingness of water rights holders to sell their water and economic considerations.

The specific plans for water acquisitions need to be developed on a case-by-case basis. The water acquisitions may need to be approved by the State Water Resources Control Board. This approval process would require compliance with the State Water Code. The Water Code prevents transfers that would have an unreasonable impact on fish, wildlife, or instream uses (Water Code Sections 1025.5(b), 1725, 1736). The Water Code also prevents public agencies from conveying transferred water if fish, wildlife, or other beneficial instream uses are unreasonably affected or if the overall economy or environment in the county where the water originates would be unreasonably affected (Water Code Section 1810(d)). The State Water Resources Control Board may need to confirm that these adverse impacts would not occur prior to approval of the transfer. These conditions would require mitigation of potentially adverse economic impacts, including economic impacts, by the willing seller prior to consideration of purchase of the water under the water acquisition program.

Impacts which could occur to third parties if groundwater was used to replace the loss in surface water diversions due to the water acquisition would need to be considered. The additional use of groundwater would generally either increase the rate of groundwater overdraft or reduce water levels in adjacent rivers and streams. These impacts would not be allowed under the Draft PEIS water transfers analysis.

The water acquisition program also would be defined to avoid impacts to downstream water users. A portion of historical agricultural diversions have returned to the river during the irrigation season. These return flows in addition to the remaining river flows serve as water supplies to downstream users. When the water is acquired for increased flows during the non-irrigation season and the diversions during the irrigation season are reduced, flows in the river downstream of the sellers could be reduced unless a portion of the water acquisition is used to replace the loss of return flows. Therefore, the acquisition also included an amount of water to be released during the irrigation season to provide adequate water supplies to the downstream users.

In Alternatives 2 and 4 and the associated Supplemental Analyses, the water would be acquired for instream and Delta purposes, and could not be used to increase Delta exports by the CVP and SWP over exports determined in Alternative 1. In Alternative 3 and Supplemental Analysis 3a, the water would only be used to increase instream flows, and therefore could be used to increase CVP and SWP Delta exports if all other conditions allowed exports.

The following sections of Attachment G3 describe the methods used to define the amount of water to be acquired in Alternatives 2, 3, and 4 and the associated Supplemental Analyses.

ALTERNATIVE 2

The December 1995 Draft Restoration Plan identified priorities for flow improvements under AFRP. The first priority was the Delta. This priority was partially addressed through Reoperation and the use of (b)(2) water. The second priority was water acquisition on the upper Sacramento River tributaries. This water acquisition was included in Alternatives 2, 3, and 4. The third priority was the San Joaquin River tributaries. Therefore, acquisitions on these rivers were the focus of Alternative 2. The amount of water acquired under Alternative 2 was dependent upon available funding. As described in Chapter II of the Draft PEIS, funding estimates were developed for the non-flow actions to be completed under the alternatives. The remaining amount of funds available (assuming that $50 million (1992 dollars) was collected every year) was used for water acquisition. It was assumed that the cost of acquired water would reflect actions taken by users to reduce water demands.

For the purposes of this analysis, it is assumed that the maximum quantity of water to be acquired from each source would be the same in all years. This assumption approximates a condition of a long term acquisition agreement that would stipulate a maximum annual quantity. Depending on hydrologic conditions, the actual amount of water that would be acquired in any year could be less than the maximum quantity. The acquisition targets and long-term average acquisition quantities for water purchased from willing sellers for instream flows on the Stanislaus, Tuolumne, and Merced rivers in Alternative 2 are 60,000; 60,000; and 50,000 acre-feet/year, respectively. These target flows include pulse flow components on the Tuolumne and Merced rivers during April through June. Therefore, the primary emphasis for use of acquired water in Alternative 2 is during the months of April, May, and June. Alternative 2 also includes purchase of water on Sacramento River tributaries that support spring-run chinook salmon. The quantity for purchase is not quantified at this time.

Acquisition of water from willing sellers would be associated with reduced agricultural water use, and would therefore result in reduced return flows to downstream portions of the rivers. To avoid unintended impacts to downstream water users not involved in the sale or acquisition of water, base flow conditions would be maintained in portions of rivers that would be affected by the use of acquired water.

ALTERNATIVES 3 AND 4

In Alternatives 3 and 4, the amount for water acquisition was determined using the four criteria developed by the AFRP planning process to identify reasonable actions. The criteria included Biological Priorities, Water Availability, Cost of Water, and Fund Availability, as described below.

- **Biological Priorities -** Flows must be managed in a way to support biological priorities, including species and lifestages. Use of water for the lifestages of species of concern would be prioritized. Preliminary biological priorities developed through the AFRP process were used to prioritize use of acquired water and the (b)(2) Water.

- **Water Availability -** Flows must be physically available assuming existing facilities.

- **Cost of Water** - The costs of acquiring water are dependent upon the watershed and the use of the water by users. The marginal cost of water analysis was used in the initial analysis for determining the range of average annual quantities that could be acquired. It is assumed that the cost of acquired water would reflect actions taken by users to reduce water demands. Cost curves were developed for each river to evaluate cost per acre-foot acquired. The break-points in the cost curves were compared with biological priorities. For the purposes of the third phase of the screening process, water costs in excess of $150/acre-foot were considered to be high and possibly unreasonable on most rivers.

- **Fund Availability -** Most of the actions considered in the PEIS are funded through the Restoration Fund, nonreimbursable Federal funds, and State of California funds. The Restoration Fund collections are limited to a maximum of $50 million/year, and are frequently less due to limitations on CVP water deliveries. Therefore, the initial fund limitation was considered to be limited by the $50 million/year Restoration Fund limitation. However, other federal, state, and local programs are currently evaluating projects that are similar to programs included in the PEIS alternatives. As a result of other funding sources, the total funds available through all sources may be greater than $50 million/year. For this analysis, a total funding capability of about $100 - 120 million/year was considered to be "available" to fund the portions of the project to be funded by the "Restoration Fund". It was assumed that funds for all projects would be available.

The Biological Priorities were determined based upon the information presented in Attachment G4. For Alternatives 3 and 4, it was determined that water would be acquired on all rivers that had quantifiable target flows identified in the preliminary AFRP memoranda.

Water Availability was determined based upon early screening analyses, and further refined during the development of Alternatives 3 and 4. For the PEIS it has been assumed that water used by urban users and the State Water Project would not be available due to both cost and willingness of the sellers.

The Cost of Water and Fund Availability were key criteria in determining the amount of water to acquire under Alternatives 3 and 4.

Based upon these criteria, instream goals for water acquisition quantities for the major streams were developed in Alternatives 3 and 4, as summarized below. Water also was acquired on the upper Sacramento River tributaries that support spring-run chinook salmon, however quantities are not known at this time. It should be recognized that these may be upper limits, and that no water would be acquired if the water rights holders did not want to sell their water to Interior.

- Yuba River - 100,000 acre-feet
- Mokelumne River - 70,000 acre-feet
- Calaveras River - 40,000 acre-feet
- Stanislaus River - 200,000 acre-feet
- Tuolumne River - 200,000 acre-feet
- Merced River - 200,000 acre-feet

Water acquisitions were not included on the Sacramento or American rivers because such actions could not occur while maintaining compliance levels under the winter-run chinook salmon biological opinion or maintaining deliveries to municipal users.

Use of the acquired water was prioritized on each stream through comparison of the available water and associated storage, and the biological priorities identified by the Service (as presented in Attachment G4).

It was assumed that water would be acquired from agricultural water users on these rivers that possess diversion and storage rights. The acquired water would be stored during the period of a contract year, and released in a manner to increase flows toward the targets. It was assumed that acquired water would be stored and released from Lake McClure on the Merced River, New Don Pedro Reservoir on the Tuolumne River, New Melones Reservoir on the Stanislaus River, New Hogan Reservoir on the Calaveras River, Camanche Reservoir on the Mokelumne River, and New Bullards Bar Reservoir on the Yuba River.

The flow targets include spring pulse flow components on the Stanislaus, Tuolumne, and Merced rivers during April through June. Therefore, the primary emphasis for use of acquired water in Alternatives 3 and 4 is generally during the months of April, May, and June. Releases of acquired water during these months would also provide increased flows at Vernalis, which would contribute toward meeting the Bay-Delta Plan Accord pulse flow requirements, if a portion of the pulse was unmet due to lack of available CVP supplies.

Attachment G4

U.S. Fish And Wildlife Service
Draft Guidelines For Allocation of Water Acquired Pursuant to Section 3406(b)(3) of the CVPIA
(Memorandum of October 22, 1996)

Draft Guidelines for Allocation of Water Acquired Pursuant to Section 3406 (b)(3) of the Central Valley Project Improvement Act

A Tool for Use in Developing an Implementation Plan for the Water Acquisition Program and in Developing a New Alternative for the Programmatic Environmental Impact Statement

Prepared for distribution at a public workshop
by the Anadromous Fish Restoration Program of the
United States Fish and Wildlife Service.

October 22, 1996

PREFACE

The Central Valley Project Improvement Act (CVPIA) directs the Secretary of the Interior to develop and implement "a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967-1991" (Section 3406(b)(1)). This program is known as the Anadromous Fish Restoration Program (AFRP).

The CVPIA also directs the Secretary to develop and implement a program for the acquisition of water to contribute to at least doubling the natural production of anadromous fish. This program is known as the Water Acquisition Program.

We developed this document to handout following a public workshop held on October 23, 1996 in Sacramento. The objective of the workshop was to present and discuss our approach to developing flow scenarios that might be achieved through water acquisition for streams on which Central Valley Project structures do not control flows (non-CVP streams). Three programs authorized by the CVPIA are involved in developing these flow scenarios. These are the AFRP, the Water Acquisition Program, and the Programmatic Environmental Impact Statement. Each of these has a specific role in the process. The workshop focused on the role of the AFRP, specifically on our approach to developing draft guidelines for allocation of acquired water. This handout contains the initial drafts of guidelines for the Feather, Bear, Yuba, Mokelumne, Calaveras, Merced, Tuolumne, and Stanislaus rivers. The intention of both the workshop and this handout is to initiate discussion with interested parties on the approach and guidelines, with the objective of improving the approach and guidelines.

We invite your comments on the approach and guidelines. For your comments on the approach to be considered for incorporation in the final Anadromous Fish Restoration Plan (scheduled to be released in December), we will need to receive them by November 29, 1996. We intend to use the guidelines to help develop a long-term implementation plan for the Water Acquisition Program in early 1997, and therefore the deadline for comments on the draft guidelines will occur sometime in early 1997.

We are available to answer questions about the approach and to meet with those individuals or groups that want to discuss the guidelines for an individual stream. If you need more information or are interested in meeting with us, call or write us and express your interest and needs. To reach us, contact:

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DRAFT GUIDELINES FOR ALLOCATION OF ACQUIRED WATER FOR EACH STREAM

LOWER SACRAMENTO RIVER AND DELTA TRIBUTARIES

Feather River

Feather River stream flows are regulated primarily by water released from Oroville Dam and Thermalito Afterbay, facilities of CDWR State Water Project (SWP). The Yuba and Bear rivers contribute flows to the lower Feather River. Fall- and spring-run chinook salmon, steelhead, striped bass, American shad, and white and green sturgeon are found in the Feather River. Flow standards were established by a FERC licence to CDWR and an agreement between CDWR and CDFG. Flow recommendations were provided by the CDFG and USFWS.

Species and life-history stage priorities

Fall- and spring-run chinook salmon, steelhead, striped bass, American shad, and white and green sturgeon are present in the Feather River. Because spring-run chinook salmon have unknown restoration potential and questionable genetic integrity in the Feather River (CDFG 1996a) and because the CDFG do not note management objectives for steelhead in the Feather River (CDFG 1996b), we considered fall-run chinook salmon the primary species of concern. Needs for anadromous, non-salmonids are less well know than those for salmonids. We assumed that the needs for non-salmonids could be partially met by meeting the needs of fall-run chinook salmon. Table 1 prioritizes life-history stages for use in conjunction with the existing standards to generate guidelines for allocation of acquired water in the Feather River.

Table 1. Draft water allocation priorities for acquired water on the Feather River. The time periods in parentheses in the life-history stage column are approximate time periods when that life-history stage is present in the river. Actual time periods vary, dependent on run-timing, environmental conditions, and rate of development.

Priority	Life-history stage	Objective
1	Spawning and incubation (October through December)	Improve attraction flows and provide adequate water temperatures for fall-run chinook salmon migrating into and spawning and incubating in the Feather River.
3	Incubation and rearing (January through March)	Improve spawning, incubating, and rearing flows and related habitat conditions for fall-run chinook salmon, and benefit sturgeon, striped bass, and American shad.
2	Rearing and outmigration (April through May)	Improve rearing and outmigration flows and related habitat conditions and provide adequate temperatures for fall-run chinook salmon in the Feather River; and contribute to improved conditions for survival of fall-run chinook salmon migrating through the lower Sacramento River and the Delta, and benefit other riverine and estuarine species, including other anadromous fish, through contribution to Sacramento River flows and Delta outflows.
4	Over-summering (June through September)	Improve rearing habitat for over-summering juvenile chinook salmon and steelhead.

White and green sturgeon and American shad were also considered in allocating acquired water. For sturgeon, water is allocated during February-May to first provide conditions suitable for adult migration (February and March), and then to improve conditions for juvenile survival (April and May). For American shad, water is allocated during April-June to first provide conditions suitable for spawning (April and May), and then to improve conditions for survival of eggs and larvae (June). Flow needs for striped bass in the Feather River were not identified (USFWS 1995)

Existing standards

The CDWR was licenced to operate the Oroville Project by FERC (Project No. 2100) in 1957. The FERC licence was amended in 1964, 1966, 1968, 1977, and 1982 (Agreement between CDWR and CDFG concerning the operation of the Oroville Division of the State Water Project for management of fish and wildlife, 26 August 1983). In 1983, CDWR and CDFG revised a 1967 agreement that provided minimum flows for fish and wildlife and complies with the FERC licence. We considered flows provided by the 1983 agreement the existing standard for the Feather River.

Power is generated from water released from Oroville Dam and diverted into Thermalito Power Canal and another powerhouse. The diverted water then flows into Thermalito Afterbay and enters the Feather River through the Thermalito Afterbay outlet. The reach of the Feather River between the power canal and Thermalito Afterbay is known as the low-flow channel. Increasing flow in the low-flow channel reduces power generation at the Thermalito Power Canal.

1983 CDWR-CDFG agreement: The 1983 agreement established standards at two locations in the Feather River. One location is the low-flow channel between Thermalito Diversion Dam and the outlet of Thermalito Afterbay, and the other location is the reach downstream of the outlet of Thermalito Afterbay to the Sacramento River confluence at Verona.

The agreement stipulated a minimum flow of 600 cfs in the low-flow channel, which results in an annual release of about 434,000 af. In the reach downstream of Thermalito Afterbay outlet, the agreement provided two minimum flow schedules. The schedules are based on unimpaired runoff of the Feather River near Oroville for April through June the preceding year and storage in Oroville Reservoir. Provided that normal operations and the appropriate minimum flow schedule would not reduce storage below about 1,500,000 af, the first schedule would result in an annual release of about 784,000 af when forecasted runoff is less than 55% of normal, and the second schedule would result in an annual release of about 977,000 when forecasted runoff is 55% or greater than normal. Normal runoff was defined as mean April through July unimpaired runoff for 1911 through 1960, 1,942,000 af. The first schedule (runoff less than 55% normal) would apply when forecasted runoff is less than 60% of normal for two or more consecutive water years. Both flow schedules stipulated flows for three time periods, October through February, March, and April through September.

The agreement provided for reductions in minimum flows downstream of Thermalito Afterbay outlet if the 1 April runoff forecast indicates that storage would fall below about 1,500,000 af under normal operation of Oroville Reservoir. Minimum flows would be reduced proportional to reductions in deliveries, up to a maximum of 25%.

In addition to the minimum flow in the low-flow channel and the two minimum flow schedules downstream of Thermalito Afterbay outlet, the agreement also provides objectives, additional conditions, and flexibility in minimum releases. Additional conditions are contingent on existing conditions and flexibility in minimum releases require concurrence between the CDWR and CDFG. Objectives for CDWR are the provision of suitable water temperatures for fall-run chinook salmon no later than 15 September and the provision of suitable water temperatures for American shad, striped bass, and other warm water fish downstream of Thermalito Afterbay outlet and between 1 May and 1 September. Additional conditions concern flow fluctuations and guidelines to maintain flows in excess of the standard that are contingent on flow events. With concurrence of CDWR, CDFG has the option to exercise flexibility in releases of water from Thermalito Afterbay from April through June. Water may be released in a fluctuating pattern to assist emigration of salmonids.

Recommendations

Minimum flow recommendations for the Feather River were made by CDFG (1993) and the USFWS identified flow needs in the AFRP Working Paper (USFWS 1995).

California Department of Fish and Game: The CDFG (1993) provides recommendations measured at two locations, the riffle one mile below Thermalito Afterbay outlet and Shanghai Bend. Shanghai Bend is downstream of the Yuba River confluence with the Feather River but upstream of the Bear River confluence. For our purposes here, we assumed that upstream recommendations were to primarily benefit salmonids, and recommendations downstream of the Yuba River were to benefit non-salmonids. In addition to minimum flows recommendations, CDFG (1993) recommended water temperatures at both locations. The recommendations consist of a flow schedule for each location.

AFRP Working Paper: The AFRP Working Paper (USFWS 1995) identified flow needs at three locations, the low-flow channel, Gridley, and Nicolaus. Gridley is downstream of Thermalito Afterbay outlet, but relatively close to the riffle one mile downstream of the outlet noted in CDFG (1993). Nicolaus is in the lowest reach of the Feather River downstream of the Bear River confluence. Flows to benefit salmonids are identified for the low-flow channel and at Gridley, needs for white and green sturgeon are identified at Gridley and Nicolaus, and needs for American shad identified at Nicolaus.

For the low-flow channel, the AFRP Working Paper needs are based on an IFIM study conducted by CDWR and CDFG. Needs are presented as flows to be used in evaluations (USFWS 1995), because there was uncertainty about the appropriate assumptions pertaining to water-depth preferences of spawning salmonids made in the IFIM study. Therefore, the needs contain two flow schedules, each to evaluate assumptions about water-depth preferences. Schedule B provides a constant flow of 800 cfs, assuming that salmonids prefer to spawn at a water depth of 1.5 feet. Schedule A provides higher flows (800-1700 cfs and 1,100-2,500 cfs, for critical-dry and below normal-wet water years, respectively), assuming that salmonids prefer to spawn at water depths greater than or equal to 1.5 feet.

Needs for salmonids at Gridley were based on a draft instream flow report by CDWR and assumptions that increased flows would improve habitat maintenance (e.g., reduce vegetation encroachment) and water temperature. The AFRP Working Paper proposed that an IFIM study should be completed to evaluate the flows (USFWS 1995). The needs consist of monthly flows for three water-year types.

Flow needs for white and green sturgeon are identified at Gridley and Nicolaus. They were calculated using a year-class index and February through May mean monthly flow at gaging stations in rivers with sturgeon. The year-class index was derived from sturgeon data collected at the SWP salvage facility, and classified as indicating either a good or poor recruitment year. Generally, the lowest mean monthly flow for a good recruitment year was adopted as the flow need for the various gaging stations. Needs apply only to above normal and wet water years.

Flow needs for American shad are presented at Nicolaus, and were calculated using historic Delta inflow from April through June and data from the CDFG midwater trawl for young-of-the-year. Delta inflow for years in which American shad exceeded the AFRP production target (1974 and 1982) was identified. For these years, mean Delta inflow was scaled to mean unimpaired flow and apportioned to rivers in which American shad spawn to produce flow needs. Flow needs are identified for five water-year types.

Draft guidelines for allocation of acquired water

The flowing tables contain draft guidelines for allocation of acquired water. Because water acquired from CDWR can be released at two locations, upstream and directly downstream of the low-flow channel, and because standards and recommendations apply to several locations and anadromous fish species, we allocated water primarily at three reaches of the Feather River, the low-flow channel, downstream of Thermalito Afterbay outlet, and Nicolaus.

Table 2 allocates water in the low-flow channel for fall-run chinook salmon. Tables 3 through 5 allocates water directly downstream of Thermalito Afterbay outlet primarily for fall-run chinook salmon and also for sturgeon. A table is developed for using each of the existing standards, flow schedule for less than 55% normal forecasted runoff with a maximum 25% reduction in all months, flow schedule for less than 55% normal forecasted runoff, and flow schedule for 55% normal or greater forecasted runoff. We made no assumptions concerning flows from the low-flow channel, and considered flow recommendations measured at the riffle one mile downstream of Thermalito Afterbay outlet (CDFG 1993) and at Gridley (USFWS 1995).

Table 6 allocates water primarily at Nicolaus for non-salmonids. However, the table also includes recommendations made for Shanghai Bend (CDFG 1993). We assumed that flows in tables 3 through 5 would be achieved before allocations in Table 6 would be made. The total volume of water in the Feather River resulting from satisfying recommendations in tables 3 through 5 is 2,713,000 af. Therefore, the volumes of acquired water in Table 6 are in addition to that needed to satisfy tables 3 through 5. We acknowledge that flows from the Yuba and Bear rivers would contribute to Feather River flows at Nicolaus, for which existing standards range from 126,000 to 174,000 af for the Yuba River and the existing standard is 10,000 af for the Bear River. However, we do not account for Yuba and Bear river flows in Table 6.

Table 2. Draft guidelines for allocation of acquired water for use in the low-flow channel of the Feather River. The time periods in parentheses in the targeted life-history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Feather River. The block of water will be managed to maximize benefits to anadromous fish, both in the Feather River and downstream, and in coordination with downstream water managers.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	36	36	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule B.
2	Rearing and outmigration (April through May)	24	60	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule B.
3	Incubation and rearing (January through March)	36	96	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule B.
4	Over-summering (June through September)	48	144	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule B.
5	Spawning and incubation (October through December)	165	309	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule A during critical and dry water years.
6	Rearing and outmigration (April through May)	109	418	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule A during critical and dry water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
7	Incubation and rearing (January through March)	160	578	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule A during critical and dry water years.
8	Over-summering (June through September)	54	632	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule A during critical and dry water years.
9	Spawning and incubation (October through December)	146	778	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule A during below normal, above normal, and wet water years.
10	Rearing and outmigration (April through May)	157	935	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule A during below normal, above normal, and wet water years.
11	Incubation and rearing (January through March)	143	1078	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule A during below normal, above normal, and wet water years.
12	Over-summering (June through September)	102	1180	AFRP Working Paper (USFWS 1995) minimum releases in low-flow channel schedule A during below normal, above normal, and wet water years.

Table 3. Draft guidelines for allocation of acquired water for the Feather River downstream of the outlet of Thermalito Afterbay with an existing standard for less than 55% normal forecasted runoff and 25% reduction in all months. The time periods in parentheses in the targeted life-history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Feather River. The block of water will be managed to maximize benefits to anadromous fish, both in the Feather River and downstream, and in coordination with downstream water managers. Note that allocations are made for sturgeon under priorities 15 and 16.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	55	55	Existing standard for unimpaired runoff less than 55% of normal and forecasted storage greater than 1,500,000 af.
2	Rearing and outmigration (April through May)	30	85	Existing standard for unimpaired runoff less than 55% of normal and forecasted storage greater than 1,500,000 af.
3	Incubation and rearing (January through March)	50	135	Existing standard for unimpaired runoff less than 55% of normal and forecasted storage greater than 1,500,000 af.
4	Over-summering (June through September)	60	195	Existing standard for unimpaired runoff less than 55% of normal and forecasted storage greater than 1,500,000 af.
5	Spawning and incubation (October through December)	91	286	Existing standard for unimpaired runoff greater than 55% of normal and forecasted storage greater than 1,500,000 af.
6	Incubation and rearing (January through March)	102	388	Existing standard for unimpaired runoff greater than 55% of normal and forecasted storage greater than 1,500,000 af.
7	Rearing and outmigration (April through May)	133	521	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during critical and dry water years.
8	Over-summering (June through September)	24	545	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during critical and dry water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
9	Rearing and outmigration (April through May)	81	626	CDFG (1993) recommended minimum releases at riffle one mile below outlet of Thermalito Afterbay.
10	Incubation and rearing (January through March)	54	680	CDFG (1993) recommended minimum releases at riffle one mile below outlet of Thermalito Afterbay.
11	Over-summering (June through September)	65	745	CDFG (1993) recommended minimum releases at riffle one mile below outlet of Thermalito Afterbay.
12	Spawning and incubation (October through December)	146	891	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during below normal, above normal, and wet water years.
13	Rearing and outmigration (April through May)	28	919	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during below normal, above normal, and wet water years.
14	Incubation and rearing (January through March)	89	1008	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during below normal, above normal, and wet water years.
15	Adult sturgeon migration and spawning (February through March)	526	1534	AFRP Working Paper (USFWS 1995) minimum releases for sturgeon at Gridley during above normal and wet water years.
16	Juvenile sturgeon survival (April through May)	484	2018	AFRP Working Paper (USFWS 1995) minimum releases for sturgeon at Gridley during above normal and wet water years.

Table 4. Draft guidelines for allocation of acquired water for the Feather River downstream of the outlet of Thermalito Afterbay with an existing standard for less than 55% normal forecasted runoff. The time periods in parentheses in the targeted life-history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the

benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Feather River. The block of water will be managed to maximize benefits to anadromous fish, both in the Feather River and downstream, and in coordination with downstream water managers. Note that allocations are made for sturgeon under priorities 11 and 12.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	91	91	Existing standard for unimpaired runoff greater than 55% of normal and forecasted storage greater than 1,500,000 af.
2	Incubation and rearing (January through March)	102	193	Existing standard for unimpaired runoff greater than 55% of normal and forecasted storage greater than 1,500,000 af.
3	Rearing and outmigration (April through May)	133	326	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during critical and dry water years.
4	Over-summering (June through September)	24	350	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during critical and dry water years.
5	Rearing and outmigration (April through May)	81	431	CDFG (1993) recommended minimum releases at riffle one mile below outlet of Thermalito Afterbay.
6	Incubation and rearing (January through March)	54	485	CDFG (1993) recommended minimum releases at riffle one mile below outlet of Thermalito Afterbay.
7	Over-summering (June through September)	65	550	CDFG (1993) recommended minimum releases at riffle one mile below outlet of Thermalito Afterbay.
8	Spawning and incubation (October through December)	146	696	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during below normal, above normal, and wet water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
9	Rearing and outmigration (April through May)	28	724	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during below normal, above normal, and wet water years.
10	Incubation and rearing (January through March)	89	813	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during below normal, above normal, and wet water years.
11	Adult sturgeon migration and spawning (February through March)	526	1339	AFRP Working Paper (USFWS 1995) minimum releases for sturgeon at Gridley during above normal and wet water years.
12	Juvenile sturgeon survival (April through May)	484	1823	AFRP Working Paper (USFWS 1995) minimum releases for sturgeon at Gridley during above normal and wet water years.

Table 5. Draft guidelines for allocation of acquired water for the Feather River downstream of the outlet of Thermalito Afterbay with an existing standard for 55% normal or greater forecasted runoff. The time periods in parentheses in the targeted life-history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Feather River. The block of water will be managed to maximize benefits to anadromous fish, both in the Feather River and downstream, and in coordination with downstream water managers. Note that allocations are made for sturgeon under priorities 9 and 10.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Rearing and outmigration (April through May)	133	133	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during critical and dry water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
2	Over-summering (June through September)	24	157	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during critical and dry water years.
3	Rearing and outmigration (April through May)	81	238	CDFG (1993) recommended minimum releases at riffle one mile below outlet of Thermalito Afterbay.
4	Incubation and rearing (January through March)	54	292	CDFG (1993) recommended minimum releases at riffle one mile below outlet of Thermalito Afterbay.
5	Over-summering (June through September)	65	357	CDFG (1993) recommended minimum releases at riffle one mile below outlet of Thermalito Afterbay.
6	Spawning and incubation (October through December)	146	503	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during below normal, above normal, and wet water years.
7	Rearing and outmigration (April through May)	28	531	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during below normal, above normal, and wet water years.
8	Incubation and rearing (January through March)	89	620	AFRP Working Paper (USFWS 1995) minimum releases for chinook salmon at Gridley during below normal, above normal, and wet water years.
9	Adult sturgeon migration and spawning (February through March)	526	1146	AFRP Working Paper (USFWS 1995) minimum releases for sturgeon at Gridley during above normal and wet water years.
10	Juvenile sturgeon survival (April through May)	484	1630	AFRP Working Paper (USFWS 1995) minimum releases for sturgeon at Gridley during above normal and wet water years.

Table 6. Draft guidelines for allocation of acquired water for the Feather River at Shanghai Bend and Nicolaus, assuming that allocations in tables 3 through 5 have been satisfied. The time periods in parentheses in the targeted life-history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of white and green sturgeon and American shad in the Feather River. The block of water will be managed to maximize benefits to anadromous fish, both in the Feather River and downstream, and in coordination with downstream water managers.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Early adult migration (January)	12	12	CDFG (1993) recommended minimum releases at Shanghai Bend to benefit non-salmonids.
2	Juvenile survival (July through August)	159	171	CDFG (1993) recommended minimum releases at Shanghai Bend to benefit non-salmonids.
3	Adult migration and spawning (February through March)	527	698	AFRP Working Paper (USFWS 1995) minimum releases for sturgeon at Nicolaus during above normal and wet water years.
4	Juvenile survival (April through May)	544	1242	AFRP Working Paper (USFWS 1995) minimum releases for sturgeon at Nicolaus during above normal and wet water years.
5	Survival of eggs and larvae (June)	8	1250	AFRP Working Paper (USFWS 1995) minimum releases for American shad at Nicolaus during below normal water years.
6	Adult attraction and spawning (April through May)	29	1279	AFRP Working Paper (USFWS 1995) minimum releases for American shad at Nicolaus during above normal water years.
7	Survival of eggs and larvae (June)	47	1326	AFRP Working Paper (USFWS 1995) minimum releases for American shad at Nicolaus during above normal water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
8	Adult attraction and spawning (April through May)	673	1999	AFRP Working Paper (USFWS 1995) minimum releases for American shad at Nicolaus during wet water years.
9	Survival of eggs and larvae (June)	304	2303	AFRP Working Paper (USFWS 1995) minimum releases for American shad at Nicolaus during wet water years.

Yuba River

The following tables present priorities (Table 1) and draft guidelines (Tables 2 through 5) for allocation of acquired water on the Yuba River for all water year types specified in the existing standard for mimimum instream flows. The primary species of concern are fall-run chinook salmon, steelhead trout, and American shad. Water allocation guidelines focus specifically on benefiting life history needs of these species in addition to ancillary downstream benefits to anadromous fish in the Sacramento River and Delta (Table 1).

For the following guidelines we consider the 1965 existing fisheries agreement between the California Department of Fish and Game (CDFG) and the Yuba County Water Agency (YCWA) as our baseline to allocate to, given that water is available and can be acquired. In addition to the 1965 standard described below, we consider four additional minimum instream flow alternatives that we use as guidance for allocating acquired water by water-year type (tables 2 through 5). The four alternatives are: 1) YCWA (Beak 1996, Draft Anadromous Fish Enhancement Actions Recommended for the Lower Yuba River), 2) CDFG 1991 (CDFG 1991, Lower Yuba River Fisheries Management Plan), 3) Federal Energy Regulatory Commission (FERC) staff, 1992 (FERC 1992, Environmental Assessment for Hydropower Licence) and, 4) the Anadromous Fish Restoration (AFRP) Working Paper (USFWS 1995). The guidelines for each of the water-year types are bracketed on the lower end by the 1965 standard for the year type and on the upper end by the AFRP Working Paper flows that apply to the year type. Although the allocation tables use the designated standards as the foundation that we add acquired water to, we expect that both the PEIS and the water acquisition program will consider the existing conditions to be the foundation. Likewise, we expect that the upper-end bracket will be determined by the PEIS estimate of the amount of water available for acquisition, rather than by the Working Paper flows.

Species and life-history stage priorities

Table 1. Draft water allocation priorities for (b)(3) water on the Yuba River. The time periods in parentheses in the life-history stage column are approximate time periods when that life-history stage is present in the river. Actual time periods vary, dependent on run-timing, environmental conditions, and rate of development.

Priority	Life-history stage	Objective
1	Spawning and incubation (October through December)	Improve attraction flows and water temperatures for fall-run chinook salmon and steelhead migrating into and spawning and incubating in the Yuba River.
3	Incubation and rearing (January through March)	Improve spawning, incubating, and rearing flows and related habitat conditions for fall-run chinook salmon and steelhead, and benefit sturgeon, striped bass, and other species through contribution to Sacramento River flows and Delta outflows.
2	Rearing and outmigration (April through May)	Improve rearing and outmigration flows and related habitat conditions and provide adequate temperatures for fall-run chinook salmon in the Yuba River; and contribute to improved migration and spawning conditions for American shad. Also, contribute to improved conditions for survival of Sacramento basin fall-run chinook salmon migrating through the Sacramento River and the Delta, and benefit other riverine and estuarine species, including other anadromous fish, through contribution to Sacramento River flows and Delta outflows.
4	Over-summering (June through September)	Improve rearing habitat for over-summering juvenile chinook salmon and steelhead.

Existing standards

1965 Agreement between the CDFG and the YCWA: The existing standard is defined in the 1965 agreement between the Yuba County Water Agency (YCWA) and the California Department of Fish and Game (CDFG); this standard specifies minimum water releases from Englebright Reservoir to maintain in the Yuba River immediately below Daguerre Point Dam. The standard only identifies one instream flow schedule to be met in normal and above water year types. Normal and above is defined as an April 1 Department of Water Resources (DWR) water-year projection that is 51% or greater than the historical streamflow average at Smartville. Guidance for reduction in the fisheries flows is given for what the standard identifies as critical dry years as follows: 46%

to 50% of a normal water year, then 15% reduction in water releases; 41% to 45% of a normal water year, then 20% reduction in water releases; and 40% or less of a normal water year, then 30% reduction in water releases. We consider each of the ranges as separate below-normal water year types. Percent streamflow reduction is allocated equitably among months for each month of the below normal water-year types, however, flow reductions may not decrease below a minimum of 70 cubic feet per second (cfs). In addition to the fore-described standard, the 1965 agreement specifies an additional range of minimum flows below Englebright Dam for the period of October 16 through January 15. However, we only use the specified minimum flows targeted below Daguerre Point Dam as part of our standard, and assume that the additional range of flows will be accounted in the predicted existing conditions by either the PEIS process or the water acquisition program.

FERC 1993 Order Issuing New License to Pacific Gas and Electric (PG&E) for continued operation of the Narrows Project: This additional standard, or an adaptively managed standard, is described in the 1993 Federal Energy Regulatory Commission (FERC) Re-licensing Order to Pacific Gas and Electric (PG&E) for their Narrows Project, number 1403-004. The order requires that PG&E supplement YWCA's project releases with up to 45,000 acre-feet (af) per year from its reservoir storage to help maintain minimum flows recommended by the CDFG in their 1991 management plan. Differing from the above standard, compliance location is specified for the Smartville gage and not Marysville, as recommended by CDFG. The FERC order gives the conditions when this standard applies, but in general, release of this water will occur when Englebright Reservoir storage exceeds 60,000 af, or when PG&E is entitled to dispatch releases of water from New Bullards Bar Reservoir per their power purchase agreement with YCWA. This standard is not used in the following allocation guidelines because we could not predict when and how it would be applied. Although we were unable to include this portion of the standard in the following tables, it is important that this 45,000 af be accounted for as part of the existing standard in allocating acquired water.

Recommendations

YCWA: The YCWA alternative for minimum flows, specified for the Marysville gage, uses stage and discharge and weighted usable area (WUA) relationships, based on fisheries studies conducted by Beak Consultants from 1986 to 1988, a water temperature model developed by Bookman-Edmunston Engineering, Inc. (1992), and operational constraints to maximize available water by year type for fall-run chinook salmon and steelhead life history requirements. Salmon life stage requirements are prioritized by two time periods, first is spawning and incubation (October 15 through March 31), and second is rearing and out-migration (April through June). The YCWA recommends minimum instream flows at Marysville for six water-year types in the draft report. They define water-year type using an index derived from the comparison of estimated annual and historical (1922 to 1992) unimpaired runoff at the Smartville gage. The annual 60:40 index is a weighted average of the percent of annual runoff to average historical runoff in the snowmelt period, April through July, weighted 60%; averaged with the percent of annual runoff to historical runoff for the entire year, weighted 40%. Using this index, two water-year allocations account for "normal and above" conditions and four water-year allocations are specified for below normal water years. Allocation within a water year first looks to achieve water temperature targets set at Marysville, and secondarily at Daguerre Point Dam from June through October 14 if the Marysville temperature criteria cannot be met. Secondly, an attempt to maximize physical habitat (≥90% of the maximum WUA value) for a given salmon life-history stage, within the range of flows that could meet the water temperature targets was determined using a stepwise iterative process.

CDFG: In their Lower Yuba River Fisheries Management Plan (CDFG 1991), the CDFG recommended instream flows at Marysville for normal and wetter water-years. Similar to the YCWA recommendation, CDFG's minimum flow recommendation targets specific benefits for fall-run chinook salmon and steelhead and secondarily for American shad, recognizing that there is little conflict between the needs for shad and salmon and steelhead. The CDFG based their water-year type designations on a comparison of the estimated unimpaired runoff at the Smartville gage for the current year, as reported in the May 1 Report of Water Conditions in California by the DWR. For below normal water years CDFG states that reductions to the recommended fishery flows shall be made, but does not specify how water would be allocated for fish in these water-year types, other than equitable reductions to for all users. CDFG's minimum flow recommendations derive from integrating information from a three-year study that included basic fisheries investigations; Instream Flow Incremental Methodology (IFIM), to determine salmon life-stage physical habitat requirements; and temperature modeling, coupled with Pacific coast anadromous fish temperature requirements. CDFG's recommendation hinges on balancing physical habitat requirements (WUA and streamflow indices) for overlapping life history stages with other concurrent fish needs such as maintenance of flows to prevent redd de-watering, juvenile standing, and juvenile out-migration.

FERC staff: FERC staff recommended minimum instream flows in their 1992 Environmental Assessment (EA) for the Narrows Project. Although FERC specified that these minimum fisheries flows were to be met below Englebright Reservoir, we generated a Marysville flow equivalent using a conversion factor generated from averaged mean monthly flows for a range of percent exceedence levels (0%, 10%, 50%, 90% and 100%) from both locations. This conversion is based on conditions that existed from 1970 to 1990, and may differ from future conditions if project operations change. Their recommendation started with the maximum and minimum flow boundaries proposed in CDFG's 1991 recommendation, the release capacity of the Narrows Project, and CDFG's WUA curves by life stage to produce a flow schedule that they felt would enhance the fishery relative to existing conditions. The recommendation is for all water-year types and considers all three anadromous species in the system.

AFRP Working Paper: The AFRP Working Paper recommends two sets of minimum instream flows, one set for salmon and steelhead and another for shad. The shad recommendation allocates water in addition to salmon flows during the April through May period for shad attraction, migration and spawning. The shad recommendation is divided into five water-year types of wet, above-normal, below-normal, dry, and critical; the salmon recommendation serves all water-year types. Water-year types for salmon and shad recommendations are based on the Sacramento River Index used in the State Water Resources Control Board (SWRCB) Draft Water Right Decision 1630. Flows for October through January are based on the water-year type for the previous year.

Draft guidelines for allocation of acquired water

Table 2. Guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Yuba River for water years 40% or less of normal.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
1	Spawning and incubation (October through December)	7	7	1965 standard for minimum instream flows below Daguerre Point Dam for a 41% to 45% of normal water year, agreement between the California Department of Fish and Game and the Yuba County Water Agency (YCWA).
2	Rearing and outmigration (April through May)	3	10	1965 standard for minimum instream flows below Daguerre Point Dam for a 41% to 45% of normal water year.
3	Incubation and rearing (January through March)	4	14	1965 standard for minimum instream flows below Daguerre Point Dam for a 41% to 45% of normal water year.
4	Over-summering (June through September)	1	15	1965 standard for minimum instream flows below Daguerre Point Dam for a 41% to 45% of normal water year.
5	Spawning and incubation (October through December)	4	19	1965 standard for minimum instream flows below Daguerre Point Dam for a 46% to 50% of normal water year.
6	Rearing and outmigration (April through May)	1	20	1965 standard for minimum instream flows below Daguerre Point Dam for a 46% to 50% of normal water year.
7	Incubation and rearing (January through March)	2	22	1965 standard for minimum instream flows below Daguerre Point Dam for a 46% to 50% of normal water year.
8	Over-summering (June through September)	1	23	1965 standard for minimum instream flows below Daguerre Point Dam for a 46% to 50% of normal water year.
9	Spawning and incubation (October through December)	11	34	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.
10	Rearing and outmigration (April through May)	4	38	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
11	Incubation and rearing (January through March)	7	45	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.
12	Over-summering (June through September)	2	47	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.
13	Rearing and outmigration (April through May)	19	66	YCWA's 1996 recommended lower Yuba River minimum instream flow at Marysville for a below-normal water year, (as cited in the Anadromous Fish Enhancement Actions Recommended for the Lower Yuba River, prepared by Beak Consultants, Incorporated, 1996).
14	Incubation and rearing (January through March)	28	94	YCWA's 1996 recommended minimum instream flow for extra critical water years.
15	Over-summering (June through September)	12	106	YCWA's 1996 recommended minimum instream flow for extra critical and critical water years.
16	Spawning and incubation (October through December)	5	111	Federal Energy Regulatory Commission (FERC), 1992 staff recommendation for minimum instream flow for all water year types, Environmental Assessment (EA) for Hydropower License, Narrows Project, FERC Project Number 1403-004, California.
17	Rearing and outmigration (April through May)	14	125	FERC, 1992 staff recommendation for minimum instream flow for all water year types.
18	Incubation and rearing (January through March)	9	134	FERC, 1992 staff recommendation for minimum instream flow for all water year types.
19	Over-summering (June through September)	3	137	YCWA's 1996 recommended minimum instream flow for below-normal water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
20	Spawning and incubation (October through December)	13	150	YCWA's 1996 recommended minimum instream flow for normal water years.
21	Rearing and outmigration (April through June)	56	206	YCWA's 1996 recommended minimum instream flow for normal water years.
22	Incubation and rearing (January through March)	9	215	YCWA's 1996 recommended minimum instream flow for normal water years.
23	Over-summering (June through September)	56	271	FERC, 1992 staff recommendation for minimum instream flow for all water year types.
24	Spawning and incubation (October through December)	30	301	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
25	Rearing and outmigration (April through June)	64	365	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
26	Incubation and rearing (January through March)	36	401	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
27	Over-summering (July through September)	45	446	YCWA's 1996 recommended minimum instream flow in a normal water year.
28	Spawning and incubation (October through December)	7	453	AFRP Working Paper (USFWS 1995) minimum releases in a critical water year, without releases targeted specifically for American shad.
29	Rearing and outmigration (April through June)	120	573	AFRP Working Paper (USFWS 1995) minimum releases in a critical water year, including releases targeted specifically for American shad.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
30	Over-summering (July through September)	28	601	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
31	Rearing and outmigration (April through June)	218	819	AFRP Working Paper (USFWS 1995) minimum releases in a dry water year, including releases targeted specifically for American shad.
32	Over-summering (July through September)	228	1047	YCWA's 1996 recommended minimum instream flow in a wet water year.
33	Rearing and outmigration (April through June)	218	1265	AFRP Working Paper (USFWS 1995) minimum releases in a below-normal water year, including releases targeted specifically for American shad.
34	Rearing and outmigration (April through June)	109	1374	AFRP Working Paper (USFWS 1995) minimum releases in an above-normal water year, including releases targeted specifically for American shad.
35	Rearing and outmigration (April through June)	266	1640	AFRP Working Paper (USFWS 1995) minimum releases in a wet water year, including releases targeted specifically for American shad.

Table 3. Guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Yuba River for water years 41% to 45% of normal.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
1	Spawning and incubation (October through December)	4	4	1965 standard for minimum instream flows below Daguerre Point Dam for a 46% to 50% of normal water year, agreement between the California Department of Fish and Game and the Yuba County Water Agency (YCWA).
2	Rearing and outmigration (April through May)	1	5	1965 standard for minimum instream flows below Daguerre Point Dam for a 46% to 50% of normal water year.
3	Incubation and rearing (January through March)	2	7	1965 standard for minimum instream flows below Daguerre Point Dam for a 46% to 50% of normal water year.
4	Over-summering (June through September)	1	8	1965 standard for minimum instream flows below Daguerre Point Dam for a 46% to 50% of normal water year.
5	Spawning and incubation (October through December)	11	19	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.
6	Rearing and outmigration (April through May)	4	23	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.
7	Incubation and rearing (January through March)	7	30	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.
8	Over-summering (June through September)	2	32	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.
9	Rearing and outmigration (April through May)	19	51	YCWA’s 1996 recommended lower Yuba River minimum instream flow at Marysville for a below-normal water year, (as cited in the Anadromous Fish Enhancement Actions Recommended for the Lower Yuba River, prepared by Beak Consultants, Incorporated, 1996).
10	Incubation and rearing (January through March)	28	79	YCWA’s 1996 recommended minimum instream flow for extra critical water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
11	Over-summering (June through September)	12	91	YCWA's 1996 recommended minimum instream flow for extra critical and critical water years.
12	Spawning and incubation (October through December)	5	96	Federal Energy Regulatory Commission (FERC), 1992 staff recommendation for minimum instream flow for all water year types, Environmental Assessment (EA) for Hydropower License, Narrows Project, FERC Project Number 1403-004, California.
13	Rearing and outmigration (April through May)	14	110	FERC, 1992 staff recommendation for minimum instream flow for all water year types.
14	Incubation and rearing (January through March)	9	119	FERC, 1992 staff recommendation for minimum instream flow for all water year types.
15	Over-summering (June through September)	3	122	YCWA's 1996 recommended minimum instream flow for below-normal water years.
16	Spawning and incubation (October through December)	13	135	YCWA's 1996 recommended minimum instream flow for normal water years.
17	Rearing and outmigration (April through June)	56	191	YCWA's 1996 recommended minimum instream flow for normal water years.
18	Incubation and rearing (January through March)	9	200	YCWA's 1996 recommended minimum instream flow for normal water years.
19	Over-summering (June through September)	56	256	FERC, 1992 staff recommendation for minimum instream flow for all water year types.
20	Spawning and incubation (October through December)	30	286	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
21	Rearing and outmigration (April through June)	64	350	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
22	Incubation and rearing (January through March)	36	386	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
23	Over-summering (July through September)	45	431	YCWA's 1996 recommended minimum instream flow in a normal water year.
24	Spawning and incubation (October through December)	7	438	AFRP Working Paper (USFWS 1995) minimum releases in a critical water year, without releases targeted specifically for American shad.
25	Rearing and outmigration (April through June)	120	558	AFRP Working Paper (USFWS 1995) minimum releases in a critical water year, including releases targeted specifically for American shad.
26	Over-summering (July through September)	28	586	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
27	Rearing and outmigration (April through June)	218	804	AFRP Working Paper (USFWS 1995) minimum releases in a dry water year, including releases targeted specifically for American shad.
28	Over-summering (July through September)	228	1032	YCWA's 1996 recommended minimum instream flow in a wet water year.
29	Rearing and outmigration (April through June)	218	1250	AFRP Working Paper (USFWS 1995) minimum releases in a below-normal water year, including releases targeted specifically for American shad.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
30	Rearing and outmigration (April through June)	109	1359	AFRP Working Paper (USFWS 1995) minimum releases in an above-normal water year, including releases targeted specifically for American shad.
31	Rearing and outmigration (April through June)	266	1625	AFRP Working Paper (USFWS 1995) minimum releases in a wet water year, including releases targeted specifically for American shad.

Table 4. Guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Yuba River for water years 46% to 50% of normal.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
1	Spawning and incubation (October through December)	11	11	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types, agreement between the California Department of Fish and Game and the Yuba County Water Agency (YCWA).
2	Rearing and outmigration (April through May)	4	15	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.
3	Incubation and rearing (January through March)	7	22	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.
4	Over-summering (June through September)	2	24	1965 standard for minimum instream flows below Daguerre Point Dam for normal and wetter water-year types.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
5	Rearing and outmigration (April through May)	19	43	YCWA's 1996 recommended lower Yuba River minimum instream flow at Marysville for a below-normal water year, (as cited in the Anadromous Fish Enhancement Actions Recommended for the Lower Yuba River, prepared by Beak Consultants, Incorporated, 1996).
6	Incubation and rearing (January through March)	28	71	YCWA's 1996 recommended minimum instream flow for extra critical water years.
7	Over-summering (June through September)	12	83	YCWA's 1996 recommended minimum instream flow for extra critical and critical water years.
8	Spawning and incubation (October through December)	5	88	Federal Energy Regulatory Commission (FERC), 1992 staff recommendation for minimum instream flow for all water year types, Environmental Assessment (EA) for Hydropower License, Narrows Project, FERC Project Number 1403-004, California.
9	Rearing and outmigration (April through May)	14	102	FERC, 1992 staff recommendation for minimum instream flow for all water year types, EA for Hydropower License.
10	Incubation and rearing (January through March)	9	111	FERC, 1992 staff recommendation for minimum instream flow for all water year types, EA for Hydropower License.
11	Over-summering (June through September)	3	114	YCWA's 1996 recommended minimum instream flow for below-normal water years.
12	Spawning and incubation (October through December)	13	127	YCWA's 1996 recommended minimum instream flow for normal water years.
13	Rearing and outmigration (April through June)	56	183	YCWA's 1996 recommended minimum instream flow for normal water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
14	Incubation and rearing (January through March)	9	192	YCWA's 1996 recommended minimum instream flow for normal water years.
15	Over-summering (June through September)	56	248	FERC, 1992 staff recommendation for minimum instream flow for all water year types, EA for Hydropower License.
16	Spawning and incubation (October through December)	30	278	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
17	Rearing and outmigration (April through June)	64	342	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
18	Incubation and rearing (January through March)	36	378	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
19	Over-summering (July through September)	45	423	YCWA's 1996 recommended minimum instream flow in a normal water year.
20	Spawning and incubation (October through December)	7	430	AFRP Working Paper (USFWS 1995) minimum releases in a critical water year, without releases targeted specifically for American shad.
21	Rearing and outmigration (April through June)	120	550	AFRP Working Paper (USFWS 1995) minimum releases in a critical water year, including releases targeted specifically for American shad.
22	Over-summering (July through September)	28	578	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
23	Rearing and outmigration (April through June)	218	796	AFRP Working Paper (USFWS 1995) minimum releases in a dry water year, including releases targeted specifically for American shad.
24	Over-summering (July through September)	228	1024	YCWA's 1996 recommended minimum instream flow in a wet water year.
25	Rearing and outmigration (April through June)	218	1242	AFRP Working Paper (USFWS 1995) minimum releases in a below-normal water year, including releases targeted specifically for American shad.
26	Rearing and outmigration (April through June)	109	1351	AFRP Working Paper (USFWS 1995) minimum releases in an above-normal water year, including releases targeted specifically for American shad.
27	Rearing and outmigration (April through June)	266	1617	AFRP Working Paper (USFWS 1995) minimum releases in a wet water year, including releases targeted specifically for American shad.

Table 5. Guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Yuba River for normal and wetter water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
1	Rearing and outmigration (April through May)	19	19	YCWA's 1996 recommended lower Yuba River minimum instream flow at Marysville for a below-normal water year, (as cited in the Anadromous Fish Enhancement Actions Recommended for the Lower Yuba River, prepared by Beak Consultants, Incorporated, 1996).

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
2	Incubation and rearing (January through March)	28	47	YCWA's 1996 recommended minimum instream flow for extra critical water years.
3	Over-summering (June through September)	12	59	YCWA's 1996 recommended minimum instream flow for extra critical and critical water years.
4	Spawning and incubation (October through December)	5	64	Federal Energy Regulatory Commission (FERC), 1992 staff recommendation for minimum instream flow for all water year types.
5	Rearing and outmigration (April through May)	14	78	Federal Energy Regulatory Commission (FERC), 1992 staff recommendation for minimum instream flow for all water year types.
6	Incubation and rearing (January through March)	9	87	Federal Energy Regulatory Commission (FERC), 1992 staff recommendation for minimum instream flow for all water year types.
7	Over-summering (June through September)	3	90	YCWA's 1996 recommended minimum instream flow for below-normal water years.
8	Spawning and incubation (October through December)	13	103	YCWA's 1996 recommended minimum instream flow for normal water years.
9	Rearing and outmigration (April through June)	56	159	YCWA's 1996 recommended minimum instream flow for normal water years.
10	Incubation and rearing (January through March)	9	168	YCWA's 1996 recommended minimum instream flow for normal water years.
11	Over-summering (June through September)	56	224	Federal Energy Regulatory Commission (FERC), 1992 staff recommendation for minimum instream flow for all water year types.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
12	Spawning and incubation (October through December)	30	254	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
13	Rearing and outmigration (April through June)	64	318	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
14	Incubation and rearing (January through March)	36	354	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
15	Over-summering (July through September)	45	399	YCWA's 1996 recommended minimum instream flow in a normal water year.
16	Spawning and incubation (October through December)	7	406	AFRP Working Paper (USFWS 1995) minimum releases in a critical water year, without releases targeted specifically for American shad.
17	Rearing and outmigration (April through June)	120	526	AFRP Working Paper (USFWS 1995) minimum releases in a critical water year, including releases targeted specifically for American shad.
18	Over-summering (July through September)	28	554	CDFG minimum instream flow recommendation for normal and above water years, Lower Yuba River Fisheries Management Plan, 1991.
19	Rearing and outmigration (April through June)	218	772	AFRP Working Paper (USFWS 1995) minimum releases in a dry water year, including releases targeted specifically for American shad.
20	Over-summering (July through September)	228	1000	YCWA's 1996 recommended minimum instream flow in a wet water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
21	Rearing and outmigration (April through June)	218	1218	AFRP Working Paper (USFWS 1995) minimum releases in a below-normal water year, including releases targeted specifically for American shad.
22	Rearing and outmigration (April through June)	109	1327	AFRP Working Paper (USFWS 1995) minimum releases in an above-normal water year, including releases targeted specifically for American shad.
23	Rearing and outmigration (April through June)	266	1593	AFRP Working Paper (USFWS 1995) minimum releases in a wet water year, including releases targeted specifically for American shad.

Bear River

The following tables present priorities and draft guidelines for allocation of acquired water on the Bear River. Species documented to occur in the bear include the fall-run chinook salmon, steelhead, and white and green sturgeon. Water allocation guidelines focus on benefiting life history needs of these species in addition to ancillary downstream benefits to anadromous fish in the Sacramento River and Delta (Table 1).

Water allocation guidance for the Bear River in the form of existing instream flow recommendations is limited. For the following guidelines we use the existing minimum instream flow standard in the 1989 amended Federal Energy Regulatory Commission (FERC) license number 2997 to the South Sutter Water District, and consider this as our baseline to build from, given that water is available and can be acquired. The remaining three recommendations are from the AFRP Working Paper (USFWS 1995).

Species and life-history stage priorities

On the Bear River, species considered include fall-run chinook salmon, steelhead and sturgeon. Priorities are specified primarily for chinook salmon, but steelhead should coincidentally benefit from the flow schedule prioritized for fall-run chinook salmon. Sturgeon are ranked secondarily to the salmonids as they are known to use the lower Bear River, but only sporadically and generally in wet years. Enough information on Bear River sturgeon exists to warrant specific allocation of water to benefit the species given that acquisition of water is feasible. Table 1 prioritizes salmon life-history stages for use in conjunction with the existing standards to generate guidelines for allocating acquired water in the Bear River. Sturgeon life-history priorities are not presented here per se. In the Working Paper, 650 cubic feet per second (cfs) of water is additionally allocated to that recommended for salmon from February through May. Thus, given that enough water can be acquired, allocation of water to improve sturgeon production would follow priorities two and three for salmon in the table below. This would encompass the allocation of water from February through May and would be implemented chronologically.

Table 1. Draft water allocation priorities for (b)(3) water on the Bear River. The time periods in parentheses in the life-history stage column are approximate time periods when that life-history stage is present in the river. Actual time periods vary, dependent on run-timing, environmental conditions, and rate of development.

Priority	Life-history stage	Objective
1	Spawning and incubation (October through December)	Improve attraction flows and water temperatures for fall-run chinook salmon and steelhead migrating into and spawning and incubating in the Bear River.
3	Incubation and rearing (January through March)	Improve spawning, incubating, and rearing flows and related habitat conditions for fall-run chinook salmon and steelhead, and benefit sturgeon, striped bass, and other species through contribution to Sacramento River flows and Delta outflows.
2	Rearing and outmigration (April through May)	Improve rearing and outmigration flows and related habitat conditions and provide adequate temperatures for fall-run chinook salmon in the Bear River; and contribute to improved conditions for survival of Sacramento basin fall-run chinook salmon migrating through the Sacramento River and the Delta, and benefit other riverine and estuarine species, including other anadromous fish, through contribution to Sacramento River flows and Delta outflows.
4	Over-summering (June through September)	Improve rearing habitat for over-summering juvenile chinook salmon and steelhead.

Existing standards

The existing minimum instream flow release requirement from Camp Far West Reservoir is defined in the Order Amending License, number 2997 issued by the Federal Energy Regulatory Commission (FERC) to the South Sutter Water District. This requirement is specified for the gage immediately below the Camp Far West diversion. The standard applies for all water-year types but may be reduced to Camp Far West Reservoir inflow if this is less than the specified standard. Species and life-history priorities or specific rationale are not evident from information presented in the FERC order.

Recommendations

The remaining three recommendations come from the Working Paper, including results of a cited PHABSIM analyses. The Working Paper salmon and PHABSIM recommendations are for normal and above water-year types and the Working Paper sturgeon recommendation is only for above normal and wet water-year types. These recommendations are specified for the Wheatland gage below Camp Far West Reservoir. Water-year types for the Working Paper recommendations are based on the Sacramento River Index used in the State Water Resources Control Board (SWRCB) Draft Water Right Decision 1630. Flows for October through January are based on the water-year type for the previous year. The Working Paper salmon and steelhead recommendation considers flows that will create passage for salmon and steelhead and provide favorable water temperatures in most months. The difference between the PHABSIM salmon recommendation and the Working Paper salmon recommendation is that PHABSIM values only represent interpreted physical habitat needs of rearing salmon from January to June. The rationale for the sturgeon recommendation is based on previous years flow conditions during above-normal and wet years when sturgeon production has been qualitatively been classified as good.

Draft guidelines for allocation of acquired water

Table 2. Guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Bear River.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
1	Spawning and incubation (October through December)	40	40	AFRP Working Paper (USFWS 1995) minimum releases to the lower Bear River for normal and wetter water-year types, without releases targeted specifically for sturgeon.
2	Rearing and outmigration (April through May)	9	49	PHABSIM minimum releases for normal and wetter water-year types as cited in the AFRP Working Paper (USFWS 1995).
3	Incubation and rearing (January through March)	32	81	PHABSIM minimum releases for normal and wetter water-year types as cited in the AFRP Working Paper (USFWS 1995).
4	Over-summering (June through September)	14	95	AFRP Working Paper (USFWS 1995) minimum releases to the lower Bear River for normal and wetter water-year types, without releases targeted specifically for sturgeon.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
5	Rearing and outmigration (April through May)	18	113	AFRP Working Paper (USFWS 1995) minimum releases to the lower Bear River for normal and wetter water-year types, without releases targeted specifically for sturgeon.
6	Incubation and rearing (January through March)	11	124	AFRP Working Paper (USFWS 1995) minimum releases to the lower Bear River for normal and wetter water-year types, without releases targeted specifically for sturgeon.
7	Sturgeon migration and spawning (February through March)	77	201	AFRP Working Paper (USFWS 1995) for minimum flow releases for above normal and wetter water-year types, including releases targeted specifically for sturgeon.
8	Sturgeon spawning and requirements for early life-history stages of the progeny (April through May)	79	280	AFRP Working Paper (USFWS 1995) for minimum flow releases for above normal and wetter water-year types, including releases targeted specifically for sturgeon.

Mokelumne River

The following is a presentation of the draft guidelines for allocation of acquired water in the Mokelumne River. Water allocation guidelines focus specifically on benefiting life history needs of the Mokelumne River fall-run chinook salmon and steelhead, however, benefits to other species are considered (Table 1). Current minimum instream flow requirements are based on the 1961 agreement between the California Department of Fish and Game (CDFG) and East Bay Municipal District (EBMUD). This fish flow standard only requires that total water releases below Camanche Reservoir be either 13 thousand acre feet (TAF) or 5.4 TAF from November through March depending on normal and wetter water year or dry year conditions, respectively. However, if this standard were minimally complied with, actual water releases from April through September would not be zero because of Camanche releases to meet the downstream water rights of the Woodbridge Irrigation District. This standard is not considered further.

For the following guidelines we consider the 1996 Principles of Agreement (POA) as our baseline standard to build from, given that water for acquisition is available. In addition to the POA standard described below, we consider five additional minimum instream flow recommendations to form the foundation of our prioritized water allocation by water-year type (tables 2 through 5). They are: 1)

FERC staff (FERC 1993, Final EIS for Proposed Modifications to the Lower Mokelumne River Project, California), 2) EBMUD (EDAW, Inc. 1993, Updated Water Supply Management Plan), CDFG (CDFG 1991, Lower Mokelumne River Management Plan), U.S. Fish and Wildlife Service (USFWS 1993 letter commenting on the draft EIS), and the Anadromous Fish Restoration Program (AFRP) Working Paper (USFWS 1995). The guidelines for each of the water-year types are bracketed on the lower end by the 1996 POA for the year type and on the upper end by the AFRP Working Paper flows that apply to the year type. Although these tables use the designated standards as the foundation to which we add acquired water, we expect that both the PEIS and the water acquisition program will consider the existing conditions to be the foundation. Likewise, we expect that the upper-end bracket will be determined by the PEIS estimate of the amount of water available for acquisition, rather than by the Working Paper flows.

Species and life-history stage priorities

Table 1. Draft water allocation priorities for (b)(3) water on the Mokelumne River. The time periods in parentheses in the life-history stage column are approximate time periods when that life-history stage is present in the river. Actual time periods vary, dependent on run-timing, environmental conditions, and rate of development.

Priority	Life-history stage	Objective
1	Spawning and incubation (October through December)	Improve attraction flows and water temperatures for fall-run chinook salmon and steelhead migrating into and spawning and incubating in the Mokelumne River.
3	Incubation and rearing (January through March)	Improve spawning, incubating, and rearing flows and related habitat conditions for fall-run chinook salmon and steelhead, and benefit sturgeon, striped bass, and other species through contribution to San Joaquin River flows and Delta outflows.
2	Rearing and outmigration (April through May)	Improve rearing and outmigration flows and related habitat conditions and provide adequate temperatures for fall-run chinook salmon in the Mokelumne River; and contribute to improved migration and spawning conditions for American shad. Also improve conditions for survival of San Joaquin basin and Delta tributary fall-run chinook salmon migrating through the San Joaquin River and the Delta, and benefit other riverine and estuarine species, including other anadromous fish, through contribution to San Joaquin River flows and Delta outflows.
4	Over-summering (June through September)	Improve rearing habitat for over-summering juvenile chinook salmon and steelhead.

Existing standards

This standard is defined in the 1996 Principles of Agreement (POA) between the East Bay Municipal Utility District (EBMUD), the U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (CDFG). The POA flows are specified for release from Camanche Reservoir, but we use its projected flow equivalent below Woodbridge in order to be comparable to the recommendations that follow. The POA allocates water by four different water-year types: 1) critically dry, 2) dry, 3) below-normal, and 4) normal and above, using a dual water-year type determination. Flows from October through March are allocated using a water-year type classification determined by November 5 combined storage in Pardee and Camanche reservoirs; year type storage limits are based on the capacities of Pardee and Camanche reservoirs in 1995. Flows from April through September are allocated using a water-year type classification determined by the water-year unimpaired runoff into Pardee Reservoir as forecasted by the California Department of Water Resources (DWR) in the April 1 Bulletin 120 Report except when combined Pardee and Camanche November 5 storage is projected to be less than 200 TAF.

For the months of April, May, and June during normal and above year types, additional releases ranging from 50 cubic feet per second (cfs) to 200 cfs are required depending on combined Pardee and Camanche storage levels relative to the maximum allowable for the end of the prior month. This water is not factored into these guidelines because its use is contingent on additional existing condition information over and above the fixed water-year type prescription described above. However, this water should be included as part of the existing conditions considered by the water acquisition program.

Recommendations

FERC Staff: The FERC staff alternative for minimum flows below Woodbridge Dam is based on an independent analysis of available data, including required Camanche conveyance releases, CDFG's 1991 IFIM study, and a temperature model (SNTMP) produced by the USFWS (Theurer et al. 1984). The staff integrated these habitat and temperature data to "optimally" allocate water for anadromous salmonids during two time periods. In October through February they attempt to maximize thermal conditions and weighted usable area (WUA) for upstream migration, spawning and incubation. A second priority is from May through June to maximize the same conditions for rearing and out-migration. In March through April when temperatures are not limiting, they reduce flows to maximize salmon rearing conditions based solely on the use of WUA values or physical habitat for juvenile rearing. FERC staff water-year types are based on a combination of end-of-the-year reservoir storage and unimpaired flow into Pardee Reservoir. Contrasting the POA, FERC staff only identifies three water-year types: 1) dry, 2) below-normal, and 3) above-normal, but uses a similar fall (September 30) reservoir storage criteria for October through February releases. Starting in March they use DWR's unimpaired runoff forecasts to identify March through September releases.

East Bay Municipal Utility District: EBMUD's recommendation for minimum instream flows derive from CDFG's 1991 IFIM study, and temperature modeling and fisheries studies conducted by Biosystems. Their recommendation focuses on improving upstream migration and spawning for chinook salmon and steelhead during the fall and winter months, as well as improved juvenile rearing habitat in the spring. Their general strategy recognizes natural variation in stream flow and fish adaptations to these conditions. Critically dry year recommendations allow for intervening trap and haul operations of juvenile salmon downstream to presumed better habitat conditions. EBMUD defines three water-year types, 1) critically dry, 2) dry, and 3) normal and above, that are based solely on predicted and actual end-of-October storage conditions in Pardee and Camanche reservoirs. From May through October a combination of observed streamflow, snowpack, and storage volumes are used to predicts end-of-October storage conditions. November through April releases at Camanche are based on actual reservoir storage at the end of October.

California Department of Fish and Game: CDFG's recommendation for minimum instream flows is based on a combination of WUA and discharge indices from their IFIM study, water temperature modeling, and knowledge of anadromous fish life stage requirements (see their 1991 Management Plan). Their plan places emphasis on using the natural hydrograph to guide flow recommendations by water-year type. Also unique to their recommendation are two blocks of water, in addition to set schedule flows, to be managed adaptively for attraction of fall spawners and spring outmigration of emigrating juveniles. Water-years- dry, normal, and wet are defined solely on the basis of unimpaired runoff above Pardee Reservoir as described for the year in DWR's Bulletin 120 series May 1, report on water conditions. A dry year is considered less than half of the 50-year average for unimpaired runoff, normal is between 50% and 110% of the 50-year average, and wet years exceed 110% of the 50-year runoff. Additional fall attraction flows from October 1 to November 15 are 20 TAF in normal and wet years, and 10 TAF in dry years. Likewise, additional outmigration flows from April 1 to June 30 are 10 TAF for normal and wet years and 5 TAF for dry years. We consider these blocks of water together with the minimum recommended flow during corresponding time periods.

U.S. Fish and Wildlife Service: USFWS's 1993 recommendation allocates water for only two water-year types, dry and critically dry, and normal and wet. Dry and critically dry water years occur when observed inflows into Pardee Reservoir are less than 360 TAF for the water year, or when average annual flows are less than 500 cfs. Normal and wet year flows would be allocated when inflows are in excess of the above cut off. Similar to CDFG's recommendation, the USFWS places high priority on salmonid attraction flows by allocating an additional 15 TAF block of water during the first two weeks in October for normal and wet years. The flow allocation attempts to mimic the natural hyrograph with the allotted water.

AFRP Working Paper: The AFRP Working Paper recommends two sets of minimum instream flows, one set for salmon and steelhead and another for shad. The shad recommendation allocates water in addition to salmon flows during the April through May period for shad attraction, migration and spawning. The salmon recommendation uses three water-year types of wet, normal and dry. The shad recommendation splits normal into above-normal and below-normal, and adds a critical water year. Water-year types for salmon and shad recommendations are based on the San Joaquin Index used in the State Water Resources Control Board (SWRCB) Draft Water Right Decision 1630. Flows for October through January are based on the water-year type for the previous year.

Draft guidelines for allocation of acquired water

The following tables show the draft guidelines for allocation of acquired water on the Mokelumne River for each of the water-year types for which the existing standards were developed. The guidelines for each of the water-year types are bracketed on the lower end by the 1996 POA for the year type and on the upper end by the AFRP Working Paper flows that apply to the year type. Ultimately, I expect that the upper-end bracket will be determined by the PEIS estimate of the amount of water available for acquisition, rather than by the Working Paper flows. Although these tables use the existing standards as the foundation to which we add acquired water, we expect that both the PEIS and the water acquisition program will consider the existing conditions to be the foundation.

Table 2. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Mokelumne River in critical water years. The time periods in parentheses in the targeted life history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Mokelumne River. The block of water will be managed to maximize benefits to anadromous fish, both in the Mokelumne River and downstream, and in coordination with the Mokelumne River Technical Advisory Committee and downstream water managers.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
1	Spawning and incubation (October through December)	3	3	1996 Principle of Agreement (POA) between the East Bay Municipal Utility District (EBMUD), the U.S. Fish and Wildlife Service (USFWS), and the California Department of Fish and Game (CDFG) for minimum flow releases to the lower Mokelumne River for a dry water year.
2	Rearing and outmigration (April through May)	13	16	POA minimum releases for a dry water year.
3	Over-summering (June through September)	1	17	POA minimum releases for a dry water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
4	Spawning and incubation (October through December)	3	20	POA minimum releases for a below-normal water year.
5	Rearing and outmigration (April through June)	15	35	POA minimum releases for a below-normal water year.
6	Incubation and rearing (January through March)	4	39	POA minimum releases for a below-normal water year.
7	Rearing and outmigration (April through June)	12	51	POA minimum releases for above-normal and wet water years.
8	Over-summering (July through September)	1	52	POA minimum releases for above-normal and wet water years.
9	Spawning and incubation (October through December)	7	59	EBMUD’s 1993 recommended minimum releases from Camanche Reservoir to the lower Mokelumne River for a dry water year, (as cited in the Lower Mokelumne River Management Plan, prepared by Biosystems Analysis, Inc. 1993).
10	Rearing and outmigration (April through June)	14	73	EBMUD’s 1993 recommended minimum releases for normal and wet water years.
11	Incubation and rearing (January through March)	7	80	Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement, 1993, staff recommended minimum releases for below-normal water years.
12	Spawning and incubation (October through December)	16	96	FERC (1993) staff recommended minimum releases for below-normal water years.
13	Over-summering (July through September)	4	100	FERC (1993) staff recommended minimum releases for below-normal water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
14	Incubation and rearing (January through March)	10	110	CDFG (1991), Lower Mokelumne River Fisheries Management Plan recommended minimum releases for dry water years.
15	Over-summering (July through September)	3	113	U.S. Fish and Wildlife Service (USFWS) flow recommendation for the Lower Mokelumne River in a critically dry and dry water years, letter submitted to FERC, 1993
16	Incubation and rearing (January through March)	3	116	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, without releases targeted specifically for American shad.
17	Over-summering (July through September)	8	124	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, without releases targeted specifically for American shad.
18	Spawning and incubation (October through December)	17	141	FERC (1993) staff recommended minimum releases for above-normal water year.
19	Rearing and outmigration (April through June)	5	146	USFWS (1993) recommended minimum releases for normal and wet water years.
20	Incubation and rearing (January through March)	15	161	USFWS (1993) recommended minimum releases for normal and wet water years.
21	Spawning and incubation (October through December)	15	176	CDFG (1991) recommended minimum releases for normal water years.
22	Rearing and outmigration (April through June)	21	197	CDFG (1991) recommended minimum releases for normal water years.
23	Incubation and rearing (January through March)	3	200	CDFG (1991) recommended minimum releases for normal water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
24	Over-summering (July through September)	1	201	CDFG (1991) recommended minimum releases for normal water years.
25	Rearing and outmigration (April through June)	36	237	AFRP Working Paper (USFWS 1995) minimum releases for normal water years, without releases targeted specifically for American shad.
26	Incubation and rearing (January through March)	3	240	AFRP Working Paper (USFWS 1995) minimum releases for normal water years, without releases targeted specifically for American shad.
27	Spawning and incubation (October through December)	9	249	CDFG (1991) recommended minimum releases for a wet water year.
28	Incubation and rearing (January through March)	6	255	CDFG (1991) recommended minimum releases for a wet water year.
29	Over-summering (July through September)	34	289	CDFG (1991) recommended minimum releases for a wet water year.
30	Rearing and outmigration (April through June)	54	343	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year, without releases targeted specifically for American shad.
31	Incubation and rearing (January through March)	18	361	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year, without releases targeted specifically for American shad.

Table 3. Guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Mokelumne River in dry water years. See the caption for Table 1 for a more complete description of the columns.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
1	Spawning and incubation (October through December)	3	3	POA minimum releases for a below normal water year.
2	Rearing and outmigration (April through June)	15	18	POA minimum releases for a below normal water year.
3	Incubation and rearing (January through March)	4	22	POA minimum releases for a below normal water year.
4	Rearing and outmigration (April through June)	12	34	POA minimum releases for above normal and wet water years.
5	Over-summering (July through September)	1	35	POA minimum releases for above normal and wet water years.
6	Spawning and incubation (October through December)	7	42	EBMUD's 1993 recommended minimum releases for a dry water year.
7	Rearing and outmigration (April through June)	14	56	EBMUD's 1993 recommended minimum releases for normal and wet water years.
8	Incubation and rearing (January through March)	7	63	Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement, 1993, staff recommended minimum releases for below-normal water years.
9	Spawning and incubation (October through December)	16	79	FERC (1993) staff recommended minimum releases for below-normal water years.
10	Over-summering (July through September)	4	83	FERC (1993) staff recommended minimum releases for below-normal water years.
11	Incubation and rearing (January through March)	10	93	CDFG (1991), Lower Mokelumne River Fisheries Management Plan recommended minimum releases for dry water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
12	Over-summering (July through September)	3	96	U.S. Fish and Wildlife Service (USFWS) flow recommendation for the Lower Mokelumne River in a critically dry and dry water years, letter submitted to FERC, 1993
13	Incubation and rearing (January through March)	3	99	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, without releases targeted specifically for American shad.
14	Over-summering (July through September)	8	107	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, without releases targeted specifically for American shad.
15	Spawning and incubation (October through December)	17	124	FERC (1993) staff recommended minimum releases for above-normal water year.
16	Rearing and outmigration (April through June)	5	129	USFWS (1993) recommended minimum releases for normal and wet water years.
17	Incubation and rearing (January through March)	15	144	USFWS (1993) recommended minimum releases for normal and wet water years.
18	Spawning and incubation (October through December)	15	159	CDFG (1991) recommended minimum releases for normal water years.
19	Rearing and outmigration (April through June)	21	180	CDFG (1991) recommended minimum releases for normal water years.
20	Incubation and rearing (January through March)	3	183	CDFG (1991) recommended minimum releases for normal water years.
21	Over-summering (July through September)	1	184	CDFG (1991) recommended minimum releases for normal water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
22	Rearing and outmigration (April through June)	36	220	AFRP Working Paper (USFWS 1995) minimum releases for normal water years, without releases targeted specifically for American shad.
23	Incubation and rearing (January through March)	3	223	AFRP Working Paper (USFWS 1995) minimum releases for normal water years, without releases targeted specifically for American shad.
24	Spawning and incubation (October through December)	9	232	CDFG (1991) recommended minimum releases for a wet water year.
25	Incubation and rearing (January through March)	6	238	CDFG (1991) recommended minimum releases for a wet water year.
26	Over-summering (July through September)	34	272	CDFG (1991) recommended minimum releases for a wet water year.
27	Rearing and outmigration (April through June)	54	326	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year, without releases targeted specifically for American shad.
28	Incubation and rearing (January through March)	18	344	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year, without releases targeted specifically for American shad.
29	Rearing and outmigration (April through May)	43	387	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, including releases targeted specifically for American shad.

Table 4. Guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Mokelumne River in in below normal water years. See the caption for Table 1 for a more complete description of the columns.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
1	Incubation and rearing (January through March)	12	12	POA minimum releases for above normal and wet water years.
2	Over-summering (July through September)	1	13	POA minimum releases for above normal and wet water years.
3	Spawning and incubation (October through December)	7	20	EBMUD's 1993 recommended minimum releases for a dry water year.
4	Rearing and outmigration (April through June)	14	34	EBMUD's 1993 recommended minimum releases for normal and wet water years.
5	Incubation and rearing (January through March)	7	41	Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement, 1993, staff recommended minimum releases for below-normal water years.
6	Spawning and incubation (October through December)	16	57	FERC (1993) staff recommended minimum releases for below-normal water years.
7	Over-summering (July through September)	4	61	FERC (1993) staff recommended minimum releases for below-normal water years.
8	Incubation and rearing (January through March)	10	71	CDFG (1991), Lower Mokelumne River Fisheries Management Plan recommended minimum releases for dry water years.
9	Over-summering (July through September)	3	74	U.S. Fish and Wildlife Service (USFWS) flow recommendation for the Lower Mokelumne River in a critically dry and dry water years, letter submitted to FERC, 1993
10	Incubation and rearing (January through March)	3	77	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, without releases targeted specifically for American shad.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
11	Over-summering (July through September)	8	85	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, without releases targeted specifically for American shad.
12	Spawning and incubation (October through December)	17	102	FERC (1993) staff recommended minimum releases for above-normal water year.
13	Rearing and outmigration (April through June)	5	107	USFWS (1993) recommended minimum releases for normal and wet water years.
14	Incubation and rearing (January through March)	15	122	USFWS (1993) recommended minimum releases for normal and wet water years.
15	Spawning and incubation (October through December)	15	137	CDFG (1991) recommended minimum releases for normal water years.
16	Rearing and outmigration (April through June)	21	158	CDFG (1991) recommended minimum releases for normal water years.
17	Incubation and rearing (January through March)	3	161	CDFG (1991) recommended minimum releases for normal water years.
18	Over-summering (July through September)	1	162	CDFG (1991) recommended minimum releases for normal water years.
19	Rearing and outmigration (April through June)	36	198	AFRP Working Paper (USFWS 1995) minimum releases for normal water years, without releases targeted specifically for American shad.
20	Incubation and rearing (January through March)	3	201	AFRP Working Paper (USFWS 1995) minimum releases for normal water years, without releases targeted specifically for American shad.
21	Spawning and incubation (October through December)	9	210	CDFG (1991) recommended minimum releases for a wet water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
22	Incubation and rearing (January through March)	6	216	CDFG (1991) recommended minimum releases for a wet water year.
23	Over-summering (July through September)	34	250	CDFG (1991) recommended minimum releases for a wet water year.
24	Rearing and outmigration (April through June)	54	304	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year, without releases targeted specifically for American shad.
25	Incubation and rearing (January through March)	18	322	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year, without releases targeted specifically for American shad.
26	Rearing and outmigration (April through May)	43	365	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, including releases targeted specifically for American shad.
27	Rearing and outmigration (April through June)	114	479	AFRP Working Paper (USFWS 1995) minimum releases for a below-normal water year, including releases targeted specifically for American shad.

Table 5. Guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Mokelumne River in in above normal and wetter water years. See the caption for Table 1 for a more complete description of the columns.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
1	Spawning and incubation (October through December)	7	7	EBMUD's 1993 recommended minimum releases for a dry water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
2	Rearing and outmigration (April through June)	14	21	EBMUD's 1993 recommended minimum releases for normal and wet water years.
3	Incubation and rearing (January through March)	7	28	Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement, 1993, staff recommended minimum releases for below-normal water years.
4	Spawning and incubation (October through December)	16	44	FERC (1993) staff recommended minimum releases for below-normal water years.
5	Over-summering (July through September)	4	48	FERC (1993) staff recommended minimum releases for below-normal water years.
6	Incubation and rearing (January through March)	10	58	CDFG (1991), Lower Mokelumne River Fisheries Management Plan recommended minimum releases for dry water years.
7	Over-summering (July through September)	3	61	U.S. Fish and Wildlife Service (USFWS) flow recommendation for the Lower Mokelumne River in a critically dry and dry water years, letter submitted to FERC, 1993
8	Incubation and rearing (January through March)	3	64	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, without releases targeted specifically for American shad.
9	Over-summering (July through September)	8	72	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, without releases targeted specifically for American shad.
10	Spawning and incubation (October through December)	17	89	FERC (1993) staff recommended minimum releases for above-normal water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
11	Rearing and outmigration (April through June)	5	94	USFWS (1993) recommended minimum releases for normal and wet water years.
12	Incubation and rearing (January through March)	15	109	USFWS (1993) recommended minimum releases for normal and wet water years.
13	Spawning and incubation (October through December)	15	124	CDFG (1991) recommended minimum releases for normal water years.
14	Rearing and outmigration (April through June)	21	145	CDFG (1991) recommended minimum releases for normal water years.
15	Incubation and rearing (January through March)	3	148	CDFG (1991) recommended minimum releases for normal water years.
16	Over-summering (July through September)	1	149	CDFG (1991) recommended minimum releases for normal water years.
17	Rearing and outmigration (April through June)	36	185	AFRP Working Paper (USFWS 1995) minimum releases for normal water years, without releases targeted specifically for American shad.
18	Incubation and rearing (January through March)	3	188	AFRP Working Paper (USFWS 1995) minimum releases for normal water years, without releases targeted specifically for American shad.
19	Spawning and incubation (October through December)	9	197	CDFG (1991) recommended minimum releases for a wet water year.
20	Incubation and rearing (January through March)	6	203	CDFG (1991) recommended minimum releases for a wet water year.
21	Over-summering (July through September)	34	237	CDFG (1991) recommended minimum releases for a wet water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Support
22	Rearing and outmigration (April through June)	54	291	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year, without releases targeted specifically for American shad.
23	Incubation and rearing (January through March)	18	309	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year, without releases targeted specifically for American shad.
24	Rearing and outmigration (April through May)	43	352	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year, including releases targeted specifically for American shad.
25	Rearing and outmigration (April through June)	114	466	AFRP Working Paper (USFWS 1995) minimum releases for a below-normal water year, including releases targeted specifically for American shad.
26	Rearing and outmigration (April through June)	49	515	AFRP Working Paper (USFWS 1995) minimum releases for an above-normal water year, including releases targeted specifically for American shad.
27	Rearing and outmigration (April through June)	123	638	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year, including releases targeted specifically for American shad.

Calaveras River

Species and life-history stage priorities

On the Calaveras River, the primary species of concern is winter-run chinook salmon. Table 1 prioritizes life-history stages for winter-run chinook salmon.

Table 2. Draft water allocation priorities for (b)(3) water on the Calaveras River. The time periods in parentheses in the life-history stage column are approximate time periods when that life-history stage is present in the river. Actual time periods vary, dependent on run-timing, environmental conditions, and rate of development.

Priority	Life-history stage	Objective
1	Adult migration (February through April)	Improve attraction flows for winter-run chinook salmon migrating into the Calaveras River.
2	Spawning and incubation (May through July)	Improve spawning and incubation flows and related habitat conditions for winter-run chinook salmon, and benefit sturgeon, striped bass, and other species through contribution to Delta outflows.
3	Incubation and rearing (August through October)	Improve incubation and rearing flows and related habitat conditions for winter-run chinook salmon in the Calaveras River; and contribute to improved conditions for survival, and contribution to Delta outflows.
4	Rearing and outmigration (November through January)	Improve rearing habitat and survival of emigrants.

Existing standards

No flow standards exist for the Calaveras River.

Recommendations

The AFRP Working Paper (USFWS 1995) identified flows for three water-year types (critical and dry, below and above normal, and wet) based on results of a preliminary instream flow study conducted by USFWS (Memorandum to the U.S. Bureau of Reclamation re: Stanislaus River basin-Calaveras River conjunctive use water program study: a preliminary evaluation of fish and wildlife impacts with emphasis on water needs of the Calaveras River. 1993) that indicated winter-run chinook salmon require flows of 50 to 225 cfs.

Draft guidelines for allocation of acquired water

Table 2 shows draft guidelines for allocation of acquired water based on flows recommended for three water-year types (critical and dry, below and above normal, and wet) in the AFRP Working Paper (USFWS 1995), and under the assumption that no flows are released at New Hogan Dam.

Table 3. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Calaveras River. The time periods in parentheses in the targeted life-history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Calaveras River. The block of water will be managed to maximize benefits to anadromous fish, both in the Calaveras River and downstream, and in coordination with downstream water managers.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Adult migration (February through April)	21	21	AFRP Working Paper (USFWS 1995) minimum releases for a critical and dry water year.
2	Spawning and incubation (May through July)	22	43	AFRP Working Paper (USFWS 1995) minimum releases for a critical and dry water year.
3	Incubation and rearing (August through October)	20	63	AFRP Working Paper (USFWS 1995) minimum releases for a critical and dry water year.
4	Rearing and outmigration (November through January)	9	72	AFRP Working Paper (USFWS 1995) minimum releases for a critical and dry water year.
5	Adult migration (February through April)	6	78	AFRP Working Paper (USFWS 1995) minimum releases for a below normal and above normal water year.
6	Spawning and incubation (May through July)	7	85	AFRP Working Paper (USFWS 1995) minimum releases for a below normal and above normal water year.
7	Incubation and rearing (August through October)	4	89	AFRP Working Paper (USFWS 1995) minimum releases for a below normal and above normal water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
8	Rearing and outmigration (November through January)	4	93	AFRP Working Paper (USFWS 1995) minimum releases for a below normal and above normal water year.
9	Adult migration (February through April)	6	99	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
10	Spawning and incubation (May through July)	7	106	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
11	Incubation and rearing (August through October)	3	109	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.

SAN JOAQUIN BASIN

Considerations for management of blocks of water for spawning and incubation

1. Consistent with efforts to address low dissolved oxygen concentrations in the lower San Joaquin River.

2. Consistent with management of (b)(2) water in the Delta and other Delta water operations.

3. In coordination with flow contributions from the San Joaquin, Merced, and Stanislaus rivers to achieve 1 and 2 above.

Considerations for management of blocks of water for rearing and outmigration

1. Consistent with the Vernalis flow requirement for April through May in the Bay-Delta Agreement.

2. Consistent with the Vernalis flow requirement for April through May in the USFWS March 6, 1995 Biological Opinion for Delta smelt.

3. Consistent with management of (b)(2) water in the Delta and other Delta water operations.

4. Consistent with experiments in the Delta, especially those addressing effects of San Joaquin River flows, CVP and SWP exports, and Delta barriers.

5. In coordination with flow contributions from all San Joaquin basin tributaries to achieve 1, 2, 3, and 4 above. (An additional consideration is that we might want to attempt to acquire flows for outmigration from upstream tributaries first to improve conditions in as much of the San Joaquin River as possible.)

Merced River

Merced River stream flows are regulated primarily by New Exchequer and McSwain dams. Both are owned and operated by Merced Irrigation District. Crocker-Hoffman Diversion Dam, located downstream of New Exchequer and McSwain dams, limits anadromous fish to the lower reach of the Merced River. Fall-run chinook salmon is the primary species of concern. Flow standards were established by a FERC licence and Davis-Grunsky contract with Merced Irrigation District. Flow recommendations were provided by the CDFG and USFWS.

Species and life-history stage priorities

On the Merced River, the primary species of concern is fall-run chinook salmon. Steelhead may also be present in the Merced River in some years, but natural production of steelhead in the river is unlikely. Late-fall run chinook salmon may be present, based on observations of adult carcasses in January and recently emerged fry in April (G. Neillands, CDFG Region 4, Fresno, personnel communication). Table 1 prioritizes life-history stages for use in conjunction with the existing standards to generate guidelines for allocation of acquired water in the Merced River.

Table 1. Draft water allocation priorities for (b)(3) water on the Merced River. The time periods in parentheses in the life history stage column are approximate time periods when that life-history stage is present in the river. Actual time periods vary, dependent on run-timing, environmental conditions, and rate of development.

Priority	Life-history stage	Objective
1	Spawning and incubation (October through December)	Improve attraction flows and provide adequate water temperatures for fall-run chinook salmon migrating into and spawning and incubating in the Merced River.
3	Incubation and rearing (January through March)	Improve spawning, incubating, and rearing flows and related habitat conditions for fall-run chinook salmon, and benefit sturgeon, striped bass, and other species through contribution to San Joaquin River flows and Delta outflows.

2	Rearing and outmigration (April through May)	Improve rearing and outmigration flows and related habitat conditions and provide adequate temperatures for fall-run chinook salmon in the Merced River; and contribute to improved conditions for survival of San Joaquin basin and Delta tributary fall-run chinook salmon migrating through the San Joaquin River and the Delta, and benefit other riverine and estuarine species, including other anadromous fish, through contribution to San Joaquin River flows and Delta outflows.
4	Over-summering (June through September)	Improve rearing habitat for over-summering juvenile chinook salmon and steelhead.

Existing standards

The Federal Energy Regulatory Commission licenced Merced Irrigation District to operate New Exchequer and McSwain dams in 1964 (Project No. 2179). In 1967, Merced Irrigation District executed Davis-Grunsky Contract No. D-GGR17 with CDWR. Both the FERC licence and Davis-Grunsky contract provide minimum flow standards.

FERC licence: The FERC license establishes two water year types (summarized in Exhibit No. WRINT Merced-3.0, testimony by Ted. C. Selb, Assistant Manager and Engineer, Merced Irrigation District), dry and normal, determined by the April 1 to July 31 forecasted unimpaired runoff into New Exchequer Reservoir. Forecasts are made by the CDWR on May 1. Years in which unimpaired runoff is forecasted to be less than 450,000 af are designated dry water years. Years in which unimpaired runoff is forecasted to be greater than 450,000 af are designated normal water years. Based on water year type, the FERC license requires minimum monthly flows that are measured at Shaffer Bridge, about 20 miles downstream of Crocker-Hoffman Dam. Annual releases are about 33,000 af in dry water years and 44,000 af in normal water years. The licence also stipulates a minimum storage pool in Lake McClure, provides 15,000 af of water to the Merced National Wildlife Refuge, and requires that if the average flow from 1 November to 31 December is greater than 150 cfs, exclusive of flood spills and emergency releases, then flow from 1 January to 31 March would not be less than 100 cfs.

Davis-Grunsky contract: The Davis-Grunsky Contract requires minimum flows of 180-220 cfs for November 1 to March 31, measured at Shaffer Bridge (summarized in Exhibit No. WRINT Merced-3.0, testimony by Ted. C. Selb, Assistant Manager and Engineer, Merced Irrigation District). Because a range of monthly flows is stipulated in the Davis-Grunsky, we assumed that the minimum of the range would apply in dry water years, as defined in the FERC licence, and the maximum of the range of flows would apply in normal water years. Thus, annual minimum flow standards of the FERC licence and Davis-Grunsky contract are about 67,000 af in dry water years and 84,000 af in normal water years.

Other standards: Pursuant to an adjudicated settlement, Merced Irrigation District is required to release 50 to 250 cfs monthly, contingent upon inflow to Lake McClure during October to February, to supply seven riparian diversions. Because all diversions are located upstream of Shaffer Bridge, the gaging site for the FERC licence and Davis-Grunsky contract, we did not include flows for riparian diversions in the existing standards.

Recommendations

The CDFG and USFWS have provided flow recommendations for the Merced River. Preliminary flow recommendations were made by CDFG in "Restoring Central Valley Streams: A Plan for Action" (CDFG 1993). Recommendations made by the USFWS were developed by the Anadromous Fish Restoration Program in the AFRP Working Paper (USFWS 1995).

California Department of Fish and Game: The CDFG (1993) noted that existing standards in the Merced River are likely inadequate to accommodate migration, spawning, egg incubation, juvenile rearing, and smolt emigration of fall-run chinook salmon, especially during the spring emigration and fall immigration periods. Although instream flow studies have not been completed but are presently underway (W. Loudermilk, CDFG Region 4, Fresno, personnel communication), CDFG (1993) provided interim flow recommendations based on instream flow study and smolt survival data from drainages similar to the Merced River.

Interim recommendations were made for five water-year types according to the San Joaquin River 60-20-20 Index; and recommendations for each year type include volumes of water for spring outmigration (April-May) and fall attraction (October). The recommendations during the spring are consistent with CDFG flow objectives for the San Joaquin River at Vernalis. To determine whether releases are depleted by riparian diversions, the CDFG (1993) also recommended that flows should be measured by CDWR gages at Crocker-Hoffman Diversion Dam and Snelling, and downstream of Snelling. Even though implementing the recommendations would improve conditions beyond the existing standards, CDFG believed that the resulting conditions would not be optimal for chinook salmon spawning, rearing, or emigration, especially in dry years (CDFG 1993).

AFRP Working Paper: The AFRP developed flow recommendations that, in conjunction with other restoration actions, would result in at least doubling natural production of fall-run chinook salmon relative to the average attained during 1967-1991. The recommendations were based on the proportion of unimpaired flow that the Merced River contributes to the San Joaquin River, the historic hydrological regime, and results of an Instream Flow Incremental Methodology (IFIM) study conducted for drainages similar to the Merced River (USFWS 1995). Additional assumptions were that flows greater than historical flows in the lower reach of the river are needed to compensate for elimination of access to upstream habitat, and flows should not be reduced between spawning and outmigration to prevent redd dewatering and stranding of rearing juveniles. Recommendations were made for five water-year types according to the San Joaquin River 60-20-20 Index. Recommendations apply to the entire lower Merced River, Crocker-Hoffman Diversion Dam to the confluence of the San Joaquin River.

Draft guidelines for allocation of acquired water

The following tables contain draft guidelines for allocation of acquired water. Table 2 applies to a dry water year, as defined in the FERC licence, using the minimum range of flows in the Davis-Grunsky contract. Table 3 applies to a normal water year using the maximum range of flows in the Davis-Grunsky contract.

Table 2. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Merced River in dry water years pursuant to FERC License No. 2179 and the low range of flows contained in Davis-Grunsky Contract No. D-GGR17. The time periods in parentheses in the targeted life history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Merced River. The block of water will be managed to maximize benefits to anadromous fish, both in the Merced River and downstream, and in coordination with downstream water managers.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	6	6	FERC License No. 2179 minimum release for a normal water year and high range of Davis-Grunsky Contract No. D-GGR17.
2	Rearing and outmigration (April through May)	2	8	FERC License No. 2179 minimum release for a normal water year.
3	Incubation and rearing (January through March)	7	15	FERC License No. 2179 minimum release for a normal water year and high range of Davis-Grunsky Contract No. D-GGR17.
4	Over-summering (June through September)	2	17	FERC License No. 2179 minimum release for a normal water year.
5	Spawning and incubation (October through December)	29	46	CDFG (1993) recommended minimum release for a critical water year.
6	Rearing and outmigration (April through May)	30	76	CDFG (1993) recommended minimum release for a critical water year.
7	Over-summering (June through September)	42	118	CDFG (1993) recommended minimum release for a critical water year.

8	Spawning and incubation (October through December)	9	127	CDFG (1993) recommended minimum release for a below normal water year.
9	Rearing and outmigration (April through May)	23	150	CDFG (1993) recommended minimum release for a dry water year.
10	Incubation and rearing (January through March)	15	165	USFWS (1995) minimum releases for a critical water year.
11	Rearing and outmigration (April through May)	35	200	USFWS (1995) minimum releases for a critical water year.
12	Over-summering (June through September)	15	215	USFWS (1995) minimum releases for a critical water year.
13	Rearing and outmigration (April through May)	33	248	USFWS (1995) minimum releases for a dry water year.
14	Incubation and rearing (January through March)	9	257	USFWS (1995) minimum releases for a dry water year.
15	Over-summering (June through September)	12	269	USFWS (1995) minimum releases for a dry water year.
16	Spawning and incubation (October through December)	10	279	USFWS (1995) minimum releases for a wey water year.
17	Rearing and outmigration (April through May)	46	325	USFWS (1995) minimum releases for a below normal water year.
18	Incubation and rearing (January through March)	16	341	USFWS (1995) minimum releases for a below normal water year.
19	Over-summering (June through September)	10	351	CDFG (1993) recommended minimum release for a wet normal water year.
20	Rearing and outmigration (April through May)	46	397	USFWS (1995) minimum releases for an above normal water year.
21	Incubation and rearing (January through March)	76	473	USFWS (1995) minimum releases for an above normal water year.
22	Over-summering (June through September)	29	502	USFWS (1995) minimum releases for a below normal water year.

23	Rearing and outmigration (April through May)	66	568	USFWS (1995) minimum releases for a wet water year.
24	Incubation and rearing (January through March)	81	649	USFWS (1995) minimum releases for a wet water year.
25	Over-summering (June through September)	136	785	USFWS (1995) minimum releases for a wet water year.

Table 3. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Merced River in normal water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	29	29	CDFG (1993) recommended minimum release for a critical water year.
2	Rearing and outmigration (April through May)	30	59	CDFG (1993) recommended minimum release for a critical water year.
3	Over-summering (June through September)	42	101	CDFG (1993) recommended minimum release for a critical water year.
4	Spawning and incubation (October through December)	9	110	CDFG (1993) recommended minimum release for a below normal water year.
5	Rearing and outmigration (April through May)	23	133	CDFG (1993) recommended minimum release for a dry water year.
6	Incubation and rearing (January through March)	15	148	USFWS (1995) minimum releases for a critical water year.
7	Rearing and outmigration (April through May)	35	183	USFWS (1995) minimum releases for a critical water year.
8	Over-summering (June through September)	15	198	USFWS (1995) minimum releases for a critical water year.
9	Rearing and outmigration (April through May)	33	231	USFWS (1995) minimum releases for a dry water year.

10	Incubation and rearing (January through March)	9	240	USFWS (1995) minimum releases for a dry water year.
11	Over-summering (June through September)	12	252	USFWS (1995) minimum releases for a dry water year.
12	Spawning and incubation (October through December)	10	262	USFWS (1995) minimum releases for a wey water year.
13	Rearing and outmigration (April through May)	46	308	USFWS (1995) minimum releases for a below normal water year.
14	Incubation and rearing (January through March)	16	324	USFWS (1995) minimum releases for a below normal water year.
15	Over-summering (June through September)	10	334	CDFG (1993) recommended minimum release for a wet normal water year.
16	Rearing and outmigration (April through May)	46	380	USFWS (1995) minimum releases for an above normal water year.
17	Incubation and rearing (January through March)	76	456	USFWS (1995) minimum releases for an above normal water year.
18	Over-summering (June through September)	29	485	USFWS (1995) minimum releases for a below normal water year.
19	Rearing and outmigration (April through May)	66	551	USFWS (1995) minimum releases for a wet water year.
20	Incubation and rearing (January through March)	81	632	USFWS (1995) minimum releases for a wet water year.
21	Over-summering (June through September)	136	768	USFWS (1995) minimum releases for a wet water year.

Tuolumne River

The following tables present salmon life history priorities and draft guidelines for allocation of acquired water on the Tuolumne River. The primary species of concern is fall-run chinook salmon. We prioritize salmon life-history stages (Table 1) for use in conjunction with the existing standards to generate guidelines for allocation of acquired water in the Tuolumne River. Steelhead may also be present in the river in some years, but natural production of steelhead is unlikely. However, given their presence, steelhead should benefit coincidentally from allocated water prioritized for salmon. Although the AFRP Working Paper provided flows for American shad, these flows were less than those needed for chinook salmon.

In 1996 FERC adopted the minimum instream flows for fish presented in the 1995 New Don Pedro Settlement Agreement. We consider this existing standard as the baseline for our prioritized water allocation scheme that follows in Tables 2 through 8. In addition to the standard we consider five additional minimum flow recommendations to assist in incremental allocation of prioritized blocks of water to benefit anadromous fish production; the first four are summarized and presented in the 1996 FERC Final Environmental Impact Statement for the New Don Pedro Project. These recommendations are 1) 1992, Turlock Irrigation District, Modesto Irrigation District and the California Department of Fish and Game(Districts and CDFG), 2) 1993, City and County of San Francisco (CCSF), 3) 1993, U. S. Fish and Wildlife Service (USFWS), 4) 1996 Federal Energy Regulatory Commission (FERC) staff, and 5) 1995, the Anadromous Fish Restoration Program (AFRP) Working Paper. The guidelines for each of the water-year types are bracketed on the lower end by the 1996 standard for the year type and on the upper end by the AFRP Working Paper flows. Although our allocation tables use the designated standards as the foundation to add acquired water to, we expect that both the PEIS and the water acquisition program will consider the existing conditions to be the foundation. Likewise, we expect that the upper-end bracket will be determined by the PEIS estimate of the amount of water available for acquisition, rather than by the Working Paper flows.

Species and life-history stage priorities

On the Tuolumne River, the primary species of concern is fall-run chinook salmon. Steelhead may also be present in the Tuolumne River in some years, but natural production of steelhead in the river is unlikely. Although the AFRP Working Paper provided flows for American shad, these flows were less than those needed for chinook salmon. Table 1 prioritizes life-history stages for use in conjunction with the existing standards to generate guidelines for allocation of acquired water in the Tuolumne River. This table is an adaptation of the tables the long-term water management planning folks have produced. I generated the priorities and objectives based on Roger Guinee's preliminary draft recommendations for the Tuolumne River and on input from Bill Loudermilk of CDFG.

Table 1. Draft water allocation priorities for (b)(3) water on the Tuolumne River. The time periods in parentheses in the life history stage column are approximate time periods when that life-history stage is present in the river. Actual time periods vary, dependent on run-timing, environmental conditions, and rate of development.

Priority	Life-history stage	Objective
1	Spawning and incubation (October through December)	Improve attraction flows and provide adequate water temperatures for fall-run chinook salmon migrating into and spawning and incubating in the Tuolumne River.
3	Incubation and rearing (January through March)	Improve spawning, incubating, and rearing flows and related habitat conditions for fall-run chinook salmon, and benefit sturgeon, striped bass, and other species through contribution to San Joaquin River flows and Delta outflows.
2	Rearing and outmigration (April through May)	Improve rearing and outmigration flows and related habitat conditions and provide adequate temperatures for fall-run chinook salmon in the Tuolumne River; and contribute to improved conditions for survival of San Joaquin basin and Delta tributary fall-run chinook salmon migrating through the San Joaquin River and the Delta, and benefit other riverine and estuarine species, including other anadromous fish, through contribution to San Joaquin River flows and Delta outflows.
4	Over-summering (June through September)	Improve rearing habitat for over-summering juvenile chinook salmon and steelhead.

Existing standards

The conditions of the standards are described in the 1995 New Don Pedro Settlement Agreement (Settlement Agreement). The stated focus of the flow agreement is specifically for restoration of fall-run chinook salmon, but generally for the whole anadromous fishery downstream of the project. This standard specifies minimum water releases from New Don Pedro Reservoir, measured at the La Grange bridge. The agreement uses ten water-year types, but in practice there are only seven year types as the last four year types all allocate the same amount of water in normal and wetter conditions. Water allocation by year type ranges from 94 thousand acre-feet (TAF) to 301 TAF. Water-year types are defined using the 60-20-20 San Joaquin Index, a weighted average index that accounts for projected April through July San Joaquin River unimpaired runoff (60%), the current year's estimated October through March runoff in the San Joaquin River (20%), and the previous year's index (20%). The six drier year type standards provide incremental increases in allocated water as the year type classification becomes wetter. In addition to specific flow schedules by year type, the Settlement Agreement provides variable sized blocks of water for smolt outmigration in each year type, and fall attraction pulses in the six wettest water-year types. The Settlement Agreement proposes a flexible adaptive management approach for use of these outmigration and upmigration pulses.

Recommendations

Turlock Irrigation District and Merced Irrigation District and California Department of Fish and Game: The Districts and CDFG recommendation defines specific flow schedules for different times of the year, including spring pulse flows for smolt out-migration for 10 different water-year types. Water allocation by year type ranges from a low of 64 TAF to 374 TAF. Water-year types are calculated based on actual and predicted regulated inflows to New Don Pedro Reservoir. The year type classification is reassessed multiple times during each year incorporating recent inflow and updated inflow predictions. This recommendation results in a general annual unimodal release schedule with a maxima in the spring, and thus is somewhat representative of the natural hydrograph.

City and County of San Francisco: The CCSF recommendation defines 11 different water-year types allocating a minimum of 64 TAF in the driest years to a maximum of 250 TAF in the wettest year types. CCSF water-year types are defined using unimpaired flows at the La Grange gage. Water-year types are calculated and redefined on April 15, May 15, and June 15, and are based on the sum of year-to-date and forecasted unimpaired runoff. This recommendation is bimodal with a two-day fall attraction flow specified for October and increased flows for outmigration in May, summer rearing flows are also provided.

U.S. Fish and Wildlife Service: The USFWS flow recommendation integrates the relationship between temperature and flow, and flow and physical habitat recognizing that habitat components in addition to physical space should be considered in flow allocation. The FWS produced annual flow schedules for four different water-year types, ranging in a minimum annual release of 120 TAF to a maximum of 304 TAF. Water-years are partitioned based on unimpaired flow in the Tuolumne basin; however, the FWS has not identified a specific method to determine how forecasts are to be used to determine unimpaired flow or the dates on which water-year types would be evaluated. Differing from the standard and the two previous recommendations no specific pulse or attraction flows are built into the minimum flow schedules.

Federal Energy Regulatory Commission staff: FERC describes only three water-year types that allocate minimum annual totals of water ranging from 84 TAF to 376 TAF. The year types are defined using unimpaired annual flow at the La Grange gage, similar to the definition of water-year type used by the CCSF and FWS but differing in breakpoint definition resulting in the three water-year types. FERC staff used a water balance model, the Hetch-Hetchy Simulation Model (HHSM), and a salmon production model or the Oak RidgeChinook Model (ORCM) to generate minimum instream flow recommendations that attempt to maximize both fishery and water user benefits and minimize costs to both. The ORCM model uses spawner escapement, daily flow data, water and air temperature and weighted usable area (WUA) data to produce smolt production estimates in this individual based model. For years of normal and wet hydrology FERC staff used an iterative process with HHSM model to generate a minimum instream flow that produced the highest number of salmon smolts. Then they capped the minimum annual flow at 357 TAF, the level where smolt increase per unit flow increased approached zero. From this cap, additional fall attraction flows were added, because this aspect of life history is not well accounted for in the model. Also, additional summer flows were added to provide for other non-salmon objectives.

In critical and dry years a similar iterative process was followed but they incorporated a balance between the ORCM model and the ORCM model.

AFRP Working Paper: The AFRP Working Paper presents minimum instream flows for five water-year types and allocates minimum annual totals of water ranging from 411 TAF to 1,544 TAF. Water-year types are based on the San Joaquin Basin 60-20-20 index described above for the existing standard. The Working Paper recommendations produce a unimodal fish allocation that peaks in the spring. Recommended fall and summer flow are derived from Instream Flow Incremental Methodology (IFIM) data. Winter and spring flow recommendations were guided both by historical monthly distribution of total annual unimpaired runoff for the Tuolumne River Basin and Vernalis flow requirements. The intent of the Working Paper flow recommendations was contribute to doubling production of Tuolumne River fall-run chinook salmon and to provide benefit to anadromous fish downstream in the San Joaquin River and Delta.

Draft guidelines for allocation of acquired water

The following tables show the draft guidelines for allocation of acquired water for each of the water-year types for which the existing standards were developed. The guidelines for each of the water-year types are bracketed on the lower end by the standard for the year type and on the upper end by the AFRP Working Paper flows that apply to the year type. Ultimately, I expect that the upper-end bracket will be determined by the PEIS estimate of the amount of water available for acquisition, rather than by the Working Paper flows.

Table 2. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Tuolumne River in critical and below water years. The time periods in parentheses in the targeted life history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Tuolumne River. The block of water will be managed to maximize benefits to anadromous fish, both in the Tuolumne River and downstream, and in coordination with the Lower Tuolumne River Technical Advisory Committee and downstream water managers.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Rearing and outmigration (April through May)	9	9	New Don Pedro Proceeding Settlement Agreement (Settlement Agreement) minimum releases for a median critical water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
2	Spawning and incubation (October through December)	1	10	Settlement Agreement minimum releases for an intermediate critical-dry water year.
3	Rearing and outmigration (April through May)	17	27	Settlement Agreement minimum releases for intermediate critical-dry and median dry water years.
4	Over-summering (June through September)	6	33	Settlement Agreement minimum releases for a median dry water year.
5	Spawning and incubation (October through December)	7	40	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
6	Rearing and outmigration (April through May)	2	42	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
7	Incubation and rearing (January through March)	5	47	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
8	Rearing and outmigration (April through May)	24	71	Settlement Agreement minimum releases for a median below normal water year.
9	Spawning and incubation (October through December)	26	97	Settlement Agreement minimum releases for median above normal and wetter water years.
10	Rearing and outmigration (April through May)	45	142	Settlement Agreement minimum releases for median above normal and wetter water years.
11	Incubation and rearing (January through March)	22	164	Settlement Agreement minimum releases for median above normal and wetter water years.
12	Over-summering (June through September)	42	206	Settlement Agreement minimum releases for median above normal and wetter water years.
13	Rearing and outmigration (April through May)	29	235	TID and MID (1992) recommended minimum releases for an intermediate above normal/wet water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
14	Spawning and incubation (October through December)	20	255	USFWS (1993) recommended minimum releases a critical water year.
15	Rearing and outmigration (April through May)	18	273	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
16	Incubation and rearing (January through March)	34	307	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
17	Over-summering (June through September)	27	334	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
18	Rearing and outmigration (April through May)	38	372	TID and MID (1992) recommended minimum releases for a median wet/maximum water year.
19	Incubation and rearing (January through March)	11	383	AFRP Working Paper (USFWS 1995) minimum releases for a critical water year.

Table 3. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Tuolumne River in median critical water years. See the caption for Table 2 for a more complete description of the columns and a definition of water-year types.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	1	1	Settlement Agreement minimum releases for an intermediate critical-dry water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
2	Rearing and outmigration (April through May)	17	18	Settlement Agreement minimum releases for intermediate critical-dry and median dry water years.
3	Over-summering (June through September)	6	24	Settlement Agreement minimum releases for a median dry water year.
4	Spawning and incubation (October through December)	7	31	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
5	Rearing and outmigration (April through May)	2	33	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
6	Incubation and rearing (January through March)	5	38	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
7	Rearing and outmigration (April through May)	24	62	Settlement Agreement minimum releases for a median below normal water year.
8	Spawning and incubation (October through December)	26	88	Settlement Agreement minimum releases for median above normal and wetter water years.
9	Rearing and outmigration (April through May)	45	133	Settlement Agreement minimum releases for median above normal and wetter water years.
10	Incubation and rearing (January through March)	22	155	Settlement Agreement minimum releases for median above normal and wetter water years.
11	Over-summering (June through September)	42	197	Settlement Agreement minimum releases for median above normal and wetter water years.
12	Rearing and outmigration (April through May)	29	226	TID and MID (1992) recommended minimum releases for an intermediate above normal/wet water year.
13	Spawning and incubation (October through December)	20	246	USFWS (1993) recommended minimum releases a critical water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
14	Rearing and outmigration (April through May)	18	264	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
15	Incubation and rearing (January through March)	34	298	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
16	Over-summering (June through September)	27	325	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
17	Rearing and outmigration (April through May)	38	363	TID and MID (1992) recommended minimum releases for a median wet/maximum water year.
18	Incubation and rearing (January through March)	11	374	AFRP Working Paper (USFWS 1995) minimum releases for a critical water year.

Table 4. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Tuolumne River in intermediate critical-dry water years. See the caption for Table 2 for a more complete description of the columns and a definition of water-year types.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Rearing and outmigration (April through May)	2	2	Settlement Agreement minimum releases for a median dry water year.
2	Over-summering (June through September)	6	8	Settlement Agreement minimum releases for a median dry water year.
3	Spawning and incubation (October through December)	7	15	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
4	Rearing and outmigration (April through May)	2	17	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
5	Incubation and rearing (January through March)	5	22	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
6	Rearing and outmigration (April through May)	24	46	Settlement Agreement minimum releases for a median below normal water year.
7	Spawning and incubation (October through December)	26	72	Settlement Agreement minimum releases for median above normal and wetter water years.
8	Rearing and outmigration (April through May)	45	117	Settlement Agreement minimum releases for median above normal and wetter water years.
9	Incubation and rearing (January through March)	22	139	Settlement Agreement minimum releases for median above normal and wetter water years.
10	Over-summering (June through September)	42	181	Settlement Agreement minimum releases for median above normal and wetter water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
11	Rearing and outmigration (April through May)	29	210	TID and MID (1992) recommended minimum releases for an intermediate above normal/wet water year.
12	Spawning and incubation (October through December)	20	230	USFWS (1993) recommended minimum releases a critical water year.
13	Rearing and outmigration (April through May)	18	248	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
14	Incubation and rearing (January through March)	34	282	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
15	Over-summering (June through September)	27	309	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
16	Rearing and outmigration (April through May)	38	347	TID and MID (1992) recommended minimum releases for a median wet/maximum water year.
17	Incubation and rearing (January through March)	11	358	AFRP Working Paper (USFWS 1995) minimum releases for a critical water year.
18	Rearing and outmigration (April through May)	56	414	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
19	Incubation and rearing (January through March)	26	440	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
20	Over-summering (June through September)	32	472	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.

Table 5. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Tuolumne River in median dry water years. See the caption for Table 2 for a more complete description of the columns and a definition of water-year types.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	7	7	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
2	Rearing and outmigration (April through May)	2	9	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
3	Incubation and rearing (January through March)	5	14	Settlement Agreement minimum releases for an intermediate dry-below normal water year.
4	Rearing and outmigration (April through May)	24	38	Settlement Agreement minimum releases for a median below normal water year.
5	Spawning and incubation (October through December)	26	64	Settlement Agreement minimum releases for median above normal and wetter water years.
6	Rearing and outmigration (April through May)	45	109	Settlement Agreement minimum releases for median above normal and wetter water years.
7	Incubation and rearing (January through March)	22	131	Settlement Agreement minimum releases for median above normal and wetter water years.
8	Over-summering (June through September)	42	173	Settlement Agreement minimum releases for median above normal and wetter water years.
9	Rearing and outmigration (April through May)	29	202	TID and MID (1992) recommended minimum releases for an intermediate above normal/wet water year.
10	Spawning and incubation (October through December)	20	222	USFWS (1993) recommended minimum releases a critical water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
11	Rearing and outmigration (April through May)	18	240	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
12	Incubation and rearing (January through March)	34	274	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
13	Over-summering (June through September)	27	301	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
14	Rearing and outmigration (April through May)	38	339	TID and MID (1992) recommended minimum releases for a median wet/maximum water year.
15	Incubation and rearing (January through March)	11	350	AFRP Working Paper (USFWS 1995) minimum releases for a critical water year.
16	Rearing and outmigration (April through May)	56	406	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
17	Incubation and rearing (January through March)	26	432	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
18	Over-summering (June through September)	32	464	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.

Table 6. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Tuolumne River in intermediate dry-below normal water years. See the caption for Table 2 for a more complete description of the columns and a definition of water-year types.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Rearing and outmigration (April through May)	24	24	Settlement Agreement minimum releases for a median below normal water year.
2	Spawning and incubation (October through December)	26	50	Settlement Agreement minimum releases for median above normal and wetter water years.
3	Rearing and outmigration (April through May)	45	95	Settlement Agreement minimum releases for median above normal and wetter water years.
4	Incubation and rearing (January through March)	22	117	Settlement Agreement minimum releases for median above normal and wetter water years.
5	Over-summering (June through September)	42	159	Settlement Agreement minimum releases for median above normal and wetter water years.
6	Rearing and outmigration (April through May)	29	188	TID and MID (1992) recommended minimum releases for an intermediate above normal/wet water year.
7	Spawning and incubation (October through December)	20	208	USFWS (1993) recommended minimum releases a critical water year.
8	Rearing and outmigration (April through May)	18	226	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
9	Incubation and rearing (January through March)	34	260	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
10	Over-summering (June through September)	27	287	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
11	Rearing and outmigration (April through May)	38	325	TID and MID (1992) recommended minimum releases for a median wet/maximum water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
12	Incubation and rearing (January through March)	11	336	AFRP Working Paper (USFWS 1995) minimum releases for a critical water year.
13	Rearing and outmigration (April through May)	56	392	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
14	Incubation and rearing (January through March)	26	418	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
15	Over-summering (June through September)	32	450	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
16	Rearing and outmigration (April through May)	79	529	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
17	Incubation and rearing (January through March)	39	568	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
18	Over-summering (June through September)	90	658	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.

Table 7. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Tuolumne River in median below normal water years. See the caption for Table 2 for a more complete description of the columns and a definition of water-year types.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	26	26	Settlement Agreement minimum releases for median above normal and wetter water years.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
2	Rearing and outmigration (April through May)	45	71	Settlement Agreement minimum releases for median above normal and wetter water years.
3	Incubation and rearing (January through March)	22	93	Settlement Agreement minimum releases for median above normal and wetter water years.
4	Over-summering (June through September)	42	135	Settlement Agreement minimum releases for median above normal and wetter water years.
5	Rearing and outmigration (April through May)	29	164	TID and MID (1992) recommended minimum releases for an intermediate above normal/wet water year.
6	Spawning and incubation (October through December)	20	184	USFWS (1993) recommended minimum releases a critical water year.
7	Rearing and outmigration (April through May)	18	202	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
8	Incubation and rearing (January through March)	34	236	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
9	Over-summering (June through September)	27	263	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
10	Rearing and outmigration (April through May)	38	301	TID and MID (1992) recommended minimum releases for a median wet/maximum water year.
11	Incubation and rearing (January through March)	11	312	AFRP Working Paper (USFWS 1995) minimum releases for a critical water year.
12	Rearing and outmigration (April through May)	56	368	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
13	Incubation and rearing (January through March)	26	394	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
14	Over-summering (June through September)	32	426	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
15	Rearing and outmigration (April through May)	79	505	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
16	Incubation and rearing (January through March)	39	544	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
17	Over-summering (June through September)	90	634	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.

Table 8. Draft guidelines for allocation of water acquired pursuant to Section 3406(b)(3) of the CVPIA for use on the Tuolumne River in above normal water years (including intermediate below normal-above normal, median above normal, intermediate above normal-wet, and median wet/maximum water years). See the caption for Table 2 for a more complete description of the columns and a definition of water-year types.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Rearing and outmigration (April through May)	29	29	TID and MID (1992) recommended minimum releases for an intermediate above normal/wet water year.
2	Spawning and incubation (October through December)	20	49	USFWS (1993) recommended minimum releases a critical water year.
3	Rearing and outmigration (April through May)	18	67	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
4	Incubation and rearing (January through March)	34	101	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
5	Over-summering (June through September)	27	128	FERC (1996) staff recommended minimum releases for a normal/wet water year based on FERC's experience with a salmon production model.
6	Rearing and outmigration (April through May)	38	166	TID and MID (1992) recommended minimum releases for a median wet/maximum water year.
7	Incubation and rearing (January through March)	11	177	AFRP Working Paper (USFWS 1995) minimum releases for a critical water year.
8	Rearing and outmigration (April through May)	56	233	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
9	Incubation and rearing (January through March)	26	259	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
10	Over-summering (June through September)	32	291	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
11	Rearing and outmigration (April through May)	79	370	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
12	Incubation and rearing (January through March)	39	409	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
13	Over-summering (June through September)	90	499	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
14	Spawning and incubation (October through December)	50	549	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
15	Rearing and outmigration (April through May)	58	607	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.
16	Incubation and rearing (January through March)	106	713	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.
17	Over-summering (June through September)	60	773	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.
18	Spawning and incubation (October through December)	76	849	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
19	Rearing and outmigration (April through May)	88	937	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
20	Incubation and rearing (January through March)	93	1030	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
21	Over-summering (June through September)	209	1239	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.

Stanislaus River

Stanislaus River stream flows are regulated primarily by water released from New Melones Dam, which is operated by the USBR. Flows are also regulated farther downstream by Tulloch and Goodwin dams, but their storage is relatively small compared to storage in New Melones Reservoir. Goodwin Dam forms the upstream limit of anadromous fish in the Stanislaus River. Fall-run chinook salmon and possibly late-fall-run chinook salmon and steelhead are found in the river. Flow standards were established by an agreement between the CDFG and USBR, and also by a SWRCB decision. Flow recommendations were provided by the CDFG and USFWS, both in 1993. The USFWS later identified additional flow needs.

Species and life-history stage priorities

The primary species of concern in the Stanislaus River is fall-run chinook salmon. Late-fall-run chinook salmon and steelhead may also be present. Table 1 prioritizes life-history stages for use in conjunction with the existing standards to generate guidelines for allocation of acquired water in the Stanislaus River.

Table 1. Draft water allocation priorities for water on the Stanislaus River. The time periods in parentheses in the life-history stage column are approximate time periods when that life-history stage is present in the river. Actual time periods vary, dependent on run-timing, environmental conditions, and rate of development.

Priority	Life-history stage	Objective
1	Spawning and incubation (October through December)	Improve attraction flows and provide adequate water temperatures for fall-run chinook salmon migrating into and spawning and incubating in the Stanislaus River.
3	Incubation and rearing (January through March)	Improve spawning, incubating, and rearing flows and related habitat conditions for fall-run chinook salmon, and benefit sturgeon, striped bass, and other species through contribution to San Joaquin River flows and Delta outflows.
2	Rearing and outmigration (April through May)	Improve rearing and outmigration flows and related habitat conditions and provide adequate temperatures for fall-run chinook salmon in the Stanislaus River; and contribute to improved conditions for survival of San Joaquin basin and Delta tributary fall-run chinook salmon migrating through the San Joaquin River and the Delta, and benefit other riverine and estuarine species, including other anadromous fish, through contribution to San Joaquin River flows and Delta outflows.
4	Over-summering (June through September)	Improve rearing habitat for over-summering juvenile chinook salmon and steelhead.

Existing standards

The existing standards are specified in a 1987 study agreement between the CDFG and USBR (CDFG and USBR 1987). The agreement specifies interim annual water allocations of 98,300-302,000 af depending on New Melones Reservoir carryover storage and inflow. Annual flow schedules are determined by the CDFG.

In addition to flows for fish, a SWRCB decision (SWRCB D-1422, April 1973) estimated that at least 70,000 af of water is available annually for release to meet water quality requirements in the lower Stanislaus River and at Vernalis on the San Joaquin River. The SWRCB decision also stated water quality goals for dissolved oxygen in the Stanislaus River. Because water quality requirements are often not met with 70,000 af of water, the USBR commonly releases additional water in an attempt to meet the SWRCB D-1422 standards on the lower San Joaquin River.

To estimate existing standards, we used USBR estimates that 98,300 af of water would be allocated to fish in critical to above normal water years of the San Joaquin River basin 60-20-20 index and 302,000 af would be allocated during wet water years (Jeff Sandberg, USBR, personal communication, September 1996). Because flows for water quality and dissolved oxygen requirements benefit fish, we assumed that 220-250 cfs would be released from June through September for these requirements in critical to above normal water years. Although lower summer flows can occur when water quality and dissolved oxygen standards are satisfied (Jeff Sandberg, USBR, personal communication, September 1996). Therefore, we have used 157,816 af pattern for the exiting standard in critical to above normal water years and 302,000 in wet water years.

Because monthly flow allocations for the two existing standards vary annually, we used mean monthly flows provided by CDFG to CH2MHill (letter dated 23 August 1996) to allocate 98,300 af for critical to above normal water years, and added the summer flows to meet water quality requirements (Table 1). Monthly allocations for wet water years were based on the flow schedule CDFG submitted to the USBR for allocation of the 302,000 af in 1996-1997 (17 April 1996 letter from CDFG to USBR).

Table 2. Estimated existing standards for the Stanislaus River in critical to above normal and wet water-year types.

Month	Flow in critical to above normal year for fish (cfs)	Minimum estimated flow for water quality (cfs)[a]	Flow in wet year for fish (cfs)
October	111	0	300
November	200	0	300
December	200	0	300
January	125	0	300
February	125	0	300
March	189	0	300
April	500	0	700
May	250	0	800
June	0	220	800
July	0	230	300
August	0	250	300
September	0	220	300

[a]Assumed minimum flow for water quality and dissolved oxygen for modeling purposes.

Recommendations

Flow recommendations have been made by the CDFG and USFWS. The USFWS made flow recommendations based on an instream flow study and subsequently identified additional flow needs in the AFRP Working Paper..

California Department of Fish and Game: The CDFG (1993) provides interim flow recommendations for the Stanislaus River. Recommendations are intended to improve conditions for fall-run chinook salmon. Recommendations are based on results of an instream flow study conducted by the USFWS (Aceituno 1993) for October through March and smolt survival studies conducted by CDFG for April through May. Recommendations are provided for five water-year types in the 60-20-20 index of the San Joaquin River basin, ranging from 185,280 to 381,498 af. The recommendations also include blocks of water to be used for spawner attraction in October and outmigration in April and May.

USFWS instream flow study: The USFWS has provided recommendations based on an instream flow study using the Instream Flow Incremental Methodology (IFIM; Aceituno 1993). Flows were to provide adequate spawning, incubation, and rearing habitats for fall-run chinook salmon. A total of about 155,000 af is recommended, irrespective of water-year type. The study noted that to protect and preserve chinook salmon in the Stanislaus River, a comprehensive instream flow regime would need to consider factors that were not included in the IFIM study, such as water quality, temperature, attraction flows, and flow for juvenile emigrations.

AFRP Working Paper: The AFRP identified flow needs that, in conjunction with other restoration actions, would result in at least doubling natural production of fall-run chinook salmon relative to the average attained during 1967-1991. The needs were based on an IFIM study (Aceituno 1993), the proportion of unimpaired flow that the Stanislaus River contributes to the San Joaquin River, and the historic hydrological regime. Assumptions were that flows greater than historical flows in the lower reach of the river are needed to compensate for elimination of access to upstream habitat, and flows should not be reduced between spawning and outmigration to prevent redd dewatering and stranding of rearing juveniles. Recommendations were made for five water-year types, according to the San Joaquin River 60-20-20 Index. The identified that flows ranged from 290,000 to 943,000 af.

Draft guidelines for allocation of acquired water

The following tables show the draft guidelines for allocation of water managed under sections 3406(b)(1), (b)(2), and (b)(3) of the CVPIA. Allocations were developed relative to two water-year types established by the existing standards. A process to determine sources of water allocated in excess of the existing standards (i.e., from sections 3406(b)(1), (b)(2), and (b)(3) of the CVPIA) is being developed.

Table 2. Draft guidelines for allocation of water for use on Stanislaus River in critical to above normal water years. The time periods in parentheses in the targeted life-history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Stanislaus River. The block of water will be managed to maximize benefits to anadromous fish, both in the Stanislaus River and downstream, and in coordination with downstream water managers.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	21	21	USFWS (Aceituno 1993) recommended minimum releases for spawning and incubation.
2	Incubation and rearing (January through March)	9	30	USFWS (Aceituno 1993) recommended minimum releases for incubation and rearing.
3	Spawning and incubation (October through December)	7	37	CDFG (1993) recommended minimum releases for a critical water year.
4	Incubation and rearing (January through March)	4	41	CDFG (1993) recommended minimum releases for a critical water year.
5	Spawning and incubation (October through December)	5	46	CDFG (1993) recommended minimum releases for a dry water year.
6	Rearing and outmigration (April through May)	24	70	CDFG (1993) recommended minimum releases for a dry water year.
7	Incubation and rearing (January through March)	5	75	CDFG (1993) recommended minimum releases for a dry water year.
8	Spawning and incubation (October through December)	4	79	CDFG (1993) recommended minimum releases for a below normal water year.
9	Rearing and outmigration (April through May)	27	106	CDFG (1993) recommended minimum releases for a below normal water year.
10	Incubation and rearing (January through March)	4	110	CDFG (1993) recommended minimum releases for a below normal water year.
11	Over-summering (June through September)	5	115	CDFG (1993) recommended minimum releases for a below normal water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
12	Rearing and outmigration (April through May)	16	131	AFRP Working Paper (USFWS 1995) minimum releases for a critical water year.
13	Incubation and rearing (January through March)	22	153	AFRP Working Paper (USFWS 1995) minimum releases for a critical water year.
14	Over-summering (June through September)	42	195	Existing standard for a wet water year.
15	Spawning and incubation (October through December)	8	203	CDFG (1993) recommended minimum releases for an above normal water year.
16	Rearing and outmigration (April through May)	48	251	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
17	Incubation and rearing (January through March)	17	268	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
18	Spawning and incubation (October through December)	9	277	CDFG (1993) recommended minimum releases for a wet water year.
19	Rearing and outmigration (April through May)	70	347	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
20	Incubation and rearing (January through March)	26	373	AFRP Working Paper (USFWS 1995) releases for a below normal water year.
21	Over-summering (June through September)	26	399	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
22	Rearing and outmigration (April through May)	46	445	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.
23	Incubation and rearing (January through March)	74	519	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.
24	Over-summering (June through September)	27	543	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.
25	Spawning and incubation (October through December)	13	556	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
26	Rearing and outmigration (April through May)	64	607	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
27	Incubation and rearing (January through March)	62	669	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
28	Over-summering (June through September)	100	769	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.

Table 3. Draft guidelines for allocation of water for use on Stanislaus River in wet water years. The time periods in parentheses in the targeted life-history stage column are approximate time periods when the block of water identified in the block of water column would be allocated for the benefit of the targeted life-history stage. Actual time periods will be based on real-time observations of run-timing, rate of development, and behavior of chinook salmon in the Stanislaus River. The block of water will be managed to maximize benefits to anadromous fish, both in the Stanislaus River and downstream, and in coordination with downstream water managers.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
1	Spawning and incubation (October through December)	21	21	CDFG (1993) recommended minimum releases for an above normal water year.
2	Rearing and outmigration (April through May)	70	91	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
3	Incubation and rearing (January through March)	30	121	AFRP Working Paper (USFWS 1995) minimum releases for a dry water year.
4	Spawning and incubation (October through December)	9	130	CDFG (1993) recommended minimum releases for a wet water year.
5	Rearing and outmigration (April through May)	69	199	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
6	Incubation and rearing (January through March)	26	225	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.

Priority	Targeted life-history stage	Block of water (taf)	Cumulative total (taf)	Source
7	Over-summering (June through September)	27	252	AFRP Working Paper (USFWS 1995) minimum releases for a below normal water year.
8	Rearing and outmigration (April through May)	46	298	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.
9	Incubation and rearing (January through March)	74	372	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.
10	Over-summering (June through September)	27	399	AFRP Working Paper (USFWS 1995) minimum releases for an above normal water year.
11	Spawning and incubation (October through December)	13	412	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
12	Rearing and outmigration (April through May)	64	476	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
13	Incubation and rearing (January through March)	64	540	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.
14	Over-summering (June through September)	99	639	AFRP Working Paper (USFWS 1995) minimum releases for a wet water year.

Attachment G5

U.S. Fish And Wildlife Service
Draft Justification of 1997 Delta Flow And Habitat Objectives Using CVPIA Tools Pursuant To Section 3406(b)(1), (b)(2), And (b)(3) of The CVPIA
(Memorandum of October 25, 1996)

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Sacramento-San Joaquin Estuary Fishery Resource Office
4001 North Wilson Way, Stockton, CA 95205-2486
209-946-6400 (Voice) 209-946-6355 (Fax)

October 25, 1996

Dear Interested Party:

In my letter of October 10 and its attached workshop “flyer”, I announced a technical workshop on Wednesday, October 30, 1996 at 3310 El Camino Avenue, Sacramento in the Fish and Wildlife Services' basement conference rooms A and B.

As noted, the focus of this workshop will be to review the Anadromous Fish Restoration Programs' proposed fish flow and habitat objectives for those Central Valley rivers and the Delta upon which the Central Valley Project has direct influence due to their operational facilities. Our goal is to develop a final set of flow and habitat objectives that make the most effective use of the water resource “tools” of the CVPIA to benefit anadromous fish.

The attached enclosure describes our proposed (draft) fish flow and habitat objectives for your review prior to the workshop. We also supplement this list of objectives with a brief package of background information describing the objectives in more detail, the fish species and life stages targeted for benefit, a concise summary of the information supporting the objective and a evaluation/monitoring approach. Due to time constraints, background information on some objectives may not be available until the workshop.

We would appreciate your suggestions and recommendations from a biological perspective regarding the objectives themselves (i.e., Are they appropriate?, Need they be modified?) and their priority order (i.e., relative their magnitude of benefit, certainty of result, level of need, etc.).

We hope to have comprehensive input from fishery biologists with expertise on the diversity of anadromous fish and habitats represented in this effort. While our time on October 30th will be limited, we encourage your follow-up input via phone calls, E-mail, letter or, as time and staff resources allow, individual meetings and additional workshops.

Broad, technical input from the interested parties is important in designing the appropriate list of flow and habitat objectives. The final fish flow and habitat objectives will be used by the CVP in coordination with the SWP to develop the operations forecast for the 1997 water year. The final list of objectives will reflect the relative desirability of all biological priorities (both in Delta and upstream actions). As noted in my letter of October 10th, the next CVPIA workshop on November 13th will present the process and initial results of developing the CVP's 1997 operational forecast. This process includes a variety of modeling efforts that are underway to estimate the water supply costs of implementing these actions.

We look forward to your participation on the 30th and your continued assistance in developing the 1997 operational forecast.

Sincerely,

Martin A. Kjelson, Program Manager
Anadromous Fish Restoration Program

Anadromous Fish Restoration Program
Draft Justification of 1997 Delta Flow and Habitat Objectives
using CVPIA tools [Section 3406(b)(1)(B), (b)(2), (b)(3)]

INTRODUCTION

The goal of the Anadromous Fish Restoration Program (AFRP) is to make all reasonable efforts to at least double natural production of anadromous fish in Central Valley rivers and streams. Presently the Delta is governed by the 1995 Water Quality Control Plan (WQCP; SWRCB, 1995) whose basis was the Delta Accord (1994). A portion of the Central Valley Project Improvement Act (CVPIA) water resources are being used to meet conditions of the Delta Accord and WQCP and the remaining portion is proposed for use to increase production of anadromous fish in the Delta in addition to that provided by the Delta Accord. This document describes proposed flow and habitat objectives for the 1997 water year in addition to those occurring as a result of the Accord, using resources provided by the CVPIA.

Most of the proposed AFRP actions in the Delta would result in extending the time period for protective measures contained within the Delta Accord. These include limiting exports to 35% of inflow, moving the X_2 position downstream, and closing the cross channel gates. The Delta Accord targets protective measures during the late winter and spring period when the majority of anadromous fish are present.

Extending the time period of Delta Accord protective measures would increase the protection of anadromous fish in the fall, winter and summer months. For instance, protecting both the early and late outmigrants of the various salmon races would provide greater life history diversity relative to outmigration timing. Providing life history diversity would decrease the risk of artificially selecting a segment of the population based on outmigration timing, a trait possibly under genetic control. Extending Delta export limitations through the month of July would likewise extend protection to juvenile striped bass and other fish populations, which are vulnerable to entrainment in the summer.

We have selected actions in the Delta to increase the natural production of anadromous fish, but other resident species would likely benefit as well. We believe that the Delta Accord provides some protection to anadromous fish. Given the additional water resources available through the CVPIA, we believe the proposed actions will further improve the natural production of anadromous fish migrating or residing in the Delta, and contribute to the goal of the AFRP to make all reasonable efforts to at least double the natural production of anadromous fish in the Central Valley.

Each action is described in a template that provides a description of the action, including background information, the species and life history stages benefitted, selected key supporting data, monitoring and evaluation needs, and sources of information.

Biological justification for the protective measures contained within the Delta Accord are available in a variety of documents, such as EPA's "Review of State of California Water Quality

Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary Under Section 303 of the Federal Clean Water Act" (EPA, 1995), the USFWS's "Measures to Improve the protection of chinook salmon in the Sacramento/San Joaquin River Delta" (USFWS, 1992), California Department of Fish and Game's exhibits to the 1992 SWRCB hearings, and a variety of reports by the Interagency Ecological Program (IEP).

The AFRP is requesting that the interested parties review the actions and relative priorities and make comments to facilitate the most effective use of our water resources in increasing the natural production of anadromous fish in the Delta.

Citations

Delta Accord, 1994. Principles for Agreement on Bay-Delta Standards Between the State of California and the Federal Government. December 15, 1994.

EPA, 1995. Technical Support Memorandum: Review of State of California Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary Under Section 303 of the Federal Clean Water Act.

SWRCB, 1995. Environmental Report. Appendix 1 to Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.

USFWS, 1992 . Measures to Improve the Protection of Chinook Salmon in the Sacramento/San Joaquin River Delta. Expert Testimony of U.S. Fish and Wildlife Service on Chinook Salmon Technical Information for State Water Resources Control Board Water Rights Phase of the Bay/Delta Estuary Proceedings. July 6, 1992 WRINT-USFWS-7.

PROPOSED DELTA ANADROMOUS FISH RESTORATION PROGRAM
ACTIONS FOR THE 1997 WATER YEAR REQUIRING WATER
ABOVE THE BAY/DELTA ACCORD AND 1995 WQCP.

Priority

1. Limit the combined SWP and CVP exports so as to maintain a San Joaquin River at Vernalis inflow total export ratio during the 30 day, April through May pulse flow period (4/15 to 5/15) by water year type as follows: 5:1 wet, 4:1 above normal, 3:1 below normal, 3:1 dry/critical.

   Note: The Service and Bureau of Reclamation are working in conjunction with the Interagency Ecological Program (IEP) agencies, the San Joaquin Tributary group and the California Urban Water Association (CUWA) to determine how best to evaluate the benefits of the proposal action and if the action should be modified to some degree.

2. Continue to evaluate a temporary rock barrier at the head of Old River to improve conditions for chinook salmon migration and survival during the April 15- May 15, or other 30 day pulse period, consistent with the Corps of Engineers Permit to the Department of Water Resources and Fish and Wildlife Services' Biological Opinion on Delta smelt.

3. Increase the level of protection targeted by the May and June X_2 requirements to a 1962 level of development. This represents an increase in numbers of days when X_2 is required at Chipps Island in Table A of the 1995 WQCP as described below. PMI is previous months index.

	1962 LOD		IN WQCP	
PMI	MAY	JUNE	MAY	JUNE
500	0	0	0	0
750	0	0	0	0
1000	0	0	0	0
1250	0	0	0	0
1500	0	0	0	0
1750	1	0	0	0
2000	4	0	1	0
2250	13	1	3	0
2500	24	3	11	1
2750	29	7	20	2
3000	30	12	27	4
3250	31	18	29	8
3500	31	23	30	13
4000	31	28	31	18
4250	31	29	31	25
4500	31	29	31	27
4750	31	30	31	28

List of Delta actions

4. Maintain at least 13,000 cfs daily flow in the Sacramento River at the I street Bridge during May to improve transport of eggs and larval and striped bass and other young anadromous fish and to reduce egg settling and mortality at low flows. Provide 9000 cfs daily flow minimum at Knights Landing during May.

   Note: The 9,000 cfs is requested at Knights Landing since striped bass spawn above the mouth of the Feather and flow is needed there initially.

5. Ramp (linearly) the total CVP/SWP export level from whatever it is on 5/15 to meet Action 1 to those export levels proposed by projects to meet the 1995 WQCP on June 1, when salmon are present.

   Note: This is a new action and meant to prevent a quick rise in exports after May 15 when salmon and other anadromous fishes could be vulnerable to such an operational change.

6. Close the Delta Cross Channel (DCC) starting on November 1.

   Note: This action is meant to supplement that in the Accord and 1995 WQCP where it asks for a closure of up to 45 days based on the NMFS draft guidelines.

7. Limit the average CVP/SWP exports to no greater than 35% of Delta inflow in July. Sub priorities: 1) July 1- July 15, 2) July 16 - July 31.

8. Establish conditions for a CWT late fall run smolt survival experiment in Dec ‘97/Jan ‘98 at exports of 65 and 35% of DOF, respectfully.

9. Limit the average CVP/SWP exports to no greater than 35% of Delta inflow in the November-January period. Sub priorities: 1) January, 2) December, 3) November.

Delta Action 1: Limit the combined SWP and CVP exports so as to maintain a San Joaquin River at Vernalis inflow total export ratio during the 30 day, April through May pulse flow period (4/15 to 5/15) by water year type as follows : 5:1 wet, 4:1 above normal, 3:1 below normal, 3:1 dry/critical.

Description: The proposed action establishes ratios of Vernalis flow to combined SWP and CVP exports (VFER) from mid-April to mid-May. Three values of VFER are proposed and vary with water-year type. Attaining the ratios will depend on coordination among SWP and CVP operators that control exports and the USBR and private reservoir operators that regulate dam releases influencing flow at Vernalis. Three tools provided by Section 3406 of the Central Valley Project Improvement Act (CVPIA), that is reoperation 3406(b)(1)(B), 800,000 af of dedicated water 3406(b)(2), and acquired water 3406(b)(3), will be used to implement the action. We acknowledge there is some uncertainty to using a ratio of variables to describe protective criteria. However, it is our intent to increase flows and decrease exports to levels that will benefit the fish. The ratio is a convenient method of identifying conditions to benefit fish even though evidence suggests that the difference between inflow and exports may be a more useful variable.

Background: Recommendations for VFER were addressed in the 1995 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (WQCP; SWRCB 1995) and a formal consultation, pursuant to section 7(a)(2) of the federal Endangered Species Act, between the USFWS and USBR concerning delta smelt (USFWS 1995a). The 1995 WQCP water quality objectives for fish and wildlife beneficial uses include limiting export rate to 1,500 cfs or 100% of San Joaquin River flow at Vernalis, whichever is greater. The objective applies to the period 15 April to 15 May, but the time period can be varied depending on real-time monitoring and the operations group. A recommendation from the consultation for delta smelt was to institute a 1.5:1 VFER. A higher VFER than in the 1995 WQCP was intended to reduce entrainment of delta smelt into the CVP and SWP facilities pumps.

The San Joaquin River Tributaries Association (SJTA) filed suit challenging the 1995 WQCP, and proposed a settlement together with other water interests (SJTA et al. 1996). The U.S. Environmental Protection Agency (EPA) and others are developing studies to reduce uncertainty noted in the proposed settlement.

The proposed action is intended to provide greater protection to fish than afforded by the regulatory documents noted above.

Fish species and life stages benefited:

- juvenile fall-run chinook salmon
- juvenile steelhead
- juvenile striped bass
- juvenile American shad
- adult white and green sturgeon
- juvenile delta smelt and other resident fishes

Supporting data: We present data to support the proposed action from various sources. Three categories of data are present here: 1) survival indices of juvenile chinook salmon derived from studies using smolts marked with coded-wire-tags (CWT), 2) stock and recruitment relationships relative to environmental conditions, and 3) timing of smolt emigration from the San Joaquin River tributaries and through the Delta.

Survival indices--The USFWS has calculated survival indices of CWT juvenile chinook salmon in the San Joaquin Delta since early in the last decade (Table 1; see USFWS 1987, 1992; and SSJEFRO data files). The studies have investigated survival of fish released from various locations to Chipps Island, effects of a barrier at the head of Old River on fish survival, and differential survival of fish from the Merced Fish Facility and Feather River Hatchery. Data from the studies were also used to develop a San Joaquin salmon smolt survival model (Brandes 1994).

Most data generated by the studies have been highly variable and open to multiple interpretations. We believe some of the data provide sufficient information for biologists to develop management recommendations for improving protection of aquatic resources. All recommendations are considered in the context of adaptive management.

Flow at Stockton has generally been correlated to survival indices of CWT smolts released at Dos Reis between 1982, 1985 to 1991 (USFWS, 1992), although in recent years that relationship has appeared to break-down (Figure 1). We believe the relationship is still present based on other evidence, but is masked by combining smolts of Feather River stock with those from Merced River stock. The groups released since 1990 have been from Feather River stock, whereas those released prior to 1989 were all from Merced River stock.

In 1995, under very high flows (20,000 - 25,000 cfs), the average survival index for smolts released at Dos Reis was 0.23, much less than would have been estimated using our previous relationship between survival and flow. Experiments performed in 1996 indicated that smolts released at Dos Reis from Merced River stock survived 5 times greater (0.10 versus 0.02) than those released at the same time and place using Feather River smolts. If we assume that this is a true difference in survival and had Merced River smolts been released in 1995, their expected survival index would have been over 100 percent. The relation between survival of fish released at Dos Reis and flow at Stockton data differed for fish from the Feather and Merced rivers (Figures 2 and 3). Survival was 9 times greater in 1995 at flows of 20,000 - 25,000 cfs than in 1996 when flows ranged between 6,000 and 12,000 for smolts originating from Feather River (Fall 1996 IEP Newsletter, in press).

Stock and recruitment relationships--Annual escapement estimates for chinook salmon (i.e., the number of 2- and 3-year-old fish that return to spawn) have been made by the CDFG for San Joaquin River tributaries. The CDFG used these data and spring flows of tributaries and the San Joaquin River at Vernalis when three-year-old fish were emigrating as smolts, to perform regression analyses (CDFG 1987, 1992). The analyses indicated significant ($p<0.05$) positive correlations between spring flow in the tributaries and at Vernalis and escapement of fish 2.5 years later (Figures 4, 5, and 6). Moreover, analyses conducted before state and federal water projects began operation resulted in regression equations for the Stanislaus and Tuolumne rivers with greater slopes and intercepts than equations calculated for the periods after operations, indicating negative effects of water export on salmon survival.

The ratio of Vernalis flow to water export has been suggested as a factor influencing salmon escapement in the San Joaquin River basin, primarily by affecting smolt survival during the peak emigration period, e.g., the AFRP Working Paper (USFWS 1995b). The USFWS performed a regression analysis to describe the relation between adult escapement (3-year-old fish) and VFER during 15 April to 15 May the year fish were smolts (Figure 7). The resulting regression equation was significant ($p<0.01$) and VFER accounted for 40% of the variance in escapement.

To better understand factors affecting chinook salmon in the San Joaquin River basin, Carl Mesick Consultants (CMC 1994, 1995, 1996) performed correlation analyses on existing data to investigate relations among streamflow, exports, VFER, water temperature, stock size (escapement of 3-year-old fish), ocean harvest, water quality, ocean conditions, and recruitment of chinook salmon cohorts (combined number of 2- and 3-year-old fish returning in 1.5 and 2.5 years).

Each report offered further refinements to the analyses, especially concerning discrimination between cohorts. All reports analyzed data from the Stanislaus and Tuolumne rivers separately, and differed from earlier analyses conducted by the CDFG (CDFG 1987, 1992) by accounting for differences in age structure of fish in escapement estimates. Data were analyzed for various time periods within the years 1951-1989, depending on data availability, and the latter two reports (CMC 1995, 1996) developed stock and recruitment relationships, and presented time-series population models to predict recruitment relative to potential restoration activities.

Overall, the analyses indicated that three variable accounted for most of the variance in recruitment of chinook salmon in the Stanislaus and Tuolumne rivers. The variables were VFER, extremely low tributary flows during smolt emigration, and stock levels below 1,000 fish. For example, VFER was typically most closely associated with recruitment. for April, May, and June of all years of record (1951-1989; CMC 1994), VFER alone accounted for >70% of the variance in recruitment for the San Joaquin River, and >50% of the variance in the Stanislaus and Tuolumne rivers. The later reports analyzed data sets truncated at 1960 and reaffirmed associations indicated earlier. Over 80% of the variance in recruitment was explained by VFER when stock ranged from 1,000 to 9,000 fish for the Stanislaus River and 1,000 to 7,000 fish for the Tuolumne river. Furthermore, recruitment appeared to be a nonlinear function of spring VFER, and can be illustrated by holding stock constant (Figures 8 and 9).

Because the proposed action applies only to a 30-day period in April and May and the predictive equations developed by CMC (1994, 1995, 1996) were derived for April through June, we expect that, if the equations are correct, implementing the action would result in recruitment lower than predicted. However, because the 30-d period encompasses the period of peak smolt emigration (see below), we believe that the action would improve smolt survival and recruitment. The action would also provide an opportunity to evaluate the response of chinook salmon to habitat conditions and project operations, and can be integrated with proposed investigations.

Migration timing--The 30-day period between 15 April and 15 May was identified in the Framework Agreement as the time period for export curtailments to allow juvenile salmon to benefit from a pulse flow. Since 1988, the CDFG has observed an annual peak migration of smolts into the Delta between 23 April and 7 May, based on sampling with Kodiak trawls during early April to late June (Figure 10; W. Loudermilk, CDFG, personal communication). In most years between 1988 to 1993, 75% of all juvenile salmon were collected by 15 May (for details, see CDFG 1988, 1989, 1990, 1991, 1992).

Monitoring and evaluation needs: The USFWS and U.S. Bureau of Reclamation are working in conjunction with IEP agencies, the San Joaquin Tributary group and the California Urban Water Association to determine whether the proposed action should be modified and how best to evaluate the action. Also, the IEP real-time monitoring program and sampling conducted in the spring at Mossdale will provide information to assist in evaluating the proposed action. Additional data from CWT fish harvested in the ocean will be used.

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Table 1. Chinook Salmon smolt survival indices and associated Delta hydrology features for two different stocks of fish, Feather and Merced rivers, for different years within the time period 1982 through 1996.

Date	Origin	Flow (cfs) at Stockton	Flow (cfs) at Vernalis	Exports (cfs)	Vernalis flow to export ratio	Survival Index
April 2, 1989	Feather	112	2,274	10,297	0.22	0.14
April 16, 1990	Feather	0	1,290	9,549	0.14	0.04
May 2, 1990	Feather	490	1,665	2,461	0.68	0.04
April 5, 1991	Feather	60	676	5,153	0.13	0.16
April 17, 1995	Feather	7,345	18,479	3,743	4.94	0.15
May 5, 1995	Feather	8,940	22,353	3,911	5.72	0.39
May 17, 1995	Feather	9,253	23,262	4,525	5.14	0.16
May 1, 1996	Feather	2,375	6,269	1,500	4.18	0.02
May 9, 1996	Feather	2,715	7,206	2,200	3.28	0
May 16, 1996	Feather	3,702	10,443	7,000	1.49	0
April 23, 1982	Merced	7,861	19,233	5,598	3.44	0.7
April 30, 1985	Merced	513	2,597	6,311	0.41	0.59
May 29, 1986	Merced	2,514	7,215	5,386	1.34	0.34
April 27, 1987	Merced	471	2,386	6,093	0.39	0.38
May 2, 1989	Merced	790	2,289	2,470	0.93	0.14
May 1, 1996	Merced	2,375	6,269	1,500	4.18	0.1

Figure 1 through 10 not available electronically.

Delta Action 2: Continue to evaluate a temporary rock barrier at the head of Old River to improve conditions for chinook salmon migration and survival during the April 15-May 15, or other 30 day pulse period, consistent with the Corps of Engineers Permit to the Department of Water Resources and Fish and Wildlife Service's Biological Opinion on delta smelt.

Description: The proposed action consists of constructing a temporary rock barrier at the head of Old River and operating the barrier during the spring when juvenile chinook salmon are emigrating from the San Joaquin River.

Background: As the San Joaquin River enters the Delta, its flow bifurcates at the head of Old River. When CVP and SWP export facilities, which are located in Old River, are not operating, about 60% of the total San Joaquin River flow at Vernalis enters the Old River channel (Morhardt et al. 1995). However, during export operations, flow in Old River can exceed total flow in the San Joaquin River at Vernalis and cause reverse flows in the San Joaquin River and other channels in the south Delta. Fish entering Old River, which have been assumed to be proportional to flow at the bifurcation, are exposed to possible entrainment at the facilities and incur potentially high mortality due to high water temperature and predators inhabiting the area near the facilities, Clifton Court Forebay, and other south Delta channels. To reduce the number of juvenile chinook salmon that enter Old River during emigration, a barrier at the head of Old River has been proposed. The barrier has been identified as a potential management tool in the SWRCB 1995 Water Quality Control Plan (WQCP; SWRCB 1995), the Environmental Protection Agency's (EPA) review of the 1995 Water Quality Control Plan (WQCP), and the Central Valley Project Improvement Act. The barrier has also been investigated by the California Department of Fish and Game (CDFG) as possible mitigation for the South Delta Temporary Barriers Project's agricultural flow control barriers and is a proposed permanent structure in the Interim South Delta Project.

Fish species and life stages benefited:

- juvenile chinook salmon in the San Joaquin River
- juvenile steelhead in the San Joaquin River

Supporting data: We present data to support the proposed action primarily from studies conducted by the Sacramento-San Joaquin Estuary Fishery Resource Office (SSJEFRO) since 1985 (see USFWS 1987, 1989, 1990, 1991, 1992, 1993, 1994; and SSJEFRO data files). The data are also summarized in draft issue papers by the California Department of Fish and Game (CDFG 1995) and the U.S. Fish and Wildlife Service (USFWS 1995). The categories of data presented are: 1) comparisons of survival indices between juvenile chinook salmon released in Old River and the San Joaquin River at Dos Reis, just downstream from the Old River bifurcation; 2) comparisons of survival indices between juvenile chinook salmon released when the barrier was and was not in operation; and 3) number of marked juvenile chinook salmon recovered at CVP and SWP fish salvage facilities when the barrier was and was not in operation.
Comparisons of survival indices between Old River and San Joaquin River--From 1985 to 1990, the U.S. Fish and Wildlife Service (USFWS) calculated survival indices for juvenile chinook salmon released in Old River and in the San Joaquin River at Dos Reis, downstream of the Old

River bifurcation. All fish were marked with coded-wire-tags (CWT) and released at each location, generally both groups within a two day period. The number of CWT fish collected at Chipps Island was used to calculate survival indices from the release location to Chipps Island.

The survival index for fish released at Dos Reis was greater than the index of fish released in Old River for six of the seven studies (Table 1). For the seven studies, the mean survival index for fish released at Dos Reis was 0.24 (range 0.04-0.59) and the mean survival index for fish released in Old River was 0.16 (range 0.01-0.62). Thus, the mean survival index from Dos Reis to Chipps Island was almost 50% greater than the mean survival index from Old River to Chipps Island.

The difference in the mean survival indices of fish released at both locations may actually be greater because indices for fish released at Dos Reis may be underestimated. Some fish released at Dos Reis apparently moved upstream of the Old River split, and were collected at Mossdale (W. Loudermilk, CDFG, personal communication). Fish moving upstream may have then entered Old River as they moved downstream.

It should also be noted that the survival indices likely overestimate the benefits of a barrier at any one export rate. This is due to increased movement of water toward the CVP and SWP facilities from the lower Old and Middle rivers and other south Delta channels that occurs when a barrier is operated. When the barrier is not operated, fish released at Dos Reis are exposed to differ flow dynamics. Thus, we assume that improvements in fish survival due to a barrier at Old River will be dependent on export levels and flow in the San Joaquin River. See discussion of data for action 1 concerning the relation between chinook salmon survival and escapement relative to flow and exports.

Comparisons of survival indices between juvenile chinook salmon released when the barrier was and was not in operation--Studies to compare survival indices between juvenile chinook salmon released when the a barrier at Old River was and was not in operation were made in 1992 and 1994. In both years, CWT fish were released at Mossdale, upstream of the Old River bifurcation, and collected at Chipps Island. Fish were released before and after a barrier at Old River was constructed.

Five groups of fish were released in 1993, two before the barrier was constructed and three after the barrier was operational. The mean survival index was 0.15 for the period before the barrier was constructed and 0.04 after the barrier was constructed (Table 2). These values were contrary to the expected relation between fish survival and barrier operation. We believe that fish survival may have been influenced by water temperature. Water temperature was 63 and 64°F during the first two studies before the barrier was constructed and increased to 69-72°F during the studies after the barrier was constructed.

To adjust for the effects of water temperature, a correction factor developed for fish released in the Sacramento River (Kjelson and Brandes 1989, USFWS 1991) was applied to the data. The mean survival indices of the adjusted data were 0.10 for fish released before the barrier was constructed and 0.28 for fish released after the barrier was constructed. Conclusions based on these results should be considered tentative because we are uncertain whether the adjustment is appropriate.

In 1994, CWT fish were released at Mossdale on four dates, one before the barrier was constructed and three after the barrier was operational. Survival indices were low for all fish, 0 for those released before the barrier was constructed and 0-0.04 for those released after the barrier was constructed (Table 3). Although survival indices were generally greater for fish released after the barrier was operational than the single value for fish released before the barrier was constructed, we believe these data are inconclusive concerning the effect of the barrier on survival indices. It should be noted that survival indices calculated for fish released at other locations in the San Joaquin River basin and the Sacramento River were relatively low in 1994 (Table 4) and that survival indices of fish released in the San Joaquin River basin have been relatively low in recent years (see tables 1 through 4, Table 5).

Number of marked juvenile chinook salmon recovered at CVP and SWP fish salvage facilities-- Numbers of CWT juvenile chinook salmon that were released at Mossdale and recovered at the CVP and SWP fish salvage facilities in 1992 and 1994 were greater for studies conducted before the barrier was constructed than those conducted after the barrier was operational (Table 5). Recoveries before and after the barrier was constructed differed by at least two orders of magnitude in 1992 and at least one order of magnitude in 1994.

Relative to the low survival indices observed for CWT juvenile salmon released in recent years (1992-1996), the number of marked fish recovered at the salvage facilities have similarly declined (Table 5). The decline does not appear to be related to whether the barrier was or was not constructed. The recent low survival indices and recovery of fish at salvage facilities suggest that environmental quality in the lower San Joaquin River and southern Delta has declined relative to conditions in the earlier years of this decade.

Monitoring and evaluation needs: The variable results obtained from studies investigating the relation between survival indices of juvenile chinook salmon and the barrier at the head of Old River indicate that the barrier may improve salmon survival. However, the high variability implies that other factors may be important, or that problems in controlling experimental conditions limit our ability to understand the effects of the barrier on smolt survival.

The variable results may be influenced by differential mortality of study fish from the Merced River Fish Facility and Feather River Hatchery. Studies in 1995 and 1996 indicated that survival indices for Feather River fish were consistently lower than indices for Merced River fish. Existing data are being used to investigate the influence study fish source on survival indices. See Action 1 for details.

Because survival indices can be relatively high when a barrier in not constructed and extremely low when the barrier is operational, we assume that factors such as river flow, exports, and water temperature, potentially influence the efficacy of the barrier. The proposed action will evaluate the relation among these factors and the efficacy of the barrier in improving survival indices.

Delta Action 2

With a barrier at the head of Old River, flow toward the CVP and SWP export facilities may increase in south Delta channels, depending on export levels. The change in flow dynamics in these channels is likely to affect other species, such as delta smelt, winter-run chinook salmon, and striped bass. Improvements afforded by the barrier to survival of chinook salmon emigrating from the San Joaquin River needs to be evaluated relative to the effects on other species and races, and relative to expected export levels.

Some biologists believe that increase in net upstream flows in the central and south Delta can result in fish being drawn toward the export facilities, thus making the fish susceptible to indirect losses such as high temperatures, agricultural diversions, and predation. Losses due to these factors can be exacerbated by an increase in export levels. This may explain the results of our studies in which few CWT fish were captured at Chipps Island or salvage facilities when the barrier was operational. Other biologist believe that a benefit of the barrier is that it reduces direct entrainment of juvenile chinook salmon emigrating from San Joaquin River by preventing fish from entering Old River. The proposed action will assist in reconciling these views.

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Table 1. Results of studies comparing survival indices of CWT juvenile chinook salmon from Dos Reis and Old River to Chipps Island.

Release at Dos Reis		Release at Old River	
Date	survival index	date	survival index
30 April 1985	0.59	29 April 1985	0.62
29 May 1986	0.34	30 May 1986	0.20
27 April 1987	0.38[a]	27 April 1987	0.16
20 April 1989	0.14	21 April 1989	0.09
2 May 1989	0.14	3 May 1989	0.05
16 April 1990	0.04	17 April 1990	0.02
2 May 1990	0.04	13 May 1990	0.01
Mean	0.24		0.16

[a]Original survival estimate (0.82) was modified based on the ratio of ocean recovery rates between the Dos Reis and Old River releases.

Table 2. Results of studies comparing survival indices of CWT juvenile chinook salmon from Mossdale to Chipps Island before and after the barrier at Old River was constructed in 1992.

Date	water temperature (°F)	survival	adjusted survival[a]
	before barrier was constructed		
7 April 1992	64	0.17	0.13
13 April 1992	63	0.12	0.07
Mean	--	0.15	0.10
	after barrier was constructed		
24 April 1992	69	0.08	0.25
4 May 1992	71	0.01	0.28
12 May 1992	72	0.02	0.32
Mean	--	0.04	0.28

[a]Values were adjusted by a correction factor developed for fish released in the Sacramento River.

Delta Action 2

Table 3. Results of studies comparing survival indices of CWT juvenile chinook salmon from Mossdale to Chipps Island before and after the barrier at Old River was constructed in 1994.

Date	water temperature (°F)	survival
	before barrier was constructed	
11 April 1994	63	0
	after barrier was constructed	
26 April 1994	60	0.04
2 May 1994	66	0
9 May 1994	68	0.02
Mean	--	0.02

Table 4. 1994 chinook salmon smolt survival indices for fish released at sited other than Mossdale. No values for survival indices indicates that no fish were recovered.

Release Location	Release Date	Water Temperature (°F)	Survival Index	Combined Fish Recoveries at the CVP and SWP
Ryde	April 12	62.5	0.20	0
Georgian Slough	April 12	62	0.06	0
Jersy Point	April 13	64	0.19	16
Ryde	April 25	62	0.18	0
Georgian Slough	April 25	62	0.11	0
Jersy Point	April 27	63	0.28	0
Miller Park	May 3	67	0.07	0
Miller Park	May 24	67		
Lower Old River	April 11	62		94
Lower Old River	April 26	62		84
Mossdale	April 11	63		752
Mossdale	April 26	60	0.04	0
Mossdale	May 2	66		36
Mossdale	May 9	68	0.02	13
New Hope Landing	May 23	67	0.16	0
New Hope Landing	May 23	67	0.18	0
combined group survival			0.17	
New Hope Landing	May 10	68	0.09	12
New Hope Landing	May 10	68	0.12	31
combined group survival			0.11	
Merced Hatchery	April 22	not available	0.04	27
Merced Hatchery	April 22	not available	0.04	49
Merced Hatchery	April 22	not available	0.08	28
Merced Hatchery	April 22	not available	0.04	24
combined group survival			0.05	
Lower Merced	April 22	not available		26
Lower Merced	April 22	not available	0.07	54
Lower Merced	April 22	not available		80
combined group survival			0.07	
Upper Tuolumne	April 23	not available	0.07	19
Upper Tuolumne	April 23	not available	0.03	24
Upper Tuolumne	April 23	not available		4
combined group survival			0.03	
Lower Tuolumne	April 24	not available	0.37	48
Lower Tuolomne	April 24	not available	0.37	38
combined group survival			0.37	

Table 5. Water temperature, survival index from Mossdale to Chipps Island, and recovery of CWT fish at CVP and SWP facilities during 1992-1996. Survival indices adjusted for

temperature are given in parentheses (see text for explanation). Each release group consisted of about 50,000 fish.

Date	Water Temperature (°F)	Survival	Recovery at CVP and SWP Facilities[a]
7 April 1992[b]	64	0.17 (0.13)	5,451
13 April 1992[b]	63	0.12(0.07)	3,491
24 April 1992	69	0.08(0.25)	56
4 May 1992	71	0.01(0.28)	36
12 May 1992	72	0.02(0.32)	6
6 April 1993	63	0.04	1,332
28 April 1993	64	0.07	1,106
4 May 1993	61	0.07	1,033
12 May 1993	65	0.07	1,445
11 April 1994[b]	63	0	752
26 April 1994	60	0.04	0
2 May 1994	66	0	36
9 May 1994	68	0.02	0
17 April 1995[c]	57	0.22	2,768
5 May 1995[c]	62	0.12	1,933
17 May 1995[c]	63	0.07	1,580
15 April 1996[c]	60	0.02	99
30 April 1996[c]	64	0.01	134

[a] All recoveries are expanded values except those for 1996.
[b] Barrier operational.
[c] Data are from two release groups, survival index is a mean and salvage recovery is a total of the two groups.

Delta Action 3: This action was not ready for inclusion here at the time of printing, but will be provided separately when available.

Delta Action 4: Maintain at least 13,000 cubic feet per second (cfs) in the Sacramento River at the I Street Bridge during May to improve transport of eggs and larval striped bass and other anadromous fish, and to reduce egg settling and mortality at low flows. Provide 9,000 cfs at Knights Landing during May.

Description: This action calls for daily minimum flows in the Sacramento River of 13,000 cfs and 9,000 cfs at the I Street Bridge and Knights Landing, respectively, to improve survival of striped bass eggs and larvae and to improve downstream transport of all anadromous fish.

Background: Key involved parties include state and federal resource regulatory agencies, affected water interests, and environmental interests. This proposed action has its foundation in results from long-term monitoring of young striped bass in the Sacramento River. The relationship between an index of survival of Sacramento River spawning cohorts and Sacramento River flow at Sacramento indicates that survival between the egg and 6mm larvae stage is low in the Sacramento River when Sacramento River flows are low, whereas at higher flows (>13,000 cfs) the survival index has been demonstrated to increase in some years. Greater transport flow associated with this standard will also benefit other downstream migrating anadromous fishes. The following is a summary of some of the pertinent biological information to support the daily minimum flow criteria for the Sacramento River of 13,000 cfs at Sacramento, and 9,000 cfs at Knights Landing above the Feather River confluence.

Fish species and life stages benefited: Striped bass, American shad, white and green sturgeon egg and larval life stages, and spring and fall chinook salmon, and steelhead juveniles are the primary beneficiaries of these minimum flow requirements in the Sacramento River during May.

Supporting data:

Historical striped bass population trend--A persistent decline in the juvenile striped bass abundance since the mid to late 1960's and adult striped bass abundance since the early 1970's has been documented by the Department of Fish and Game (CDFG 1987; Exhibit 25). The adult striped bass population has declined from about 1.8 million to about 600,000. The juvenile striped bass index decreased even more, from indices in excess of 100 in the mid-late 1960's to indices averaging less than 20 since the late 1970's (Figure 1). Much of the supporting information for the proposed action that follows is derived from the ongoing annual striped bass monitoring program and subsequent analyses and modeling efforts that have been reported. For more information the reader should refer to the following summary documents: CDFG 1987; Exhibit 2, A re-examination of factors affecting striped bass abundance in the Sacramento-San Joaquin Estuary, and IEP Technical Report 20 1987, CDFG Exhibit 25, Factors affecting striped bass abundance in the Sacramento-San Joaquin River system, and the USFWS Working Paper, 1995 (also see reference section).

Striped bass spawning--Striped bass primarily spawn in two areas: in the Sacramento River mainly from the city of Sacramento to Colusa, and in the western Delta between Antioch and Venice Island (CDFG 1987, Exhibit 25). About one-half to two-thirds of the bass spawn in the Sacramento River from late April into June (CDFG 1992, Exhibit 2). Survival of eggs and larvae spawned in the Sacramento River is partially influenced by flows in the river (CDFG 1987, Exhibit 25).

Delta Action 4

Limitations to juvenile striped bass production and its relation to the proposed action--It has been demonstrated that when abundance of early larval life-history stages is low, abundance of the 38mm life stage is also low (Figure 2, and CDFG 1987, Exhibit 25). Thus survival of early larvae partially establishes year class strength in mid-summer, which in turn affects adult recruitment (CDFG 1992, Exhibits 2 and 3). Setting a minimum daily flow requirement in the Sacramento River will benefit egg and larvae survival. Other factors affecting system productivity, such as toxicity and factors affecting increased adult striped bass mortality also may warrant investigation and remediation. However, this proposal specifically focuses on improving river habitat conditions to increase juvenile striped bass survival with the May minimum flow criterium and is consistent with the tools of the CVPIA and its goals for natural fish production.

Relationship between the proposed action and survival of larval striped bass--Information from the early 1970's to the early 1990's documenting the relationship between an index of survival of eggs and larvae in the Sacramento River and flow at Sacramento indicates that survival between the egg and 6mm larva stage is low in the Sacramento River when Sacramento River flows are low (Figure 3). Thus given a minimum daily flow requirement of 13,000 cfs at Sacramento, and a concurrent minimum of 9,000 cfs at Knights Landing, a potential for greater egg and larva survival exists for fish in the Sacramento system during some years. There are four possible mechanisms that may contribute to this relationship.

- At lower flows, eggs and larvae may settle to the river bottom and die when they encounter near zero velocity during periods of flood tides in tidally influenced reaches (CDFG 1992, Exhibit 2).
- Slower transport at low flows may result in lower survival because larvae are delayed in reaching downstream nursery areas where feeding conditions are generally considered to be more favorable (CDFG 1992, Exhibit 2; Figure 4).
- When flows are low, more larvae may die due to longer exposures to higher concentrations of toxic substances that may enter the river (CDFG 1992, Exhibit 2).
- More eggs and larvae would be diverted from the Sacramento River through the Delta Cross Channel and Georgiana Slough (Figure 5 and CDFG 1992, Exhibit 2). While this may not cause immediate mortality, fish will be transported more rapidly to the south Delta where there is a greater risk of entrainment via export operations at the CVP and the SWP pumps (CDFG 992, Exhibit 2).

The relative contribution of these potential mechanisms cannot be sorted out with the existing data, but all are likely to be detrimental (CDFG 1992, Exhibit 2). Thus based on these data, and data summarized for Action 7 relative to juvenile entrainment losses, a reasonable and prudent biological approach would be to establish the 13,000 cfs Sacramento flow standard for the month of May.

American shad, sturgeon and chinook salmon production considerations--Juvenile American shad abundance is positively correlated with flow during the primary spawning months, April through June (USFWS, Working Paper, Volume 2, 1995; Figure 6). While this documented relationship is based on Delta outflows, outflow is influenced by, and will sometimes positively co-vary with, Sacramento River inflow; so to some extent outflow is likely a surrogate for inflow. Flow associated factors that may influence juvenile shad survival are likely similar to those influencing juvenile striped bass eggs and larvae. Thus the potential negative effects of lower flows include: reduced survival due to egg and larva settling, greater exposure times to toxins, poor feeding conditions, and greater numbers of juveniles moving to the central and south Delta (USFWS, Working Paper, Volume 2).

Kohlhorst et al. (1991 as cited in the USFWS, Working Paper, Volume 2) found a significant positive correlation between year-class strength of white sturgeon and Sacramento River outflow from April to July. During years with high April to July flow (1982 and 1983), white sturgeon year-class strength was greater than in years between 1975 and 1985 with lower outflows (Figure 7). Mechanisms responsible for increased recruitment are not well defined but are possibly similar to those mentioned above for striped bass and shad.

For chinook salmon, correlation between Sacramento River flows during the smolt emigration period and the number of adults returning to Sacramento River tributaries indicate that flow, or factors related to flow, affect chinook salmon survival and abundance (Dettman et al. 1987). Likewise, mark-recapture studies of fall-run chinook salmon smolts demonstrated that smolt survival through the Delta is positively correlated with Sacramento River temperatures and negatively correlated with the fraction of Sacramento River flow diverted in to the Delta Cross Channel and Georgiana Slough during the April through June emigration period (USFWS 1987). Though no significant relationship between chinook salmon smolt survival and Sacramento River flow has been documented, increases in river flows should contribute to beneficial water temperatures for migrating salmon and possibly reduce the magnitude of negative effects associated with fish migration through the central and south Delta (USFWS 1992). Thus the potential greater flows in May associated with the proposed May daily minimum flows should be beneficial to chinook salmon smolts emigrating through the Sacramento River system during this time. Accrued benefits should also be similar for migrating juvenile steelhead based on life-history similarities between the two species.

Predicted fish benefits: This flow related habitat improvement measure, combined with reductions in juvenile striped bass entrainment, and improvements in water quality will enhance the ability of the striped bass population to recover in future years. The magnitude of striped bass production increase relative to the proposed action is currently unknown and will vary depending on the magnitude of flows that would otherwise be in the river. The information reviewed also suggests that this proposed minimum May flow target should afford survival benefits to sturgeon, American shad, and salmon.

Monitoring and evaluation needs: The current striped bass monitoring program implemented through the Interagency Ecological Program (IEP) will yield information that will allow analysis of the effects of the proposed action, but absolute verification may require more future egg larva monitoring than currently planned by the IEP. IEP monitoring also addresses benefits to the other anadromous species.

Citations

California Department of Fish and Game. 1987. Factors affecting striped bass abundance in the Sacramento-San Joaquin River system. Exhibit 25, entered by the California Department of

Fish and Game for the State Water Resources Control Board 1987 water rights proceeding on the San Francisco and Sacramento-San Joaquin Delta.

California Department of Fish and Game. 1992. A re-examination of factors affecting striped bass abundance in the Sacramento-San Joaquin Estuary. WRINT-DFG-Exhibit 2, entered by the California Department of Fish and Game for the State Water Resources Control Board, 1992, water rights phase of the Bay-Delta estuary proceedings.

California Department of Fish and Game. 1992. A model for evaluating the impacts of freshwater outflow and export on striped bass in the Sacramento-San Joaquin estuary. WRINT-DFG-Exhibit 3, entered by the California Department of Fish and Game for the State Water Resources Control Board, 1992, water rights phase of the Bay-Delta estuary proceedings.

Dettman, D.H., D.W. Kelly, and W.T. Mitchell. 1987. The influence of flow on Central Valley salmon. D.W. Kelly and Associates. Newcastle, CA. Prepared for California Department of Water Resources, Sacramento, CA.

Kohlhorst D.W., L.W. Botsford, J.S. Brennan, and G.M. Cailliet. 1991. Aspects of the structure and dynamics of an exploited central California population of white sturgeon (*Acipenser transmontanus*) 1991. Pages 277-293 *in:* Proceedings of the First International Symposium on the Sturgeon, P. Williot, editor. CEMAGREF. Bordeaux, France.

USFWS. 1987. The needs of chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary. (USFWS Exhibit No. 31, State Water Resources Control Board 1987 water quality/water rights proceeding for the San Francisco Bay/Sacramento-San Joaquin Delta, Sacramento, CA.) U.S. Fish and Wildlife Service, Sacramento, CA.

USFWS. 1992. Measures to improve the protection of chinook salmon in the Sacramento/San Joaquin River Delta. WRINT-USFWS-7, Testimony to the State Water Resources Control Board, Water Rights phase of the Bay/Delta Estuary Proceedings, July 6, 1992.

USFWS. 1995. Anadromous Fish Restoration Program, working paper on restoration needs, habitat restoration actions to double natural production of anadromous fish in the Central Valley of California, Volume 2.

Figure 1 through 7 not available electronically.

Delta Action 5: Ramp (linearly) the total CVP/SWP export level from whatever it is on 5/15 to meet Action 1 to those export levels proposed by projects to meet the 1995 WQCP on June 1, when juvenile salmon are present.

Description: This action is meant to overcome a quick rise in exports in late May when juvenile salmon and other anadromous fish would continue to be vulnerable to a low inflow/export ratio. If temperatures are high and juvenile salmon do not appear to be migrating into the Delta from the San Joaquin basin the action would be suspended. If flow levels and permits allow a barrier at the head of Old River to be used (Action 2), it would continue to be in place with its respective benefits during the proposed ramping.

Background: Between April 15 and May 15, the San Joaquin inflow to CVP/SWP export ratio per the AFRP proposed Delta action 1 can range from 5:1 to 3:1, depending on the water year type. Between May 15 and May 31, exports can increase to levels greater than during the first half of May but still meet the monthly average of 35% of Delta inflow. For example in 1996, the 1995 WQCP allowed export rates to increase from approximately 1500 cfs on May 15 to over 10,000 cfs in less than two weeks time. The extreme change and high absolute level of exports would be detrimental to a variety of anadromous fish that are present in the central and southern delta. Reducing export levels and increasing gradually would provide additional protection for these by allowing a greater fraction of the fall run smolt outmigrants and possible other species to move downstream out of the influence of the pumps.

Fish species and life stages benefited: Juvenile San Joaquin salmon are expected to benefit from the reduction in exports between 5/15 and 5/31. Juveniles of other species such as Striped Bass, steelhead, White and Green Sturgeon and American Shad and other resident species may also benefit.

Supporting data: It is believed that decreasing exports for the later half of May by ramping will benefit the San Joaquin chinook population. The exact benefit for San Joaquin smolts will be contingent on the number of smolts migrating through the Delta and the flow and export levels during the latter half of May.

In some years, at least part of the juvenile salmon population from the San Joaquin basin migrate through the Delta between May 16 and May 31 (figure 1 and 2). Reductions in exports at any one flow level are expected to increase survival of smolts migrating through the Delta (see action 1). This added protection would provide better outmigration conditions for that portion of the population migrating through the Delta during that time. Protecting a greater proportion of the total population would help meet the goals of the AFRP and assure greater genetic diversity within the stock.

Monitoring and evaluation needs: Interagency Ecological Program (IEP) real time monitoring (kodiak trawling) will occur at Mossdale between March 15 and June 30, seven days/week. Daily rotary screw trapping also is proposed for the at the mouth of the Stanislaus. Both sites will provide data to determine if Action 5 is necessary and for how long. See discussions of actions 1 and 2 for additional evaluations.

Citations

California Department of Fish and Game (DFG), 1995. Annual Performance Report, Federal Aid in Sport Fish Restoration Act. Grant Agreement No: F-51-R-6, Project No. 38, Job No. 4: Index and Estimate San Joaquin Drainage Salmon Smolt Production.

Figure 1 through 2 not available electronically.

Delta Action 6: Close the Delta Cross Channel (DCC) starting on November 1.

Description: The AFRP action is intended to augment the Accord by providing gate closures for an additional three month period (November 1- January 31).

Background: The cross channel gates have been closed between February 1 and April 30 as a winter run protection measure since 1993. The Delta accord further extended closure of the Delta cross channel until May 20, with provisions for potential closures between November and January and after May 20 until June 14. The Delta Accord and 1995 WQCP call for the closure of the Delta cross channel gates for up to a maximum of 45 days between November 1 and January 31, to be decided by the CALFED operations group. NMFS has provided draft guidelines on triggers for gate closures during this period. Closures are needed for flood control when flows at Freeport are above 25,000 cfs and also have been made in the fall when water quality impacts were negligible (fall of 1995). This action has a potential impact of lessening water quality in the Delta below that required under the 1995 WQCP unless increases in Delta outflow are provided.

Fish species and life stages benefited: Fall, late fall and tributary spring yearling and winter run fry chinook salmon may all benefit from closing the cross channel starting on November 1. Figure 1 and 2 document the abundance of juvenile salmon between November and January entering the Delta and within the Delta.

Supporting data: Several pieces of data based on results of mark and recapture work using juvenile chinook salmon indicate a benefit associated with closing the cross channel gates at a variety of lifestages. Specific data for the various lifestages follows:

Fry: Coded wire half tagged (CW1/2T) fall run salmon fry released between 1981 and 1986, indicate that smolts released into the Central Delta in low flow years survive at a lower rate than those released on the mainstem Sacramento River (table 1).

Smolts: Through mark and recapture experiments, it has been found that fall run chinook salmon smolts released above the cross channel gates on average survive to the western Delta at a greater rate than those released below the cross channel gates. Survival is increased by about 50% by closing the cross channel gates using two independent estimates of survival (table 2). Although critics of this result believe the data is biased from results of one group released above the opened cross channel gates (Courtland) at high temperatures, similar high temperatures were present for the paired, below cross channel gate, release making relative comparisons generally valid. Furthermore a release into Steamboat Slough on the same day at the same high temperature survived at a much greater rate than those released at Courtland (USFWS, 1996).

Poor relative survival in the Central Delta versus that in the mainstem river is further confirmed from marked smolt releases made at Courtland, Ryde and in the North and South Forks of the Mokelumne river in 1983-1986 (USFWS, 1992) and paired releases made at Ryde and into Georgiana Slough between 1992-1994 (table 3 and table 4).

Yearlings: Additional experiments using marked late fall yearlings in December and January, indicate that survival also is less for late fall juveniles released into Georgiana Slough versus those released at Ryde. There is no indication that the larger late fall released at low temperatures survive at a better rate in the central delta than fall run (table 3). Experiments conducted in December of 1996, also showed high survival for yearlings released at Courtland and Ryde with the gates closed compared to those released into Georgiana Slough (table 5).

Monitoring and evaluation needs: Kodiak or midwater trawl sampling will be conducted on the Sacramento River near Sacramento between October and June to index juvenile salmon immigration into the Delta. Additional monitoring using a rotary screw trap may be done on the Sacramento River near Knights Landing. This combined monitoring can be used to determine if the timing of such action regarding the cross channel gate closure is warranted. Additional mark and recapture work would be necessary to further document the benefits. It has been suggested that the benefit of the closing the cross channel be further tested using CWT late fall or fall run hatchery smolts released at Coleman National Fish Hatchery. Two groups would be released, one with the gate open and one with the gate closed and the survival index to the western Delta (Chipps Island) compared. Both marked late fall and fall run juveniles will be released at Sacramento to index survival through the Delta under conditions of the Delta accord, including closure of the cross channel gates.

Citations

USFWS, 1992 . Measures to Improve the Protection of Chinook Salmon in the Sacramento/San Joaquin River Delta. Expert Testimony of U.S. Fish and Wildlife Service on Chinook Salmon Technical Information for State Water Resources Control Board Water Rights Phase of the Bay/Delta Estuary Proceedings. July 6, 1992 WRINT-USFWS-7.

USFWS, 1996. U.S. Government Memorandum to Lisa Holsinger (NMFS) from Pat Brandes (USFWS) regarding Benefit of closing the cross channel gates dated July 8, 1996.

Table 1: Ocean recovery rates of coded wire half tag (CW1/2T) fry released in the Delta at Ryde or Isleton on the Sacramento River and in the Central Delta (Lower, North Fork or South Fork Mokelumne River). The ratio (Ryde/Mokelumne) reflects the relative difference in survival between the two areas of the Delta.

Year	Release Site	Recovery Rate	North and South Fork Mean	Ratio
1981	Isleton	0.001013		2.0
	Lower Mokelumne River	0.000506		
1982	Isleton	0.000657		1.2
	Lower Mokelumne River	0.000539		
1983	Isleton	0.000482		0.9
	Lower Mokelumne River	0.000557		
1984	Ryde	0.002440		2.1
	North Fork Mokelumne River	0.001447	.001156	
	South Fork Mokelumne River	0.000866		
1985	Ryde	0.001815		1.2
	North Fork Mokelumne River	0.001506	.001503	
	South Fork Mokelumne River	0.001500		
				$\bar{x}$ ratio 1.5

Table 2: Indices of survival to Chipps Island and ocean recovery rates for CWT fall run smolts released above and below the Cross Channel gates with the gates open and closed between 1984 and 1989. When the below to above ratios (B/A) are compared with the gates open versus closed, an estimate of the benefit associated with closing the Cross Channel gates is obtained.

Smolt Survival Estimates

	Year	Above	Below	B/A
Cross Channel Open	1984	0.70	0.73	1.0
	1985	0.34	0.77	2.3
	1986	0.37	0.68	1.8
	1987	0.41	0.88	2.1
	1988	0.73	1.27	1.7
	1988	0.02	0.34	17.0
	1989	0.84	1.20	1.4
	1989	0.35	0.48	1.4
	1989	0.22	0.16	0.7
				Average = 3.3
Cross Channel Closed	1983	1.22	1.39	1.1
	1987	0.66	0.84	1.3
	1988	0.68	0.93	1.4
	1988	0.17	0.40	2.4
				Average = 1.6

Ocean Recovery Rates

	Year	Above	Below	B/A
Cross Channel Open	1984	.0064	.0045	0.7
	1985	.0038	.0086	2.3
	1986	.0171	.0195	1.1
	1987	.0142	.0203	1.4
	1988	.0091	.0248	2.7
	1988	.0007	.0053	7.6
	1989	.0048	.0082	1.7
	1989	.0008	.0016	2.0
	1989	.0009	.0002	0.2
				Average = 2.2
Cross Channel Closed	1983	.0044	.0040	0.9
	1987	.0198	.0315	1.6
	1988	.0111	.0204	1.8
	1988	.0097	.0046	0.5
				Average = 1.2

Table 3: Survival indices for smolts released at Ryde and Georgiana Slough in 1994, 1993, and 1992 and the ratio of survival between the two paired groups. Numbers in parentheses are raw recovery numbers at Chipps Island.

Date	Ryde	Georgiana Slough	Ryde/Georgiana Slough Ratio
FALL RUN			
4/12/94	0.198 (11)	0.054 (3)	3.7
4/25/94	0.183 (11)	0.117 (6)	1.5
4/14/93	0.41 (23)	0.13 (7)	3.2
5/10/93	0.86 (43)	0.29 (15)	3.0
4/06/92	1.36 (78)	0.41 (23)	3.3
4/14/92	2.15 (97)	0.71 (41)	3.0
4/27/92	1.67 (93)	0.20 (11)	8.4
LATE FALL RUN			
12/2/93	1.91 (37)*	0.28 (5)	6.8
12/5/94	0.57 (15)*	0.16 (4)	3.6
1/4/95	0.33 (11)	0.12 (4)	2.8
1/10/96	0.66 (21)	0.17 (5)	3.9

*Actual release made at Isleton, about 5 miles downstream of Ryde.

Table 4: Ocean recovery rates of the Ryde and Georgiana Slough release groups of 1992 and 1993 and the ratios (Ryde: Georgiana Slough) of these ocean recovery rates.

Release Date	Ryde	Georgiana Slough	Ryde/Georgiana Slough Ratio
4/6/92	0.0066	0.0028	2.38
4/14/92	0.0116*	0.0045	2.26
4/27/92	0.0040	0.0006	6.67*
4/14/93	0.0092	0.0033	2.78
5/10/93	0.0204	0.0056	3.64

*The Ocean recovery rate for the 1992 release made at Ryde is underestimated due to the fact that some (10,500) of the fish were inadvertently released at Georgiana Slough by mistake. The resulting ratio, therefore, is also biased low.

Table 5: Survival indices to Chipps Island for late fall run CWT yearlings released in January 1996.

Release Site	Survival Index
Courtland	.78
Ryde	.66
Georgiana Slough	.17

Delta Action 7: CVP/SWP export limitation of 35% or less of Delta inflow during July Action sub-priority: a) July 1 to July 15 and b) July 15 to July 31

Description: This action calls for State and Federal water contractors to limit Delta exports to not more than 35% of total Delta inflow during July, extending juvenile anadromous fish protection from potential entrainment losses at the pumps. This is a continuation of the protective Delta export:inflow ratio of 35% already in place for February through June according to State Water Resources Control Board (SWRCB) water quality standards and operational constraints.

Background: Key involved parties include state and federal resource regulatory agencies, agriculture and urban water interests, and environmental interests. The Delta habitat objective of a 35% limitation on export:inflow ratio in July was preceded by a similar February through June limitation that was established by the 1994 Bay-Delta Accord, and incorporated in the May, 1995 SWRCB Water Quality Control Plan. A goal of these water quality standards is to provide interim comprehensive ecosystem protection for the Bay/Delta system. The export:inflow limitation proposed for the month of July is in addition to the conditions established by the Bay-Delta Accord, with its main objective the maintenance of more favorable Delta hydrology in an effort to reduce juvenile anadromous fish mortality associated with water exports. This habitat objective will further contribute to the goals of the Accord, as well as contribute to the goals of the Anadromous Fish Restoration Program (AFRP).

The following is a summary of some of the pertinent biological information and justification that has led to the development of the July export:inflow ratio limitation to support increased survival of juvenile striped bass and other anadromous fish.

Fish species and life stages benefited: Striped bass, American shad, and white and green sturgeon juveniles are the primary beneficiaries of maintaining the Delta export:inflow ratio at 35% through July.

Supporting data:

Historical striped bass population trend--Persistent declines in the juvenile striped bass index (38 mm index) since the late 1960's and in adult abundance since the early 1970's have been documented by the Department of Fish and Game (CDFG 1987; Exhibit 25). The adult striped bass population declined by two thirds in that time, to a present population of about 600,000. The juvenile striped bass index decreased even more, from indices in excess of 100 in the mid to late 1960's to indices averaging less than 20 since the late 1970's. (Figure 1). During this period, combined Delta exports at State Water Project (SWP) and Federal Water Project (CVP) pumps have continually increased (Figure 2). Much of the supporting information for the proposed action that follows is derived from the ongoing annual striped bass monitoring program and subsequent analyses and modeling efforts that have been reported. For more information, see the following summary documents: CDFG 1992; Exhibit 2, A re-examination of factors affecting striped bass abundance in the Sacramento-San Joaquin Estuary, and IEP Technical Report 20 1987, CDFG Exhibit 25, Factors affecting striped bass abundance in the Sacramento-San Joaquin River system.

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Striped bass spawning--Striped bass spawn in two areas: in the Sacramento River spawning occurs mainly from the city of Sacramento to Colusa; the San Joaquin population generally spawns in the western Delta between Antioch and Venice Island (CDFG 1987, Exhibit 25). Most spawning in the Delta occurs from April through May, with ambient salinity conditions playing an important role in specific location (CDFG 1992, Exhibit 2). After spawning, young striped bass rear in the Delta and Suisun Bay. The distribution of young striped bass in their first few months of life is largely influenced by the magnitude of outflow and Delta water exports. Young striped bass residing in the central and south Delta are vulnerable to being entrained by SWP and CVP pumping operations (CDFG 1987, Exhibit 2).

Production limitations--For fish abundance to decline, productivity must decrease or mortality must increase. The thesis that we predicate our July export:inflow ratio on is that recruitment of 3-year-old striped bass has continued to decline based on an increase in mortality, predominately during the first year of life, and caused largely by increased losses of juvenile fish entrained in water exports by the State and Federal Water Projects (CDFG 1992, Exhibit 2). Other factors affecting system productivity, such as toxicity and increased adult striped bass mortality also may warrant investigation and remediation. However, we propose to create improved Delta habitat conditions in July using the tools of the CVPIA in an attempt to reduce juvenile striped bass entrainment at the SWP and CVP pumps.

Limitations to juvenile striped bass production and its relation to the proposed action--To support the hypothesis that entrainment losses of larval and juvenile striped bass can partially be mitigated by the July export:inflow limitation, we primarily rely on information summarized and presented by the CDFG in their exhibits presented to the State Water Resources Control Board, 1992.

- Losses of young bass entrained in the water project diversions constitute a significant portion of the population. Since 1970 annual total estimated losses of juvenile striped bass (21mm to 150mm) have been conservatively estimated to constitute 14% to 58% of the estimated abundance of young bass in the Estuary depending on assumptions related to sampling efficiencies (CDFG 1992, Exhibit 2, Page 35). The magnitude and annual trend in estimates of juvenile striped bass losses at SWP and CVP Delta pumping facilities from 1957 to 1989 is presented in Figure 3. In terms of yearling equivalents, peak losses occur in July. Large losses also occur in May, June and August, and a secondary peak occurs later in the year from November through January (Brown 1992; Figure 4).

- Prior to 1970, juvenile striped abundance was closely related to the percentage inflow diverted (Figure 5). As percent of effective inflow diverted increased striped bass abundance decreased. This relationship explained nearly 80% of the dependent variable (juvenile striped bass index) response. As export:inflow ratios increased above 35% the YOY index declined. While these percentages include internal Delta use, this relationship indicates that juvenile striped bass entrainment losses would be reduced if water exports were reduced.

- After the SWP began pumping large amounts of water in about 1970, the abundance of striped bass began to decline (Figure 1). This decline has persisted through the early 1990's and has been most distinct in the Delta, the area most affected by diversions, compared to downstream habitats such as Suisun Bay (CDFG 1992, Exhibit 2, page 19 and Figure 6).

- Regression analysis suggests that during the period of 1959-1990, April through July and May through July, outflow and water exports account for 65% and 73%, respectively, of the variability in the fraction of the young striped bass population residing in the Delta (CDFG 1992, Exhibit 2, Table 4). Delta outflow and water export rates interact to affect the distribution of juvenile striped bass residing in the Estuary and entrainment losses. Over a range of flows, similar export reductions will have a greater relative benefit in drier years, when greater proportions of juvenile striped bass reside in the Delta (Figure 7).

- The magnitude of estimated percentage reductions in abundance due to losses of striped bass eggs and larvae entrained in water projects is substantial. Such losses have been estimated (CDFG 1987, Exhibit 25, pages 70 to 78) to cause from 31% to 99% reductions in the population before young bass reach the 20 mm stage (also see CDFG 1992, Exhibit 2, page 34). This is significant as it has been demonstrated that mid-summer juvenile striped bass abundance, as described by the 38mm index, is at least partially determined by the abundance of larvae. This juvenile index, and subsequent entrainment losses, in turn largely determines subsequent recruitment of adults (CDFG 1992, Exhibits 2 and 3).

Based on these data, water exports reduce abundance of young striped bass, and if a year class gets off to a poor start it reduces adult recruitment. These results are consistent with a conclusion that more restricted July exports will provide additional protection to juvenile striped bass which in turn will benefit adult recruitment.

American shad and sturgeon production considerations--Juvenile American shad are the third most common fish species salvaged at the CVP and SWP pumping facilities with thousands of fish salvaged annually and thousands more lost to other diversions (USFWS, Working Paper, Volume 2, 1995). The bulk of the juvenile American shad entrainment at these facilities occurs from July through December. However, Evaluations of screening efficiencies comparable to studies for striped bass have not been conducted, consequently the proportion of entrained juveniles has not been quantified. It has been estimated that salvaged American shad suffer mortality rates in excess of 50% in the summer months and the proposed July export limitation would help reduce this value (USFWS, Working Paper, Volume 2, 1995).

Larval and juvenile sturgeon are transported downstream primarily by river currents and are susceptible to entrainment associated with water export pumping. Magnitude of these entrainment losses and effects on population abundance are currently unknown (USFWS, Working Paper, Volume 2, 1995).

Benefits: The magnitude of striped bass production increase relative to the proposed action is currently unknown but could be addressed through modeling simulations using estimates of juvenile entrainment for various water year scenarios. Sturgeon and American shad will also likely benefit from reduced export pumping in July. Changes in flow patterns associated with reduced export pumping also may result in fewer young fish being transported to the south Delta where entrainment and associated losses are great.

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Monitoring and evaluation needs: Current fisheries monitoring implemented through the Interagency Ecological Program (IEP) will document effects of the proposed action. Currently, the striped bass monitoring efforts assess both juvenile and adult population attributes and provide valuable long-term population trend information relative to Delta and estuarine conditions.

Summary: The loss of juvenile striped bass to July export pumping in the Delta is well documented. This information suggests that providing additional protection to juvenile striped bass from entrainment losses in July by limiting the export:inflow ratio at 35% will provide increased survival during their first year of life. This is turn will contribute to increased adult abundance which along with other coordinated improvements to Delta operations for the benefit of anadromous fish, will likely allow fishery production benefits to accrue more rapidly.

Citations

Brown, R.L. 1992. Bay/Delta fish resources. WRINT DWR-30, State Water Resources Control Board, 1992 Proceedings, Sacramento, CA.

California Department of Fish and Game. 1987. Factors affecting striped bass abundance in the Sacramento-San Joaquin River system. Exhibit 25, entered by the California Department of Fish and Game for the State Water Resources Control Board 1987 water rights proceeding on the San Francisco and Sacramento-San Joaquin Delta.

California Department of Fish and Game. 1992. A re-examination of factors affecting striped bass abundance in the Sacramento-San Joaquin Estuary. WRINT-DFG-Exhibit 2, entered by the California Department of Fish and Game for the State Water Resources Control Board, 1992, water rights phase of the Bay-Delta estuary proceedings.

Kohlhorst, D.W., D.E. Stevens, and L.W. Miller. 1992. A model for evaluating the impacts of freshwater outflow and export on striped bass in the Sacramento-San Joaquin estuary. WRINT-DFG-Exhibit 3, entered by the California Department of Fish and Game for the State Water Resources Control Board, 1992, water rights phase of the Bay-Delta estuary proceedings.

USFWS. 1995. Anadromous Fish Restoration Program, working paper on restoration needs, habitat restoration actions to double natural production of anadromous fish in the Central Valley of California, Volume 2.

Figure 1 through 7 not available electronically.

Delta Action 8: Establish conditions for a CWT late fall run juvenile survival experiment in Dec'97/Jan '98 at cxports of 65 and 35% of Delta inflow, respectively.

Description: This action would entail manipulating CVP and SWP exports and potentially flow at Sacramento to meet the desired export/inflow ratios for testing. This action was proposed to estimate the value of the lower export/inflow (E/I) ratio (35%) to survival of juvenile salmon migrating through the Delta between November and January.

Background: The experiment planned for the winter of 97-98 would be the second of three annual experiments designed to determine if survival to Chipps Island is greater for CWT late fall yearlings released at Sacramento during the low export/inflow ratio period than for those released during the higher export/inflow ratio period. To broaden the objectives of the study, releases made as part of this experiment will be timed, if possible to coincide with late fall production releases made at Coleman National Fish Hatchery. The production also is tagged so estimates of survival between Battle Creek and Sacramento can also be made. Estimates of survival are generated from recoveries of marked fish recaptured at Chipps Island. An additional release will be made at Port Chicago/Benecia to allow survival to be estimated from differential recoveries of adults in the ocean fishery from the two groups released at Sacramento. Unfortunately, release group sizes are relatively small and sample variation could influence our ability to detect small differences in survival should they exist. Replication of the experiment in 1998/1999 will provide additional results to test the hypothesis.

Since flows may be variable between the December and January releases, exports will be modified to meet the proposed ratios. The higher ratio was selected for the December period, since inflows will likely be less in December than January, thereby making the ratio more attainable using export modification. The fish may be slightly larger for the later release increasing their survival irrespective of the export/inflow ratio. This is somewhat problematic. The cross channel gates would be closed during both test periods, to minimize the effect of other factors between groups.

The specific proposal has been out for review since June 11, 1996. Specific comments on the proposal included the suggestion of redefining the hypothesis and using a particle tracking model to determine test conditions that are a better reflection of flow movement to the south delta project export facilities than that of the E/I ratio (USFWS, 1996b and 1996c).

Fish species and life stages benefited: If the lower export/inflow ratio increases survival through the Delta for yearling chinook salmon it would suggest that a lower E/I ratio of 35% would benefit outmigrant juvenile salmon during the November - January period and add justification for implementation of Action 9.

Supporting data: There is some evidence that indicates that marked late-fall chinook salmon released at Ryde (or Isleton) and into Georgiana Slough survive more similarly when the export/inflow ratio is lower, both when the cross channel gates are open and when they are closed (table 1). This analyses assumes the Ryde groups are a good index of survival through the Delta without impacts associated with the pumps. Although some recoveries are made at the fish facilities from fish released at Ryde, indicating they are still influenced to some degree by project pumping they are much less influenced than the releases made into Georgiana Slough.

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The experiment proposed is designed to index survival through the Delta with late fall yearlings released at Sacramento with the gates closed at the two ratios. It is uncertain how much decreasing the export/inflow ratio from 65% to 35% would increase survival for juvenile salmon migrating through the Delta.

Monitoring and evaluation needs: Evaluation of the effectiveness of this action will be determined from the results of the experiment. Confirmation of the Chipps Island survival indices will be provided by recovering marked fish in the ocean fishery as adults.

Citations

USFWS, 1996a. Proposal to compare survival indices of coded-wire tagged (CWT) late-fall released in the Delta in December, 1996 and January, 1997 under two levels of Delta export/inflow ratio. Draft 11 June 1996.

USFWS, 1996b. Letter from William J. (BJ) Miller, Consulting Engineer to Marty Kjelson (USFWS), regarding comments on June 11 draft proposal to index juvenile late fall survival at two different export/inflow ratios. Dated July 2, 1996.

USFWS, 1996c. Response from USFWS (Marty Kjelson) to BJ Miller regarding comments on the June 11 late fall proposal. Dated July 23, 1996.

Table I: Survival indices for late fall yearlings released at Ryde and into Georgiana Slough in 1993-1996 and mean Qwest, CVP, and SWP exports and flow at Vernalis for 17 days after release. The cross channel gate status, export/inflow ratio and the Ryde/Georgiana Slough survival index ratio are also included.

Date	Ryde Survival Index	Georgiana Slough Survival Index	Ryde/ Georgiana Slough	Qwest	Exports	Vernalis Flow	Cross Channel Gate Status	Export/ Inflow Ratio	Sacramento Flow at Freeport
12/2/93	1.91	0.28	6.8	1054	10,660	1,618	Open	50%	21,440
12/5/94	0.57	0.16	3.6	-165	7,075	1,297	Open	37%	19,133
1/4/95	0.33	0.12	2.8	10024	11,763	3,444	Closed	18%	62,900
1/10/96	0.66	0.17	3.9	37	11,370	2,665	Closed	32%	33,881

*Actual release made at Isleton, about 5 miles downstream of Ryde.

Delta Action 9: Limit the average CVP/SWP exports to no greater than 35% of Delta inflow in the November- January period. Sub priorities: 1) January, 2)December, 3)November.

Description: This action is designed to protect a variety of anadromous fish that migrate through the Delta between November and January by reducing the export/inflow ratio from 65% per the Delta accord to 35%. The action would require reduction in exports by the CVP and SWP or an increase in delta inflow or both.

Background: Reducing the export levels to no greater than 35% is designed to reduce the direct and indirect entrainment affects of export pumping. January is given the highest sub-priority because more juvenile salmon are in the system during that month (figure 1) with December of next priority and November being of lowest priority. Fewer fish were observed in November than in December or January.

There is considerable uncertainty as to the quantitative benefits of this action. Based on the late fall experiment conducted in December 1996 and January 1997 and experience with make up pumping, the justification for this action should be better understood. A problem occurs in implementing sub priorities because if one does not take action in November the chance is lost. However, water conditions in early fall may enable operators to determine if November or December reductions are a possibility.

Fish species and life stages benefited: Fall, late fall and spring run yearling chinook migrate through the Delta during these months. Winter and fall run fry may also enter the Delta during this time and rear in the Delta for up to several months. Actions to protect late fall, tributary spring and winter run are of high priority since these races are at extremely low population levels. Other species that could benefit would include juvenile striped bass, steelhead, American shad, white and green sturgeon and adult San Joaquin basin fall-run chinook salmon.

Supporting data: Annual expanded recoveries at the CVP and SWP fish facilities of late fall run yearlings released at Coleman National Fish Hatchery have ranged between 0.09 and 0.26 percent between 1994 and 1996 (table 1). Although, these numbers are relatively low, the fact that they reach the fish facilities is of concern. Assuming that the indirect losses in the Delta associated with being diverted off their main migration path towards the pumps are much greater than the direct losses (estimates have ranged between 4 and 7 times greater) the total impact associated with exports could range as high as 1 to 2 percent of the release.

Modeling based on fall run smolts indicate that after the variability due to temperature is removed, 17% of the variability in central delta survival was due to combined CVP/SWP exports (Kjelson, et al., 1989).

Depending on the length of curtailment benefits would vary. It is expected that indirect and direct losses (salvage) of all anadromous fish would decrease during the months of reduction in the export/inflow ratio. Decreases in exports relative to Delta inflow, with the cross channel gates closed would increase QWEST. Increases in QWEST during the November - January period could help juvenile anadromous fish diverted into the Central Delta via Georgiana Slough find their way to the ocean. Limited data has affected our ability to understand the importance of reverse flows in the western San Joaquin River on smolt survival in the central Delta

Monitoring and evaluation needs: Sampling for late fall CWT tags will occur at the fish facilities and at Chipps Island to assess entrainment and survival under the various export/flow conditions between November and January. Salvage also occurs for the other species and races of anadromous fish. Additional work using juvenile salmon with radio tags may assist in understanding the influence of QWEST flow levels on smolt migration in the Delta.

Citations

Kjelson, M.A., Greene, S. and P. Brandes, 1989. A Model for Estimating Mortality and Survival of Fall-Run Salmon Smolts in the Sacramento River Delta Between Sacramento and Chipps Island.

Table 1: Expanded recoveries at the CVP and SWP fish facilities, total number released and the total percent recovered of late - fall run juveniles released in the upper Sacramento River in 1994-1996.

Year	Total Number Released	Expanded SWP	Expanded CVP	Total Number Salvaged Expanded	Percent Recovered at SWP & CVP
1995	497,129	868	246	1,114	0.224
1994	613,565	99	433	532	0.087
1996	797,243	1,602	468	2,070	0.259

Stanislaus River Action 1: Implement an interim river regulation plan that meets the following flow schedule (Table 1) by supplementing the 1987 agreement between USBR and CDFG, through reoperation of New Melones Dam, use of (b)(2) water, and acquisition of water from willing sellers as needed.

Description: The implementation of AFRP flow objectives on the Stanislaus River continues to require balancing among improving river flows for the aquatic ecosystem in the basin, meeting temperature criteria, and providing adequate carryover storage in New Melones Reservoir. We recommend that releases from Goodwin Dam be maintained at not less than the flows identified by the AFRP (Table 1) to help the declining salmon and steelhead populations in the Stanislaus River continue to recover from the adverse effects of the recent drought. We are participating in the ongoing process to evaluate the “sustainable” CVP yield in the Stanislaus River basin available for helping to meet the AFRP flow objectives, as well as the potential of acquiring water from willing sellers.

Our flow objectives include the release of increased springtime flows (April to June 1997) to the Stanislaus River below Goodwin Dam. The springtime releases from Goodwin Dam should result in an increase in Stanislaus River flows, lower San Joaquin River flows, and Delta outflow. Combined with the Merced River and Tuolumne River flows; our intention is that these springtime flows will contribute to meeting the Vernalis flow standard for April and May consistent with the Bay-Delta Agreement and the Fish and Wildlife Service’s March 6, 1995 biological opinion for delta smelt (USFWS 1995a).

In addition to the springtime flows, the objectives for the Stanislaus River include: 1) flows below Goodwin Dam during October through March to provide spawning and rearing habitat for salmon and steelhead; and 2) minimum base flow in the summer. A fall attraction pulse flow using approximately 15,000 to 30,000 af is being considered for release during October 1997 to facilitate upstream migration of adult fall-run chinook salmon. If we wish to pursue this measure or use the water in another fashion, as indicated by the results of real-time monitoring, we will advise the agencies, stakeholders, and the public at a later date.

Background: Although New Melones Reservoir is the largest impoundment (2.4 maf) in the Stanislaus River basin, Goodwin Dam is located downstream of New Melones Dam and is the upstream barrier for salmon migration (Reynolds et al. 1993, USFWS 1995b). Existing releases to meet needs of chinook salmon in the lower Stanislaus River are specified in a 1987 study agreement between CDFG and USBR (CDFG and USBR 1987, USFWS 1995b). This agreement specifies interim annual flow allocations of 98,300 af to 302,100 af, depending on New Melones Reservoir carryover storage and inflow. Since the agreement was signed, water shortages have limited the quantity of water allocated to meeting fish needs to 98,300 af in all years except 1996. This quantity has proven to be inadequate for survival of all life stages of chinook salmon (Loudermilk 1994, USFWS 1995b).

The 1987 agreement provides for a 7-year study with seven study elements that are in various stages of completion. To date, results of smolt survival studies by CDFG and a 1992 instream flow study by USFWS (Aceituno 1993) has yielded sufficient data to allow formulation of minimum stream flow schedules with increased allotments for fish. In August 1992, CDFG submitted revised flow schedules to USBR and CDWR. The revised flows range from 185,280 af to 381,498 af (Reynolds et al. 1993). CDFG has indicated that these are minimum flows that are subject to revision upon completion of the remaining studies (Reynolds et al. 1993). The purpose of establishing minimum flows is to maintain the current population or prevent further decline as water demands increase (Reynolds et al. 1993). Therefore, a key assumption of the AFRP was that increasing natural production of chinook salmon in the Stanislaus River would require flows higher than the specified minimum flows.

Fish species and life stages benefited:

- spawning adult chinook salmon
- rearing and outmigrating juvenile chinook salmon
- spawning adult steelhead
- juvenile striped bass
- juvenile American shad
- juvenile delta smelt and other estuarine species

Supporting data: Escapement of adult chinook salmon into the Stanislaus River is associated with spring outflow in both the San Joaquin River at Vernalis and the Stanislaus River at Ripon (CDFG 1987, USFWS 1995b). Annual escapement estimates for chinook salmon (i.e., the number of 2 and 3-year old fish that return to spawn) have been made by the CDFG for San Joaquin River tributaries. The CDFG used these data and spring flows of tributaries and the San Joaquin River at Vernalis when three year old fish were emigrating as smolts, to perform regression analyses (CDFG 1987, 1992). The analyses indicated significant ($p<0.05$) positive correlations between spring flow in the tributaries and at Vernalis and escapement of fish 2.5 years later (Figures 1 and 2). An additional concern is that low flows in the fall may delay adult migration and spawning (CDFG 1992, USFWS 1995b).

The ratio of Vernalis flow to water export has been suggested as a factor influencing salmon escapement in the San Joaquin River basin, primarily by affecting smolt survival during the peak emigration period, e.g., the AFRP Working Paper (USFWS 1995). The USFWS performed a regression analysis to describe the relation between adult escapement (3 year old fish) and the Vernalis flow to combined SWP and CVP exports (VFER) during 15 April 15 May the year ,fish were smolts (Figure 3). The resulting regression equation was significant (p‣0.01) and VFER accounted for 40% of the variance in escapement.

To better understand factors affecting chinook salmon in the San Joaquin River basin, Carl Mesick Consultants (CMC 1994, 1995, 1996) performed correlation analyses on existing data to investigate relations among streamflow, exports, VFER, water temperature, stock size (escapement of 3 year old fish), ocean harvest, water quality, ocean conditions, and recruitment of chinook salmon cohorts (combined number of 2 and 3 year old fish returning in 1.5 and 2.5 years).

Each report offered further refinements to the analyses, especially concerning discrimination between cohorts. All reports analyzed data from the Stanislaus and Tuolumne rivers separately, and differed from earlier analyses conducted by the CDFG (CDFG 1987, 1992) by accounting for differences in age structure of fish in escapement estimates. Data were analyzed for various time periods within the years (1951-1989, depending on data availability, and the latter two reports (CMC 1995, 1996) developed stock and recruitment relationships, and presented time-series population models to predict recruitment relative to potential restoration activities. Overall, the analyses indicated that three variables accounted for most of the variance in recruitment of chinook salmon in the Stanislaus and Tuolumne rivers. The variables were VFER, low tributary flows during smolt emigration, and stock levels below 1,000 fish.

The CDFG (Reynolds et al. 1993) provided interim flow recommendations for the Stanislaus River (Table 2). Recommendations were intended to improve conditions for fall-run chinook salmon, and were based on results of an instream flow study conducted by the USFWS (Aceituno 1993) for October through March and smolt survival studies conducted by CDFG for April through May (CDFG 1992). Recommendations are provided for five water-year types in the San Joaquin 60-20-20 index, ranging from 185,280 to 381,498 af. The recommendations also include blocks of water to be used for spawner attraction in October and outmigration in April and May.

Recommendations from the instream flow study were thought to provide adequate spawning, incubation, and rearing habitats for fall-run chinook salmon. A total of about 155,000 af was recommended, irrespective of water-year type. However, the study noted that to protect and preserve chinook salmon in the Stanislaus River, a comprehensive instream flow regime would need to consider factors that were not included in the study, such as water quality, temperature, attraction flows, and flow for juvenile emigration.

The AFRP identified flow needs that, in conjunction with other restoration actions, would result in at least doubling natural production of fall-run chinook salmon relative to the average attained during 1967-1991 (USFWS 1995b). The needs were based on Aceituno (1993), the proportion of unimpaired flow that the Stanislaus River contributes to the San Joaquin River, and the historic hydrological regime. Assumptions were that flows greater than historical flows in the lower reach of the river are needed to compensate for elimination of access to upstream habitat, and flows should not be reduced between spawning and outmigration to prevent redd dewatering and stranding of rearing juveniles. Needs were then identified for five water-year types, according to the San Joaquin 60-20-20 index. The identified flows ranged from 290,000 to 943,000 af per year.

The AFRP flow objectives were derived from comments and additional information received on the flow needs identified in the Working Paper (USFWS 1995b). The resulting flow objectives are consistently higher than the CDFG recommendations, especially in the spring, but overall, they are similar at other times.

Monitoring and evaluation needs: The monitoring and assessment of these proposed AFRP flow objectives for the Stanislaus River is essential to obtain data on anadromous fish production and to facilitate an evaluation of the effects of this restoration action. The AFRP recommends that CDFG continue its existing monitoring programs, such as escapement surveys. The AFRP also encourages the water districts to continue monitoring juvenile salmon emigration using the rotary screw traps in partnership with the AFRP. Finally, the AFRP recommends the completion of the study elements identified in the 1987 agreement between CDFG and USBR, including CWT smolt survival studies and linking the existing USBR temperature model (Rowell 1993) with the USFWS instream flow model (Aceituno 1993). These proposed monitoring and study efforts can be coordinated with other monitoring and assessment programs in the San Joaquin basin and integrated through the Comprehensive Assessment and Monitoring Program (Section 3406(b)(16) of the CVPIA) with all CVPIA restoration actions and evaluations.

Citations

Aceituno, M. E. 1993. The relationship between instream flow and physical habitat availability for chinook salmon in the Stanislaus River, California. U.S. Fish and Wildlife Service, Ecological Services, Sacramento.

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U.S. Fish and Wildlife Service. 1995b. Working paper on restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volume 3. May 9, 1995. Prepared for the U.S. Fish and Wildlife Service under the direction of the Anadromous Fish Restoration Program Core Group. Stockton, California.

Stanislaus River

Table 1. Flow objectives for the Stanislaus River downstream of Goodwin Dam during 1 April 1997 through 31 March 1998. Water year type is based on the San Joaquin 60-20-20 index.

Month	Stanislaus River flow objectives (cfs) by water year type				
	Wet	Above normal	Below normal	Dry	Critical
October	350[a]	350[a]	250[a]	250[a]	200[a]
November-December	400[a]	350[a]	300[a]	275[a]	250[a]
January-March	400[b]	350[b]	300[b]	275[b]	250[b]
April 1-15	1500[c]	1500[c]	1500[c]	300	300
April 16-30	1500[c]	1500[c]	1500[c]	1500[c]	1500[c]
May 1-15	1500[c]	1500[c]	1500[c]	1500[c]	1500[c]
May 16-31	1500[c]	1500[c]	300	300	300
June	1500[d]	800[d]	250	200	200
July-September	300	300	250	200	200
Total (taf)	467	410	313	257	247

[a]Flow based on IFIM recommendations and the assumption that greater than historic flows are needed to compensate for elimination of access to upstream habitat. A pulse flow using approximately 15,000 to 30,000 af is being considered during October to attract adult chinook salmon.

[b]Flow based on the recommendation that flow should not be reduced between spawning and outmigration to prevent redd dewatering and stranding of rearing juveniles.

[c]Recommended springtime flows to improve survival of emigrating chinook salmon smolts in the Stanislaus River and San Joaquin River basin, benefit delta smelt and other estuarine species, and aid in the downstream transport of striped bass eggs and larvae. The timing, magnitude, and duration of the April-May and October flows must be flexible and responsive to changing hydrologic conditions and coordinated with flows on the Toulumne and Merced rivers.

[d]The June releases may be adjusted in cooperation with CDFG and USBR, depending on “real-time” chinook salmon monitoring, water temperatures in the Stanislaus and San Joaquin rivers, and concurrent flow releases in the Merced and Tuolumne rivers.

Table 2. Flow recommendations for the Stanislaus River downstream of Goodwin Dam (after Reynolds et al. 1993). Water year type is based on the San Joaquin 60-20-20 index.

	Stanislaus River flow objectives (cfs) by water year type				
Month	Wet	Above normal	Below normal	Dry	Critical
October 1-14	300	300	250	250	200
October 15-December 31	400	350	300	275	250
January-March	350	300	250	225	200
April-May	500	450	400	350	300
June-September	350	300	250	200	200
April-May pulse[a] (af)	89,100	68,310	47,520	26,730	5,940
October pulse (af)	15,000	15,000	15,000	15,000	15,000
Total (af)	381,498	325,959	269,034	221,811	185,280

[a]Based on 30 day flow of 400 cfs (100 cfs for 30 days in addition to spring base flow f 300 cfs) for critical year. Stanislaus River flow contribution at Vernalis = 20 percent.
Based on 30 day flow of 800 cfs (450 cfs additional flow for 30 days from base spring flow of 350 cfs) for dry year.
Based on 30 day flow of 1,200 cfs (800 cfs for 30 days in addition to spring base flow of 400 cfs) for below normal year.
Based on 30 day flow of 1,600 cfs (1,150 cfs for 30 days in addition to spring base flow of 450 cfs) for above normal year.
Based on 30 day flow of 2,000 cfs (1,500 cfs for 30 days in addition to spring base flow of 500 cfs) for wet year.

Figure 1 through 3 not available electronically.

American River Action 1: Develop and implement a river regulation plan that meets the flow objectives in Table 1 by modifying CVP operations, using (b)(2) water, and acquiring water from willing sellers as needed.

Description: To improve immigration, spawning, incubation, rearing, and emigration conditions for chinook salmon and steelhead in the lower American River, develop and implement a river regulation plan that meets the following flow objectives below Nimbus Dam.

Table 1. Flow Objectives (cfs)[1] for the American River for April 1, 1997 through March 31, 1998.

	Year type				
Month	Wet	Above normal	Below normal	Dry	Critical dry
April-June	4500[a]	3000	3000	2000	2000
July	2500[b]	2500	2500	1500	1500
August	2500[b]	2000	2000	1000	1000
September	2500[b]	1500	1500	500	500
October-December[2]	2500[c]	2000	2000	1750	1750
January-February	2500[c]	2000	2000	1750	1750
March	4500[a]	3000	3000	2000	2000

[1]A multi-agency and interested party management team should be formed to review and develop flow objectives in consideration of reservoir carryover storage and hydrologic conditions as needed to provide for the long-term needs of anadromous fish.

[a]Recommended flows to provide appropriate juvenile rearing habitat availability and out migration flows, and temperature control during May and June (i.e., maintain mean monthly river water temperatures below 65°F at H-Street).

[b]Recommended flows to provide some thermal protection (i.e., maintain mean monthly river temperatures at or below 70°F) for steelhead juveniles.

[2]Minimum flows for October 1 through December 31, 1997 will be based on the water year type for 1997 and reservoir storage conditions as of September 30, 1997. To be responsive to changing hydrologic conditions, flows may be ramped up or down in cooperation with CDFG and USBR in January 1997 and 1998.

[c]Flows needed for chinook salmon spawning. The 2500 cfs flow recommendation approaches the maximum release rate that can be sustained throughout this and subsequent months without exceeding water availability.

We understand that operating primarily to meet new water quality standards pursuant to the Bay-Delta Agreement and water supply demands south of the Delta will determine flows in the American River from April through September 1997. This will depend on reservoir inflow, storage, flow in the Sacramento River and other hydrologic conditions. In any event, American River flows (i.e., Nimbus releases) should be maintained at no less than the schedule in Table 1.

American River

Depending on hydrologic conditions, a carryover storage of not less than 600,000 AF at the end of September 1997 should be retained in Folsom Reservoir. This would provide for releases below Nimbus Dam of not less than 2,500 cfs from October 1997 through February 1998, and not less than 4,500 cfs in March 1998. Carryover storage greater than 600,000 AF will help supply the water to meet these instream flow objective, and to meet fall water temperature objectives. We are continuing to work on the relationship among October 1997 through March 1998 flow objectives and the 1997 reservoir storage, inflow and hydrologic conditions. We will coordinate with the agencies, stakeholders, and the public regarding the flow objective in the event Folsom Reservoir is less than 600,000 AF at the end of September. To be responsive to changing hydrologic conditions, flows may be ramped up or down in cooperation with CDFG and Reclamation in January 1997 and 1998. These flow objectives will provide spawning and rearing habitat for salmon and steelhead, improve survival of downstream migrating late fall-run, winter-run, and spring-run chinook salmon through the Delta; and assist in meeting the needs of estuarine species consistent with the Bay-Delta Agreement.

To the extent possible, flow fluctuations should be eliminated during this period. Interim criteria on significant flow thresholds and ramping rates are being prepared by CDFG and the Service in cooperation with Reclamation to assist Reclamation staff in minimizing adverse fishery impacts due to flow fluctuations. We will continue to work together to develop ramping criteria for the long-term.

Fish species and life stages benefited:

- Spawning adult fall-run chinook salmon
- Incubating, rearing and outmigrating juvenile fall-run chinook salmon
- Spawning adult steelhead
- Incubating, rearing and outmigrating juvenile steelhead
- Spawning adult American shad
- Juvenile American shad
- Adult and juvenile striped bass
- Other anadromous and resident fishes (including splittail)

Background: Efforts to implement the American River flow objectives are consistent with the objectives of the Water Forum, a broad-based regional planning effort that includes business and agricultural leaders, environmental groups, citizens groups, regional water managers, and local governments (letter of comment on the draft Anadromous Fish Restoration Plan dated March 1, 1996 and signed by Melvin Johnson, Executive Director of the Sacramento City-County Office of Metropolitan Water Planning).

The American River flow objectives and models for implementation of the objectives were developed and refined by teams of biologists and hydrologists with representation from Save the American River Association, the Water Forum's Surface Water Negotiation Team, the California Department of Fish and Game, the East Bay Municipal Utility District (EBMUD), business interests in the Water Forum, State Water Resources Control Board, Service, Reclamation, and others. The objectives and models for implementation where generally supported by the participants, although concerns were raised about potential effects on over-summering steelhead and late-fall-run chinook salmon.

Prior to development of the American River flow objectives (in 1972), the Environmental Defense Fund (EDF) filed suit against EBMUD challenging a proposed diversion of water from Nimbus Dam through the Folsom South Canal, bypassing the lower American River. A 1990 court decision resulting from this case (known as the Hodge decision) ordered the following flows for the protection of salmonid resources in the lower American River: 2,000 cfs between 15 October and 28 February; 3,000 cfs between 1 March and 30 June; and 1,750 cfs between 1 July and 14 October.

The Hodge flows prescribe conditions that must be met prior to diversion of American River water by EBMUD. In most dry and critical years, those flow conditions could not be met and therefore EBMUD could not divert water. We recommend higher flow objectives to provide greater benefits than the Hodge flows in wet, above, and below normal years and lower flow objectives in drier years, such that flows could reasonably be met in almost all years. In addition, the Hodge flows were to protect all public trust resources and therefore the summertime flows included consideration of recreational activities, including wading, swimming and rafting.

Supporting data: The Hodge flows were established after extensive review of available scientific data concerning the relationship between lower American River flows and salmonid production. Additional information addressing optimal instream flows for salmonid spawning and incubation, rearing, outmigration, and temperature control has been developed subsequent to the Hodge decision, either as part of the retained jurisdiction associated with *EDF et al. v. EBMUD* (Williams 1995), as part of AFRP Technical Team efforts to develop the AFRP Working Paper (USFWS 1995), or as part of the Water Forums regional planning efforts (Bratovich et al. 1995). Bratovich et al. (1995) listed over thirty studies of fish and related hydrology on the lower American River and Williams (1995) summarized and discussed many of these studies, focusing on evidence and analysis bearing on the flows and water temperatures needed to protect chinook salmon in the lower American River. This additional information was used to develop the instream flow recommendations for the lower American River that appear in Table 1.

Monitoring and evaluation needs: Monitoring the effectiveness of the American River flow objectives is essential to obtain data on anadromous fish production and to facilitate an evaluation of the effects of this restoration action. We recommend that existing monitoring programs continue, including escapement surveys, redd surveys, emigrant trapping, and seine surveys. Refinement of existing methods should continue and additional studies should be conducted (see Williams [1995] for a discussion of potential additional studies). In a letter of comment on the draft Anadromous Fish Restoration Plan dated January 12, 1996, John Williams identified several assumptions he felt should be the focus of an adaptive management approach to the American River flow objectives. The monitoring and study efforts should be coordinated with other monitoring and study programs in the Central Valley and integrated through CAMP with all CVPIA restoration actions and evaluations.

Citations

Bratovich, P.M., S.L. Taylor, and D.B. Christophel. 1995. Sacramento Area Water Plan Forum: Final Fish Biologists Working Session Summary. Prepared for the Sacramento City-County Office of Metropolitan Water Planning, Sacramento, California.

U.S. Fish and Wildlife Service. 1995. Working paper on restoration needs: habitat restoration actions to double natural production of anadromous fish in the Central Valley of California. Volume 3. May 9, 1995. Prepared for the U.S. Fish and Wildlife Service under the direction of the Anadromous Fish Restoration Program Core Group. Stockton, California.

Williams, J.G. 1995. Report of the Special Master, Environmental Defense Fund v. East Bay Municipal Utility District, Alameda County (California) Superior Court Action No. 425955.

Sacramento River Action 1: Minimum Keswick releases of 5,300 from April 1, 1997 through September 30, 1997 and between 3,250 and 5,300 from October 1, 1997 to March 30, 1998 based on October 1, 1997 Shasta Reservoir carryover storage.

Description: During April, 1997, we recommend that releases from Keswick Dam be maintained at not less than 5,300 with such flows to remain in the river below Red Bluff Diversion Dam. Flows from May to September should be determined by operations required to meet temperature control criteria for winter-run chinook salmon. In any event, Sacramento River flows (i.e. Keswick releases) should be maintained at not less than 5,300 through September 30. Flows from October, 1997 through the following March should be based on October 1, 1997 Shasta reservoir carryover storage according to the following table.

Carryover storage (maf) (October 1, 1997)	Keswick Release (cfs)	Carryover storage (maf) (October 1, 1997)	Keswick Release (cfs)
less than 1.9[1]	3250	2.6	4,500
1.9 to 2.1	3,250	2.7	4,750
2.2	3,500	2.8	5,000
2.3	3,700	2.9	5,250
2.4	4,000	3.0 or greater	5,300
2.5	4,250		

Background:
The flow schedule recommended addresses fluctuations by limiting flow reductions and fluctuations to less than have previously occurred. During the fall, prior to passage of CVPIA, it was not uncommon to have flows running at 5-6 k cfs during October-November primarily for cross-delta deliveries (e.g. to refill San Luis Reservoir). When fall rainfall and natural accretions increased sufficiently to satisfy cross-delta needs, the flows from Shasta were dropped to minimums (3k cfs) regardless of the storage conditions in Shasta (i.e. maximizes storage for next summer's releases). The flow reduction would usually occur over a very short time period and strand many eggs and juveniles. This would occur even flood control operations in January-March required flows to be greatly increased. However, it also makes no sense to drain the reservoir during the winter with increased in-stream releases and not have enough cold water to provide for winter run spawning during the following summer. The recommended flow schedule is a balance between needs for storage and instream flows is realized.

[1] In the event forecasted carryover storage drops below 1.9 maf, USBR must reinitiate consultation with NMFS.

Sacramento River

Fish species and life stages benefited:

- Spawning adult chinook samon
- Rearing and outmigrating juvenile chinook salmon
- Spawning adult steelhead
- Rearing and outmigrating juvenile steelhead

Supporting data: The proposed flow schedule provides the most productive and stable environment that can be attained under the reservoir storage, runoff, and project operation conditions during the water year. Specifically this flow recommendation will provide for improved spawning and rearing of chinook salmon and steelhead, and improved survival of downstream migrating late-fall run, winter-run, and spring-run chinook salmon.

The algorithm for flow is built on the minimum flow and carryover requirements established in the Biological Opinion (BO) for CVP and State Water Project (SWP) effects on Sacramento River winter-run chinook salmon (NMFS 1993, CVPIA Working Paper, Vol. 3) and Water Rights Order 90-5 stipulating minimum instream flows. The BO also requires a minimum instream flow of 3,250 cfs from October 1 to April 30 and temperature control operation from May 1 to September 30 (NMFS 1993).

Clear Creek Action 1: Release a minimum flow into Clear Creek from Whiskeytown Dam of:
150 cfs from April 1, 1997 through May 30, 1997;
50 cfs from June 1, 1997 through September 30, 1997;
150-200 from Oct 1, 1997 through May 30, 1998; and
Release a spring pulse flow in May 1997.

Description: The recommended releases from Whiskeytown Dam to Clear Creek are 150-200 cfs from October to April and 50 cfs for the remainder of the year with variable spring-time releases depending on water year type.

The recommended flows provide habitat and temperature requirements for fall-run and late fall-run chinook salmon and steelhead and, to a lesser extent, for spring-run chinook salmon, which are presently extirpated from the stream. If the spring-run chinook salmon population becomes successfully reintroduced, it may require an even lower summer water temperature regime, necessitating increased flows. The releases are measured at Whiskeytown Dam to provide more precise temperature regulation and prevent harmful flow fluctuations.

A springtime flushing flow recommendation will be developed empirically to accomplish sediment removal, prevent riparian vegetation encroachment, maintain the proper channel configuration, distribute new spawning gravel, facilitate timely juvenile outmigration, and attract adult spring-run salmon and steelhead into the stream. The schedule and amount of flow would be determined by a series of experiments designed to intensify and augment a storm flow at strategic times. The flushing flow releases would not exceed the natural inflow into Whiskeytown Reservoir during the storm.

Background: The cumulative effects of water diversion, gold mining, gravel mining, logging, road building, residential development, and the construction of Whiskeytown Dam have contributed to the decline of the Clear Creek anadromous fishery habitat.

Existing Clear Creek habitat supports an estimated 2% of the Sacramento River's salmon population. Restoration of habitat and increased flow releases from Whiskeytown Reservoir could triple the present production of salmon in Clear Creek. Steelhead populations would similarly benefit.

McCormick Saeltzer (Saeltzer)Dam is located six miles upstream from the Sacramento River on Clear Creek. Whiskeytown Dam is ten miles upstream from Saeltzer Dam. Because the fish ladder on Saeltzer Dam doesn't function very well, the upper ten miles of Clear Creek is currently inaccessible to most if not all salmon and steelhead.

Increased flows were provided in Clear Creek from October 1, 1995 to April 28, 1996, with benefits to the fishery including: 1) improved fish passage into Clear Creek; 2) improved Clear Creek water temperatures in October; 3) increased the amount of spawning and rearing habitat in Clear Creek; and 4) record numbers of fall-run chinook salmon spawning in Clear Creek. The

Clear Creek

Service distributed a report (Brown 1996) in the summer of 1996 on the fishery impacts of the flow release, based on field studies conducted by FWS, CDFG and DWR. The FWS and CDFG and again requested similar flows in 96-97 and flows were again increased in October, 1996 and are expected to continue through May, 1997.

Fish species and life stages benefited:

- Spawning adult chinook salmon
- Rearing and outmigrating juvenile chinook salmon
- Spawning adult steelhead
- Rearing and outmigrating juvenile steelhead

Supporting data: The recommended flow releases can nearly double available fall-run and late fall-run chinook salmon habitat over that provided by the present minimum releases of 50 cfs. By increasing the flows below Whiskeytown Dam, it is possible to add back approximately five miles of spring-run habitat and 10 miles of steelhead habitat and to possibly reintroduce spring-run chinook salmon. If successful, another distinct and genetically viable population of spring-run chinook salmon and steelhead could become established in the Central Valley, which would reduce the probability of these species going extinct. In addition, Clear Creek is one of two tributaries in the upper Sacramento River that can provide habitat for three races of salmon and steelhead.

These recommendations (CDFG correspondence report 1993, Working Paper, Vol. 3) are based on attainable temperature objectives and habitat requirements that were determined by an instream flow study (DWR 1986, Working Paper, Vol. 3) and the Clear Creek hydrologic data at Whiskeytown Dam for 1923 to 1994 (USBR Central Valley Project Operations Hydrologic Data, Working Paper, Vol. 3).

Attachment G6

Minimum Instream Fishery Releases For Trinity River

Attachment G6

MINIMUM INSTREAM FISHERY RELEASES FOR TRINITY RIVER

The following release schedule for Trinity River was developed by the Service for use in the Draft PEIS alternatives on April 26, 1995.

Flow alternative assumes a restored channel configuration, channel morphology (maintenance), riparian innundation and dessication (and seed dispersion), sediment transport, rearing, overwintering, and redd separation.

Water Year	Wet		Above Normal		Below Normal		Dry		Critical	
Exceedence>	0.25		0.50		0.70		0.90		<0.90	
TRD INFLOW	1,600,000		1,050,000		860,000		600,000		<600,000	
Week										
01 Oct	275		225		200		200		200	
09 Oct	300		250		225		225		225	
16 Oct	350		275		250		250		250	
23 Oct	400		300		300		300		300	
30 Oct	450	337	325	265	325	248	325	248	325	248
06 Nov	450		350		350		350		350	
13 Nov	500		375		350		350		350	
20 Nov	500		400		400		400		400	
27 Nov	500	480	425	373	499	364	400	364	400	364
04 Dec	500		450		400		400		400	
11 Dec	500		475		450		450		400	
18 Dec	500		500		450		450		400	
25 Dec	500	500	500	476	450	434	450	434	400	400
01 Jan	600		500		450		450		450	
08 Jan	600		500		450		450		450	
15 Jan	600		500		450		450		450	
22 Jan	600		500		450		450		450	
29 Jan	600	600	500	500	450	450	450	450	450	450
05 Feb	600		500		450		450		450	
12 Feb	600		500		450		450		450	
19 Feb	600		500		450		450		450	
26 Feb	600	600	500	500	450	450	450	450	450	
05 Mar	600		600		500		500		500	
12 Mar	650		600		500		500		500	
19 Mar	700		600		500		500		500	
26 Mar	750	663	600	587	500	494	500	494	500	494
02 Apr	800		800		700		600		600	
09 Apr	850		800		700		600		600	
16 Apr	900		800		700		600		600	
23 Apr	1,000		800		800		600		600	
30 Apr	1,500	903	1,000	800	1,000	727	800	603	800	603
07 May	2,000		2,000		1,500		1,000		2,000	
14 May	4,000		5,200		2,000		1,500		2,000	
21 May	8,500		5,200		4,500		4,500		2,000	
28 May	3,750	4,048	3,000	3,381	2,000	2,258	1,750	1,961	2,000	1,768
04 Jun	3,500		2,500		1,500		1,500		2,000	
11 Jun	3,000		1,500		1,200		1,000		750	
18 Jun	2,500		1,000		1,000		850		600	
25 Jun	2,000	2,875	900	1,647	750	1,213	650	1,087	500	1,082
02 Jul	1,500		650		550		450		450	
09 Jul	1,000		500		400		300		300	
16 Jul	700		400		300		275		250	
23 Jul	500		350		300		250		250	
30 Jul	400	926	300	477	250	390	200	322	200	311
06 Aug	350		300		250		200		200	
13 Aug	300		300		250		200		200	
20 Aug	275		275		225		200		200	
27 Aug	250	314	250	286	200	236	175	196	175	196
03 Sep	225		225		200		175		175	

Water Year	**Wet**		**Above Normal**		**Below Normal**		**Dry**		**Critical**	
Exceedence>	**0.25**		**0.50**		**0.70**		**0.90**		**<0.90**	
TRD INFLOW	**1,600,000**		**1,050,000**		**860,000**		**600,000**		**<600,000**	
Week										
10 Sep	200		200		175		150		150	
17 Sep	200		200		200		150		150	
24 Sep	250	221	200	209	200	194	175	163	175	163
Total	752,252		573,804		449,757		408,177		393,278	

ATTACHMENT H

SPECIAL STATUS SPECIES HIGH-PRIORITY NEEDS WITHIN AREAS POTENTIALLY AFFECTED BY THE CENTRAL VALLEY PROJECT

Attachment H

SPECIAL STATUS SPECIES HIGH-PRIORITY NEEDS WITHIN AREAS POTENTIALLY AFFECTED BY THE CENTRAL VALLEY PROJECT

Special Status Species	Actions by Tool
AMPHIBIANS	
California red-legged frog *Rana aurora draytonii*	*Acquirement* - Protect habitat for the California red-legged frog by acquiring land in title or easement, or acquiring development rights.
	Removal of Nonnative Species - Participate in ongoing efforts to control bullfrog populations as deemed appropriate.
	Reestablishment of Species - Provide reintroduction of the species as is determined appropriate to existing public lands.
	Improve Habitat - Participate in ongoing habitat enhancement activities, and implement the protection strategy plan as outlined below.
	Research, Studies, and Planning - (a) Survey distribution and map suitable habitat areas using ARCINFO GIS; (b) Develop a protection strategy plan; (c) Identify habitat for conservation activities; and (d) Contribute to ongoing bullfrog control research.
REPTILES	
blunt-nosed leopard lizard *Gambelia (crotaphytus) silus*	*Acquirement* - Acquire from willing sellers, title or easement of properties appropriate for the species conservation plan.
	Improve Habitat - Implement the habitat conservation and management plan, prioritizing protection efforts of natural lands in western Madera County.
	Research, Studies, and Planning - (a) Survey all accessible parcels for existence and map appropriately using ARCINFO GIS; (b) Identify appropriate natural lands in western Madera County; and (c) Develop a conservation plan including protection and acquisition priorities and specific management prescriptions.
giant garter snake *Thamnophis gigas*	*Acquirement* - Protect habitat for the giant garter snake by acquiring land or easements.
	Improve Habitat - Implement BMP's and O&M guidelines from the protection strategy plan that provide a better quality of habitat including a reduction of toxic chemical concentrations, and will provide enhancement of habitats areas which are or could provide habitat for the giant garter snake.
	Research, Studies, and Planning - (a) Identify giant garter snake habitat; (b) Survey species distribution and map in ARCINFO GIS; (c) Complete protection strategy plan; (d) Identify giant garter snake rice industry benefits; and (e) Develop and publish O&M guidelines for agricultural activities in giant garter snake habitat.
MAMMALS	
San Joaquin kit fox *Vulpes macrotis mutica*	*Acquirement* - Protect habitat for the San Joaquin kit fox by acquiring land in title, easement, or the acquirement of development rights to conserve the species, including the maintaining of habitat corridors where land use changes threaten the species with habitat fragmentation.
	Improve Habitat - Implement the habitat conservation and management plan.

Special Status Species	Actions by Tool
	Research, Studies, and Planning - (a) Survey species distribution and map using ARCINFO GIS; (b) Map existing and proposed conversions of land use from native habitats using ARCINFO GIS; (c) Identify use of agricultural lands by the San Joaquin kit fox; and develop agricultural guidelines for the species using this information in conjunction with the American Farmland Trust; and (d) Develop a species conservation plan with protection and acquisition priorities, and specific management prescriptions, including: 1) the identification of habitat of thee conservation of the species, 2) the protection of habitat of the species specifically prioritizing natural lands in western Madera county subsequent to surveying all accessible parcels, and 3) the completion of protection strategy which utilizes the land retirement program within the CVPIA.
San Joaquin Valley woodrat *Neotoma fuscipes ssp. Riparia*	*Acquirement* - Purchase appropriate habitat from willing sellers to be added to the San Joaquin River NWR.
	Reestablishment of Species - Provide reintroduction of the species as is determined appropriate to existing public lands.
	Improve Habitat - Implement a fire management plan as outlined below, and protect, enhance, and restore riparian habitats and corridors to conserve resources for the species.
	Research, Studies, and Planning - (a) Survey and map GIS; (b) Research genetics coordinating with any ongoing work underway; (c) Monitor known populations using non-intrusive methodologies; (d) Establish a species conservation/management plan which will include: 1) the completion of a fire management plan for Caswell Memorial State Park for prevention of excessive burns which might remove too much of the species limited habitat (The plan must provide for continued connectivity of cover to allow for appropriate levels of interbreeding), 2) the completion of a preplan for the reestablishment of the species to suitable habitats including any needed biological and ecological research regarding the parameters which will influence these introductions to unoccupied habitat, 3) the coordination with interested participants to develop one or more safe harbor-like HCP's to aid in conserving the species, and 4) to provision for additional mapping needs for HCP processes; (e) initiate efforts to elicit input from landowners regarding BMP's and other cooperative efforts to aid conservation including funding the publishing of pamphlets and information sheets; and (f) Initiate a research and monitoring program providing annual monitoring of known populations using quantitative but no intrusive methods.
riparian brush rabbit *Sylvilagus bachmani ssp. Riparius*	*Reestablishment of Species* - Establish at least three additional wild populations of the species in the San Joaquin Valley which include areas of flood refugia and a working fire management plan.
	Improve Habitat - Construct flood refugia adjacent to havitat at Caswell Memorial State Park including construction of suitable knolls and the establishment of brush and connecting corridors.
	Acquisition - Purchase appropriate habitat from willing sellers to be added to the San Joaquin River National Wildlife Refuge.

Special Status Species	Actions by Tool
	Research, Studies, and Planning - (a) Survey potential habitat for the species on the lower Stanislaus River and the San Joaquin River downstream from Fremont Ford State Park; (b) Research genetics coordinating with any ongoing work underway; (c) Coordinate with interested participants to develop one or more safe harbor-like HCP's to aid in conserving the species; (d) Develop a cooperative recovery program which will implement management elements detailed by Williams (1993); (e) Implement studies which will determine biological information needed for management and design of the program; (f) Protect species by implementing brush and fire control measures to reduce the changes of an intense wildfire consuming too much woody riparian and eliminating necessary brush cover, including the coordination of similar management planning efforts on Corps of Engineers easement properties; (g) Determine likely flood depth requirements; (h) Provide for additional mapping needs for the HCP processes; (i) Initiate efforts to elicit input from landowners regarding BMP's and other cooperative efforts to aid conservation including funding the publishing of pamphlets and information sheets; (j) Develop a preplanning effort to reestablish any extirpated populations; and (k) Institute quantified annual monitoring to track status and trends of the species populations at Caswell Memorial State Park.
Buena Vista Lake ornate shrew *Sorex ornatus ssp. Relictus*	*Research, Studies, and Planning* - (a) Survey and map all accessible suitable habitat in the Tulare basin for the species placing into ARCINFO GIS; (b) Research genetics coordinating with any ongoing work underway; (c) Design and implement biological and ecological studies to determine the recovery and management needs of the species; (d) Provide for both short-term and long-term release of water by gravity flow from existing conveyance facilities to provide suitable habitat for the species; (e) Continue negotiations and provide positive incentives to landowners for the protection of the Kern Lake population of the species; (f) Coordinate to ensure an appropriate consideration of species needs are met in the Kern Fan Water Bank and Tulare Elk Reserve planning processes; (g) Develop a preplan for the introduction of the species into suitable habitat in the Tulare basin; and (h) Monitor species populations annually.
San Joaquin kangaroo rat *Dipodomys nitratoides ssp.*	*Improve Habitat* - Implement the management plan including efforts to expand the habitat area by potentially retiring additional leased agricultural lands on base.
	Research, Studies, and Planning - (a) Complete studies on the relationships and taxonomic identify of isolated populations of subspecies of San Joaquin kangaroo rats; (b) Institute research and monitoring of known populations peripheral to historic range of the Fresno kangaroo rate; (c) Develop a management plan; (d) Continue and intensify habitat management studies through the Endangered Species Recovery Planning Program and/or other agencies; (e) Coordinate with the Department of Defense (USN) to assist in protecting the species; and (f) Determine fire management objectives.
Fresno kangaroo rat *Dipodomys nitratoides exilis*	*Acquirement* - Acquire from willing sellers, title or easement of properties appropriate for the species conservation plan.
	Improve Habitat - Implement the habitat conservation and management plan.
	Research, Studies, and Planning - (a) Continue and intensify efforts to locate and map populations of the Fresno kangaroo rat within historic ranges within ARCINFO GIS; (b) Complete studies on the relationships and taxonomic identity of isolated populations of subspecies of San Joaquin kangaroo rats; (c) Institute research and monitoring of known populations peripheral to historic range of the Fresno kangaroo rat; (d) Develop and conservation plan, including protection and acquisition priorities, and specific management prescriptions; (e) Identify and protect natural lands in western Madera County subsequent to surveying all accessible parcels; and (f) Develop a preplan to reintroduce the species to suitable habitat, including any additional information needs.

Special Status Species	Actions by Tool
INVERTEBRATES	
Doyen's Trigonoscuta dune weevil *Trigonoscuta doyeni*	*Reestablishment of Species* - Establish at least four viable populations of the species through introductions into suitable habitat.
	Research, Studies, and Planning - (a) Locate and map the extant population of the species into ACRINFO GIS; (b) Research the biology and natural history of the species to determine its habitat and management needs; (c) Determine the ownership and use of the land parcel(s) at the site of the extant population of the species; (d) Pursue opportunities to implement the measures needed to conserve the species; and (e) Encourage the publication of the scientific name and description of the species.
PLANTS	
large-flowered fiddleneck *(Amsinckia grandiflora)*	*Acquirement* - Protect habitat for the large-flowered fiddleneck by acquiring land in title or easement, or acquiring development rights.
	Reestablishment of Species - Provide care for existing populations of large-flowered fiddleneck, and implement the long-term plan established below.
	Improve Habitat - Restore existing bunch grass type habitat areas.
	Research, Studies, and Planning - (a) Identify and map (ARCINFO GIS) existing potential habitat by using soil maps and digital elevation data; (b) Develop a protection strategy plan; (c) Establish a long-term management agreement for all lands acquired for the species; and (d) Monitor existing known populations.
Palmate-bracted birds-beak *Cordylanthus palmatus*	*Acquirement* - Protect habitat and existing populations of the palmate-bracted bird's-beak by acquiring title, easement, or development rights associated with management purposes for conservation of the species.
	Improve Habitat - Participate in ongoing habitat enhancement activities, and implement protection strategy and conservation/management plan as outlined below.
	Research, Studies, and Planning - (a) Survey, identify and map habitat distribution of the species using ARCINFO GIS; (b) Research ecology of the palmate-bracted bird's-beak including hydrology, soil characteristics, genetics, fire ecology pollinators, exotic competition, and other habitat factors; (c) Develop a conservation plan, including protection and acquisition priorities, and specific management prescriptions; and (d) Identify and protect natural lands in western Madera county subsequent to surveying all accessible parcels.
Kern mallow *Eremalche kernensis*	*Research, Studies, and Planning* - (a) Map all subpopulations of the species and place into ARCINFO GIS; (b) Research genetics, coordinating with any ongoing work underway; (c) Do ecological research study of the conservation significant of pollinators, fire, grazing, exotic species competition, reproductive biology (including introgression where applicable), soil characteristics, etc., in CVP affected area; (d) Do population viability analyses including population structure and census data; (e) Coordinate with Chevron's Lokern mitigation bank and the Kern County Valley Floor HCP planning processes to ensure the protection of at least 90 percent of the remaining occupied habitat; (f) Do studies on the effects of herbicides and pesticides spraying on pollinators; and (g) Begin a monitoring program including the establishment of photo points, field data sheets (including insect visitors, grazing observations, soil moisture and phenologic conditions), and visit each population 1-4 times per year.

Special Status Species	Actions by Tool
Bakersfield catus *Opuntia basilaris var. Treleasei*	*Acquirement* - Acquire lands in fee title or by easement from willing sellers as needed to meet the goals that cannot be protected in a timely manner via the implementation of the HCP process.
	Research, Studies, and Planning - (a) Do population viability analyses including population structure and census data; (b) Research genetics, coordinating with any ongoing work underway; (c) Do ecological research study of conservation significant of pollinators, fire, grazing, exotic species competition, reproductive biology (including introgression, where applicable), soil characteristics, etc., in CVP affected areas; (d) Coordinate with Metropolitan Bakersfield HCP implementation and the Kern County Valley Floor HCP planning processes to protect at least 90 percent of the remaining occupied habitat; (e) Do studies on the effects of herbicides and pesticides spraying on pollinators; and (f) Begin a monitoring program including the establishment of photo points, field data sheets (including insect visitors, grazing observations, soil moisture and phenologic conditions), and visit each population 1-4 times per year.
Bakersfield smallscale *Atriplex tularensis*	*Acquirement* - Protect the Kern Lake site from the potential of agricultural, and municipal and industrial conversion by purchase or easement.
	Improve Habitat - Protect the species by conserving habitat at the Kern Lake site including the negotiation and acquirement of a short-term water right and subsequent long-term water supply to maintain suitable habitat conditions.
	Research, Studies, and Planning - (a)Survey and map all accessible suitable habitat and map any new populations found in ACRINFO GIS; (b) Research genetics, coordinating with any ongoing work underway; (c) Research the efficacy of greenhouse propagation in the species preservation; (d) Do ecological research study of conservation significant of pollinators, fire, grazing, exotic species competition, reproductive biology (including introgression, where applicable), soil characteristics, etc., in CVP affected areas; (e) Adequately participate in the Kern County Valley Floor HCP planning processes to ensure the protection of suitable habitat and any subsequently discovered species; (f) Develop a preplan for habitat protection and reintroduction; and (g) Begin a monitoring program including the establishment of photo points, field data sheets (including insect visitors, grazing observations, soil moisture and phenologic conditions), and visit each population 1-4 times per year.
oil neststraw *Stylocline citroleun*	*Improve Habitat* - Until exact sites of occurrence are known, protect the general areas of all known occurrences of the species from disturbance.
	Research, Studies, and Planning - (a)Survey, map existing populations in ACRINFO GIS, and characterize microsites within the Elk Hills area; (b) Map suitable habitat throughout appropriate ecological zones of Kern County for new populations in ARCINFO GIS; (c) Begin a monitoring program including the establishment of photo points, field data sheets (including insect visitors, grazing observations, soil moisture and phenologic conditions), and visit each population 1-4 times per year.
Keck's sidalcea *Sidalcea keckii*	*Improve Habitat* - Implement the habitat protection plan as appropriate, depending on the location of new populations and cooperation of landowners, and seek permission to visit known occurrences on private lands to look for additional occurrences and remove exotic weeds that may be crowding out the species.
	Research, Studies, and Planning - (a)Survey and map (focusing on public and private lands allowing access) potential habitat of the species to locate any new populations placing into ACRINFO GIS; (b) Develop and institute a safe harbor-like program; (c) Establish a conservation plan, including habitat protection for the species; (d) Preplan reintroduction strategies and studies; and (e) Do quantified annual monitoring of any known populations subsequent to approval by landowners.

Special Status Species	Actions by Tool
Gabbro Soils Habitat	*Acquirement* - Acquire the Gabbro Soils Plant Preserve.
	Improve Habitat - Implement the acquisition and management plan for the preserve.
	Research, Studies, and Planning - Develop an acquisition and management plan for the preserve which includes fire management planning.
Vernal Pool Habitat	*Improve Habitat* - Implement the vernal pool protection strategy plan to protect venal pool habitat.
	Research, Studies, and Planning - (a) Survey, identify, and map vernal pool complex habitats into ARCINFO GIS; (b) Research the ecology of vernal pool species; (c) Develop a protection strategy plan which specifically prioritizing actions regarding Sacramento orcutt grass populations near the Sacramento Landfill, the Springtown Alkali Sink area, and Ollcott Lake, Vina Plains, Haystack Mountain, and Table Mountains areas; (d) Develop and disseminate guidelines to agricultural and Municipal and Industrial developers on avoidance of vernal pool areas (slick spots); and (e) Investigate the potentials for artificial vernal pool creation.
Raparian Habitat	*Acquirement* - Acquire title or development rights for riparian habitats that contribute to the conservation of listed and proposed riparian and aquatic species.
	Improve Habitat - Implement the riparian management plan mentioned below.
	Research, Studies, and Planning - (a) Survey and map (ACRINFO GIS) suitable riparian habitat; (b) Develop protection strategies and an implementation plan which will identify and protect riparian habitat suitable for the conservation of listed and proposed riparian and aquatic species; (c) Consider sites with potential for natural reversion to riparian functionality where applicable; and (d) Wherever possible acquire associated water rights simultaneous to land acquisitions.
Woodland Habitat	*Acquirement* - Acquire woodland habitats in fee or easement to provide for associated sensitive species.
	Research, Studies, and Planning - Provide appropriate planning and management efforts associated with the acquisition efforts mentioned previously.
General Chemical Use	*Research, Studies, and Planning* - Promote cost-share voluntary grant programs that reduce chemical uses including participation in ongoing programs such as BIOS and BIFS administered by the University of California.

CENTRAL VALLEY PROJECT IMPROVEMENT ACT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

DRAFT TECHNICAL APPENDIX

Surface Water Supplies and Facilities Operations

September 1997

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LIST OF ABBREVIATIONS AND ACRONYMS

ACID	Anderson-Cottonwood Irrigation District
Act	Rivers and Harbors Act of 1935
CEQ	Council on Environmental Quality
cfs	cubic feet per second
COA	Coordinated Operations Agreement
COE	U.S. Army Corps of Engineers
CVGSM	Central Valley Groundwater and Surface Water Model
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVPM	Central Valley Production Model
D_	State Water Resources Control Board Decision
DCC	Delta Cross Channel
Delta Plan	Delta Water Quality Control Plan
Delta	Sacramento - San Joaquin Delta
DFG	California Department of Fish and Game
DO	dissolved oxygen
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utility District
EID	El Dorado Irrigation District
GCID	Glenn-Calusa Irrigation District
M&I	municipal and industrial
mg/l	milligrams per liter
MID	Modesto Irrigation District
MOA	Memorandum of Agreement
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NWR	National Wildlife Refuge
OID	Oakdale Irrigation District
PCWA	Placer County Water Agency
PEIS	Programmatic Environmental Impact Statement
PG&E	Pacific Gas and Electric Company
PROSIM	Project Simulation Model
Reclamation	U.S. Bureau of Reclamation
RM	river mile
RWQCB	Regional Water Quality Control Board
SANJASM	San Joaquin Area Simulation Model
Service	U.S. Fish and Wildlife Service
SEWD	Stockton East Water District
SMUD	Sacramento Municipal Utility District
SSJID	South San Joaquin Irrigation District
SWP	State Water Project
SWRCB	California State Water Resources Control Board

TDS	total dissolved solids
TID	Turlock Irrigation District
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
Western	Western Area Power Administration
WMA	Wildlife Management Area
WMP	Water Management Plan

CHAPTER I

INTRODUCTION

Chapter I

INTRODUCTION

The Draft Programmatic Environmental Impact Statement (PEIS) summarizes the evaluation of the direct and indirect impacts of implementing a wide range of actions identified in the Central Valley Project Improvement Act (CVPIA). Detailed information used in the definition of the affected environment and analysis of the environmental consequences are presented in more detail in the technical appendices of the Draft PEIS.

This technical appendix presents a summary of conditions that would affect surface water supplies and facilities operations, including background information that was used during the PEIS preparation, and the results of the impact analyses for conditions that occurred throughout the study area, shown in Figure I-1.

The surface water analysis was primarily based upon changes in CVP facilities operations, stream flows, water deliveries to CVP contractors, and the management of water acquired from willing sellers for delivery to wildlife refuges and for increased instream flows and Delta outflow.

The information from this technical appendix was used in all issue area analyses included in the Draft PEIS. Changes in river flows , reservoir operations, and water deliveries were used in the fisheries, groundwater, agricultural economics and land use, vegetation and wildlife, power, recreation and recreation economics, water transfer opportunities, municipal water costs, and cultural resources analyses.

The results of the analyses for Alternatives 1, 2, 3, and 4 and Supplemental Analyses 1a and 1d are presented in this technical appendix and summarized in the Draft PEIS. A summary of assumptions related to the surface water supplies and facilities operations analyses for these alternatives and supplemental analyses are presented in Table I-1. A summary of results of the surface water operations analyses of these alternatives and supplemental analyses are presented in Table I-2. The assumptions and results of Supplemental Analyses 1b, 1c, 1e through 1i, 2a through 2d, 3a, and 4a are summarized only in the Draft PEIS.

FIGURE I-1

STUDY AREA

TABLE I-1

SUMMARY OF ASSUMPTIONS FOR SURFACE WATER SUPPLIES AND FACILITIES OPERATIONS

No-Action Alternative	Projected 2020 level water demands based on water rights, CVP contract amounts, historical diversion data, and DWR Bulletin 160-93 projections. Continued CVP operations under CVP-Operations Criteria and Plan, October 1992. Continued operation of CVP and SWP under Bay-Delta Plan Accord, SWRCB D-1422, Winter Run Chinook Salmon and Delta Smelt Biological Opinions as amended in 1995, and Coordinated Operation Agreement. Shasta temperature control device in operation. SWP operations per Monterey Agreement.
1	No-Action Alternative assumptions plus the following: Implementation of 3406(b)(1)(B) and (b)(2) water management including Bay-Delta Plan Accord component and additional operations on Sacramento River, American River, Stanislaus River, and Clear Creek. Water accounting for (b)(2) water use based on changes in deliveries to CVP Water Service Contractors. Firm Level 2 refuge supplies per 1989 Refuge Water Supply Study. Includes a 25 percent shortage in Critical years per the Shasta Index. Increased Trinity River instream fishery flows.
1a	Alternative 1 assumptions plus the following: Implement preliminary (b)(2) water management actions in the Delta in addition to Bay-Delta Plan Accord.
1d	Alternative 1 assumptions plus the following: Delivery of full Level 2 refuge water supplies in all years without shortage.
2	Alternative 1 assumptions plus the following: Implement 3406(b)(3) water acquisition for Level 4 refuge water supplies. Acquire up to 170,000 af/yr from willing sellers on the Stanislaus, Tuolumne, and Merced Rivers for instream and Delta fishery needs.
3	Alternative 1 assumptions plus the following: Implement 3406(b)(3) water acquisition for Level 4 refuge water supplies. Acquire up to 800,000 af/yr from willing sellers on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba Rivers for instream fishery needs. Acquired water may be exported by the projects when it reaches the Delta.
4	Alternative 1 assumptions plus the following: Implement (b)(2) water management actions in the Delta in addition to Bay-Delta Plan Accord. Implement 3406(b)(3) water acquisition for Level 4 refuge water supplies. Acquire up to 800,000 af/yr on Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba Rivers for instream and Delta fishery needs. Acquired water may not be exported by the projects when it reaches the Delta.

TABLE I-2

SUMMARY OF IMPACT ASSESSMENT OF SURFACE WATER SUPPLIES AND FACILITIES OPERATIONS

Affected Factors	No-Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Supplemental Analysis 1a	Supplemental Analysis 1d
Surface Water Deliveries		***Change from No-Action Alternative***				***Change from Alternative 1***	
Average Annual CVP Deliveries 1922 - 1990 (1,000 af/yr)	5,770	-470 (-8%)	-590 (-10%)	-390 (-7%)	-620 (-11%)	-100 (-2%)	-10 (0%)
Average Annual CVP Refuge Deliveries 1922 - 1990 (1,000 af/yr)	260	+230 (+88%)	+370 (+142%)	+370 (+142%)	+370 (+142%)	no change	+10 (2%)
Average Annual SWP Deliveries 1922 - 1990 (1,000 af/yr)	3,330	+100 (+3%)	+80 (+2%)	+270 (+8%)	-20 (-1%)[1]	-30 (-1%)[1]	no change

NOTE:
(1) Intent was to prevent impacts as compared to the No-Action Alternative. Minimal impacts are due to model limitations.

CHAPTER II

AFFECTED ENVIRONMENT

Chapter II

AFFECTED ENVIRONMENT

INTRODUCTION

This chapter provides an overview of historic and recent surface water conditions in Central Valley watersheds, and describes major federal, state, and local water supply projects within the Trinity River Basin and the Central Valley. Major surface water projects in these regions include the Central Valley Project (CVP), other federal water supply and flood control projects, the California State Water Project (SWP), and local surface water supply projects based in the Central Valley. Because the PEIS alternatives would primarily affect the operation of facilities and the delivery of surface water in the Central Valley, this chapter focuses primarily on rivers and water supply facilities in the Central Valley.

The Central Valley of California is a vast, oblong valley that runs down the interior of the state, 400 miles north-to-south and about 50 miles east-to-west. The Central Valley is flanked on the east by the Cascade and Sierra Nevada mountain ranges, and on the west by the Coast Range. Three major drainage areas are present in the Central Valley: the Sacramento River Basin, the San Joaquin River Basin, and the Tulare Lake Basin. The Sacramento River Basin consists of the northern third of the Central Valley and is drained by the Sacramento River, yielding approximately 35 percent of the total outflow of all rivers in the state. Most of the southern two-thirds of the Central Valley, a much drier region, is drained by the San Joaquin River, which flows west, then north, and meets the Sacramento River at the Sacramento-San Joaquin Delta (Delta). The Sacramento and San Joaquin rivers join in the Delta where their combined flows continue west through Susuin and San Francisco bays to the Pacific Ocean. The southernmost portion of the Central Valley, the Tulare Lake Basin, is an inland drainage area that receives flows from four rivers and several smaller streams that drain the western slope of the Sierra Nevada Range, and from several ephemeral streams that drain the eastern slope of the Coast Range. Figure II-1 shows major rivers and streams that drain Central Valley watersheds, and major water supply projects that affect streamflows.

This chapter begins with a historical perspective of water supply development in California, including significant events that affected the development of water resource facilities in the Central Valley. Following are descriptions of surface water conditions and facilities in the major watersheds in the Central Valley drainage areas in the Sacramento River, San Joaquin River, and Tulare Lake basins.

The watershed-based descriptions are followed by a summary of the CVP operational criteria, facilities in the various divisions and units of the CVP, site-specific and division-specific operational criteria, CVP contract types, and the process by which water delivery quantities are determined for each CVP contract type. Site-specific information is not provided

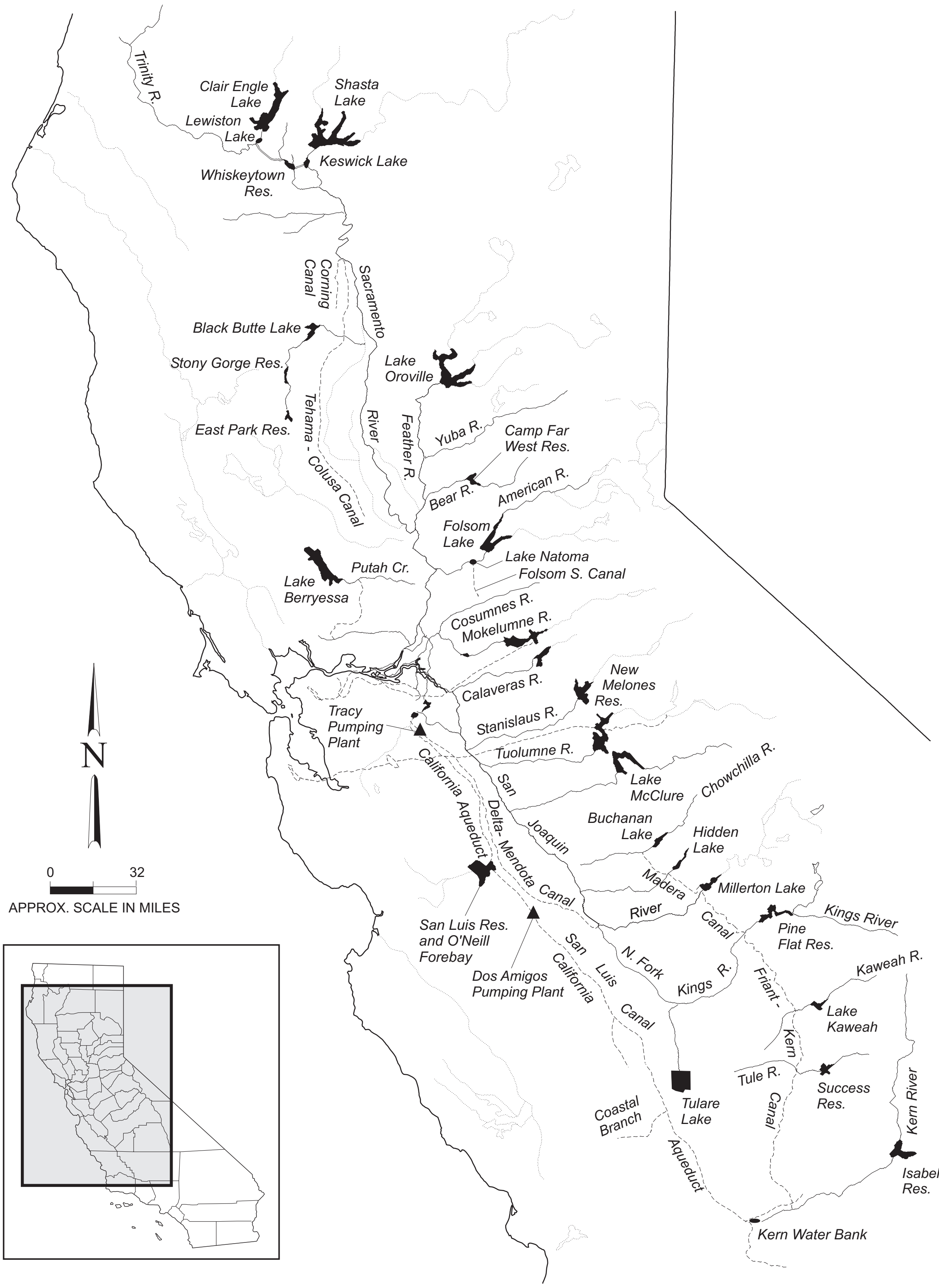


FIGURE II-1

WATER FACILITIES IN THE CENTRAL VALLEY

for all operational facets of individual facilities discussed in this chapter. Rather, information is presented on a division-wide or project-wide level, to illustrate the relationship of operations between facilities. As a result, the level of detail of information varies by facility. The description of the CVP is followed by a brief summary of the SWP facilities, operations, contractors, and decision-making criteria.

The general historical study period reviewed for water supply facilities extends from the inception of water supply development in California, in approximately 1770, to the present. Emphasis is placed on the period from 1940 to 1992 because the CVP, the SWP, and several local water supply projects were developed during this period.

IDENTIFICATION OF STREAMS IN THE STUDY AREA

Historic streamflow data were collected to provide a representation of streamflows in the study area. The level of detail of the PEIS precludes including data for all California streams therefore, only streams that may be affected by CVPIA actions are included. The selection of these streams was accomplished through a screening process, applying one or more of the following criteria:

- The stream includes a CVP facility or is directly affected by CVP operations.
- The stream was identified in the Central Valley Anadromous Fisheries and Riparian Habitat Protection and Restoration Action Plan prepared by the California Department of Fish and Game (DFG) (1993).
- The stream is used to convey CVP water to refuges.
- The stream has important water quality significance that affects CVP operations.

Table II-1 shows the results of the screening process.

DATA SOURCES

In the development of this document, data were collected to summarize historic streamflow conditions, surface water quality, the historical perspective, descriptions of facilities, and operations criteria. These data were obtained from a variety of sources, as described below.

Streamflow data were obtained from U.S. Geological Survey (USGS) published streamflow records. The USGS maintains daily stream flow data collected from more than 250 stream flow gauging stations throughout the Central Valley. The period of record varies from station to station. The selection of stations for use in this document was based upon several screening criteria. First, those gauges that provide a good representation of flow entering the valley floor from the surrounding mountains and gauges that represent flow in reaches of rivers on the valley floor were sought. Where multiple gauges are located on one reach of a river, the gauge located

TABLE II-1
SELECTION OF STREAMS FOR EVALUATION

Geographic Subregion	Stream Name	CVP Facilities or Directly Affected by CVP Operations	Central Valley Anadromous Fisheries	Conveys CVP Water to Refuges	Water Quality Concerns
Sacramento River Region					
	Sacramento River	X	X		
	Cow Creek		X		
	Bear Creek		X		
	Battle Creek		X		
	Paynes Creek		X		
	Antelope Creek		X		
	Mill Creek		X		
	Deer Creek		X		
	Big Chico Creek		X		
	Butte Creek		X		
	Feather River		X		
	Yuba River		X		
	Bear River		X		
	American River	X	X		
	Clear Creek	X	X		
	Cottonwood Creek		X		
	Elder Creek		X		
	Thomes Creek		X		
	Stony Creek (1)	X	X		
	Cache Creek				
	Putah Creek				
	Colusa Basin Drain			X	X
San Joaquin RiverBasin					
	San Joaquin River	X	X		X
	Cosumnes River	X	X		
	Mokelumne River	X	X		
	Calaveras River		X		
	Stanislaus River	X	X		
	Tuolumne River		X		

TABLE II-1. CONTINUED

Geographic Subregion	Stream Name	CVP Facilities or Directly Affected by CVP Operations	Central Valley Anadromous Fisheries	Conveys CVP Water to Refuges	Water Quality Concerns
	Merced River		X		
	Chowchilla River (2)	X			
	Fresno River (2)	X			
	Fresno Slough			X	
	Mud Slough (3)			X	X
	Salt Slough (4)			X	
Sacramento-San Joaquin Delta					
	(no rivers listed)	X	X		
Tulare Lake Region					
	Kings River (5)	X			
	Kaweah River (5)	X			
	Tule River (5)	X			
	Deer Creek (5,6)			X	
	Poso Creek (5,6)			X	
	Kern River (5)	X			

NOTES:
(1) Stony Creek can be used to augment flows in the Tehama- Colusa Canal.
(2) At times used to convey Madera Canal deliveries and/or spills.
(3) At one time used to convey water to the southeast area of the Los Banos Wildlife Management Area (WMA).
(4) Used to convey water to the west side of the San Luis Wildlife Refuge.
(5) At times used to convey Friant-Kern Canal deliveries and/or spills.
(6) Not included in evaluation.

directly below the primary controlling structure was selected. Finally, gauging stations with longer periods of record were preferred, but when this was not possible, multiple gauges close to one another on the same stream were used. The selected USGS stream gauges are referenced on figures showing historic streamflow data in this chapter.

Surface water quality data were obtained from a variety of publications by the California State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCB); the California Department of Water Resources (DWR); the USGS; and studies conducted by federal, state, and local agencies. Surface water quality data were not widely collected prior to the early 1950s. Since that time the USGS has been actively involved in the collection of water quality data for the surface waters of California. In addition, DWR, SWRCB, Reclamation, and various local agencies have conducted water quality monitoring programs. The U.S. Environmental Protection Agency (USEPA) has collected much of this information in a common database referred to as STORET.

The historical perspective on water development in California has been drawn from several works, including Cooper, 1968; Harding, 1960; U.S. Bureau of Reclamation (Reclamation), 1975 and 1981; Water and Power Resource Service, 1981; U.S. Army Corps of Engineers (COE), 1975; and the California Department of Water Resources (DWR), 1974. The first two of these publications provide a general historic overview of water development in California. The roles of Reclamation, the COE, and DWR in the development of water resource facilities are provided in the remaining documents.

Information regarding water supplies and water management facilities in the affected environment was collected from agencies responsible for the construction and operation of these facilities. Data employed in the preparation of this document were obtained in various forms, including published documents, unpublished data from agency files, and direct communication with agency personnel and others familiar with the water supplies and facilities in the Central Valley. Reclamation, the COE, DWR, and the USGS were particularly helpful in providing information presented in this chapter.

Descriptive information of several CVP facilities was drawn from the Water and Power Resources Service (1981). Descriptions of the operational criteria for CVP facilities were initially obtained from the *Long-Term Central Valley Project Operations Criteria and Plan* (Reclamation, 1992), and updated to reflect recent operational criteria. The description of the operational criteria for the SWP was obtained from the Delta Smelt Assessment (1993).

HISTORICAL PERSPECTIVE

Throughout the past 200 years, the development of water supplies for mining, agricultural, and municipal purposes in the Central Valley has been affected by numerous factors, including the influx of people to California during several significant events, periods of severe floods or drought, economic conditions, and legal considerations. A summary of events that have influenced the development and operation of water supply facilities in California during the past two centuries is provided on Table II-2.

TABLE II-2
EVENTS THAT INFLUENCED WATER SUPPLY DEVELOPMENT IN CALIFORNIA

Year	Event
1769	Spanish established permanent settlements in Alta, California.
1769	Spanish feral livestock introduced floral species to California.
1770	Zanja Madre constructed to convey water to the Pueblo de Los Angeles and adjacent irrigated areas.
1770s	First major storage, diversion, and conveyance irrigation project in California. Project was for San Diego Mission and included 12-foot-high dam and 245-foot-wide dam on San Diego River and 6 miles of canals.
1776-1815	Irrigation diversion systems constructed for San Juan Capistrano, San Fernando, San Luis Rey, Pala, and San Bernardino missions.
1805	Drought.
1809-1810	Drought.
1816-1817	Drought.
1820-1821	Drought.
1822	Mexico began land grant program.
1828-1830	Drought.
1830s	Many native plants consumed by feral livestock during droughts.
1830s	Significant decline in beaver.
1840-1841	Drought.
1841	Canal constructed from San Gabriel River to irrigation area near Azusa.
1846	Hudson Bay Company closed French Camp due to lack of beaver and antelopes.
1848	Gold discovered at Coloma.
1848	California annexed to United States.
1849	Gold Rush started.
1849	First major levee constructed in Delta on Grand Island.
1850	California became a state and adopted English Common Law, which included the concept of riparian rights.
1850	Congress adopted Arkansas Swamp Act to sell floodplain land to developers who would construct levees and drainage systems.
1850s	California legislature recognized Los Angeles and San Diego prior water rights on the Los Angeles and San Diego rivers, respectively.
1852	Wheaton Mining Dam constructed at La Grange on the Tuolumne River.
1852	Hydraulic mining started.
1853	Large irrigation facilities constructed to divert Mill Creek water (tributary of Kaweah River).
1854	Large irrigation facilities constructed near Snelling to divert Merced River water to alfalfa fields, orchards, and vineyards.
1857	Irrigation was provided to large areas of orchards and vineyards near Chico.
1859	Stockton constructed artesian wells to serve the city.
1859-1865	Large irrigation facilities constructed to divert Tule River water.
1860	California legislature authorized formation of levees and reclamation districts.
1860s	San Joaquin River flows high enough to allow shipping to Herndon.
1861-1862	Major floods changed many river channel configurations.
1863-1864	Drought.
1864	Feral livestock reduced due to droughts and rodeos.

TABLE II-2. CONTINUED

Year	Event
1867	Kern River: Water diverted through one canal to irrigate 700 acres.
1868	California legislature adopted Green Act that allowed formation of reclamation districts with taxing authority.
1869	Main and Outside canals constructed.
1860s-1870s	Primary crops in San Joaquin were wheat, barley, grass, and livestock (cattle and sheep).
1870	Drought.
1870	Drill rigs and engine-driven pump technology became available.
1870	Railroad constructed to Modesto.
1870	State Fish Commission created to enforce catch restrictions and require fish ladders for all physical obstructions.
1870s	People's, Last Chance, and Lemoore canals constructed to convey water from Kings River.
1870s	Railroad companies opened duck hunting clubs in Delta.
1871	Mendota Dam (Weir) constructed, and navigation impaired east of new dam.
1872	California legislature adopted the Statutes of 1872, which provide for appropriative water rights.
1872	Miller-Lux Canal constructed along west side of San Joaquin Valley to convey water from San Joaquin River.
1872	First salmon hatchery in California operated by U.S. Fish Commission. Hatchery located on the McCloud River in Shasta County.
1872-1873	Major economic depression.
1873	The Federal Alexander Commission completed study of Sacramento and San Joaquin rivers and encouraged development of water plan to transfer water from Sacramento River to San Joaquin River.
1873	Kern River: Water diverted through six canals to irrigate 7,000 acres.
1874	First release of fish from California hatchery (Eastern Brook Trout).
1874	Railroad constructed to Bakersfield.
1874	California legislature adopted the 1874 Act, the first law to address groundwater and conservation.
1874	Federal Law, No Fence Law, required livestock owners to pay for damages of wandering livestock. This law favored farmers over ranchers and reduced feral livestock that ate native vegetation.
1877	Desert Land Act of 1877 allowed Haggin and other landholders to acquire odd-numbered land sections that had been covered under the Railroad Land Grant.
1878	State Engineer, Hall, studied irrigation, drainage, and navigation problems on Sacramento and San Joaquin rivers.
1878	Kern Lake eliminated due to drought and diversions.
1879	Striped bass introduced to Delta.
1880	Kern River: Water diverted to irrigate 40,000 acres.
1880	Farmer's Canal constructed to convey Merced River water.
1880	Kings River: Water diverted to irrigate 85,000 acres.
1880	State Fish Commission became responsible for game as well as fish.
1880	California legislature approved Drainage Act to provide flood control in Central Valley.
1880s	University of California, Berkeley, reported that the Kern River had excessive salts, and that Tulare Lake water quality was extremely poor due to return flows and could not be used for irrigation or potable water supplies.

TABLE II-2. CONTINUED

Year	Event
1880s	Artesian wells constructed throughout San Joaquin Valley (including a 7-foot diameter well, 330-feet-deep, with 800,000 gallons-per-day production capacity).
1880s	Many woodlands disappeared for fences and fuel, including fuel for pumps.
1880s	Large salmon canneries on Sacramento River (2.9 million pounds per year).
1884	Federal injunction banned use of hydraulic mining unless sediment was controlled (Woodruff vs North Bloomfield et al.)
1887	Wright Act adopted that allowed for formation of public irrigation districts.
1890s	Central Irrigation District started construction of large facilities near Glenn-Colusa area.
1890s	Electric and natural gas pumps installed in San Joaquin Valley.
1890s	Extensive hunting of white swans, mink, gray fox, weasel, kit fox, bison, and bighorn antelope caused major reduction of populations. Hunters also reduced populations of bears, rabbits, deer, quails, and pigeons. American Common Egret hunted for feathers. Turkey vultures and California Condor hunted for target practice.
1892	Congress established California Debris Commission to remove mining debris from rivers and navigable waters.
1892	Railroad constructed to Fresno.
1893	Modesto Irrigation District (MID) and Turlock Irrigation District (TID) constructed La Grange Dam on Tuolumne River. TID began diversions in 1900 and MID began diversions in 1903.
1895	Debris dams constructed along Sacramento River tributaries.
1895	(Old) Folsom Dam constructed on the American River.
1897	California Legislature adopted Bridgeford Act to define irrigation districts rights that would increase profitability of districts.
1900s	Demand for wheat declined as England found other sources. Railroads increased demand for rice, orchard and row crops, dairies, and cotton.
1900	Bear River Dam on Mokelumne River completed.
1901	State Fish Commission adopted bag limits for waterfowl (50 birds per day).
1902	Union Dam completed on North Fork Stanislaus River.
1902	Congress adopted Reclamation Act.
1904	Sutter Butte Canal Company started construction of large facilities near Gridley.
1905	Shaver Dam completed on Stevinson Creek
1905	Pacific Gas and Electric Company (PG&E) incorporated.
1906	San Joaquin Valley: 522 artesian wells and 597 electric or gas pumps on wells.
1906	Alpine Dam completed on Silver Creek.
1907	First striped bass hatchery was operated by State Fish Commission on Bouldin Island.
1908	First wells constructed in Kern County to serve citrus orchards.
1910	San Joaquin Valley: 5,000 electric or gas pumps on wells.
1910	The U.S. Reclamation Service completed studies of the Kings, Pit, and San Joaquin rivers, developed the Orland Project, and studied the Iron Mountain Dam.
1910	Utica Dam completed on North Fork Stanislaus River.
1911	Use of airplanes to hunt waterfowl began.
1912	Goodwin Dam completed on Stanislaus River.
1913	MID constructed Dallas-Warner Reservoir on Tuolumne River.
1913	Congress passed Raker Act, which allowed San Francisco to divert water from Tuolumne River. The Act also required San Francisco to protect prior water rights of MID and TID, to provide roads into Yosemite park, and to restrict sales of power produced from project.

TABLE II-2. CONTINUED

Year	Event
1913	Almanor Dam completed on North Fork Feather River.
1913	General angling license required in California for all persons over 18 (cost was $1 per person).
1914	Sacramento River Flood Control Project levees constructed to minimize flooding due to increased elevation of river bed caused by mining debris.
1914	Water Commission Act enacted to establish system to deliver appropriative water rights.
1914-1918	World War I.
1916	Newer Mendota Dam constructed with movable section to allow navigation.
1915	Oakdale Irrigation District (OID) and South San Joaquin Irrigation District (SSJID) began diversions from Stanislaus River.
1915	To protect public health, Sacramento began to chlorinate water supply.
1915	State Water Problems Conference discussed many problems, including riparian rights.
1916	First shad hatchery was operated on Feather River near Yuba City.
1916	Main Strawberry Dam completed on South Fork Stanislaus River.
1919	Merced Irrigation District constructed Exchequer Dam and Power Plant.
1919	USGS developed the Marshall Plan that recommended a series of storage reservoirs on the Sacramento River with large canals along the west and east sides of the Sacramento and San Joaquin valleys, and diversion of the Kern River to Los Angeles.
1920	San Joaquin Valley: 11,000 electric or gas pumps on wells.
1920	Irrigation along Suisun Marsh abandoned due to high salinity caused by drought.
1920-1930	Drains installed in over 5,000 farms in the San Joaquin Valley.
1923	O'Shaugnessy Dam (Hetch Hetchy Reservoir) constructed on Tuolumne River.
1923	MID and TID constructed Don Pedro Reservoir on Tuolumne River.
1924	To protect public health, Sacramento began to filter water supply.
1924	Melones Dam constructed on the Stanislaus River.
1924	Nevada Irrigation District allowed PG&E to build powerplants on existing reservoirs on Yuba and Bear rivers.
1924	(Old) Bullards Bar Dam completed on Yuba River.
1925	Lake Briton Dam completed on Pit River.
1925	Pit River No. 3 Dam completed.
1925	Calaveras Dam completed.
1927	Pit River No. 4 Dam completed.
1927	Herminghaus v. Southern California Edison Company decided that a senior riparian right to flood flows (overflow) was superior to an appropriative ight for a storage project. This case precipitated the constitutional amendment regarding reasonable and beneficial use.
1927	Bucks Dam completed on Bucks Creek.
1927	Balch Diversion Dam completed on North Fork Kings River.
1928	California legislature adopted a constitutional amendment that while preserving riparian rights prohibited waste of water and established the reasonableness doctrine.
1928-1934	Drought.
1929	Lower Bucks Lake Dam completed on Bucks Creek.
1929	Pardee Dam and Mokelumne Aqueduct completed, diversions of Mokelumne River water to East Bay Municipal Utility District EBMUD) began.
1930	Lyons Dam on South Fork Stanislaus River completed.

TABLE II-2. CONTINUED

Year	Event
1930	San Joaquin Valley: 23,500 electric or gas pumps on wells.
1930s	Fertilizers and vector poisons were introduced on farmlands.
1931	The Federal Government and the State Water Resources Commission (Hoover-Young Commission) recommended that the Federal government construct the Central Valley Project and the State operate the facilities. The State Water Resources Commission said that the project would be economical if the interest rate was not more than 3.5 percent
1931	Salt Springs Dam completed on North Fork Mokelumne River.
1933	State of California authorized bonds for $170 million for the CVP Shasta Dam and Power plant, Friant Dam and Power plant, Contra Costa Canal, Madera Canal, Friant Kern Canal, other dams and pumps on the San Joaquin River, transmission lines from Shasta to Antioch, and a pump between the Sacramento and San Joaquin rivers. Due to the economic conditions of the Great Depression, bonds not purchased.
1934	Hetch Hetchy Aqueduct completed; diversion of Tuolumne River water to San Francisco began.
1935	Federal government approved $20 million in Emergency Relief Appropriation Fund and the CVP authorized by the Rivers and Harbors Act.
1937	Congress reauthorized Rivers and Harbors Act including reauthorization of the CVP and stated the purposes of the project.
1939	Construction of Friant Dam on the San Joaquin River began.
1939-1945	World War II.
1940	Congress reauthorized Rivers and Harbors Act including reauthorization of the CVP by restating the purposes of the project and including authorization for construction of local distribution systems as part of CVP construction projects.
1940	Water diversions start at Contra Costa Canal.
1941	U.S. enters World War II.
1943	Pit River Dam No. 5 completed.
1944	Diversions to upper portion of Madera Canal from Friant Dam on the San Joaquin River began
1944	Congress adopted Flood Control Act of 1944 including authorization for Shasta, Folsom, and New Melones dams
1944	Shasta Dam completed on the Sacramento River, initial CVP water contracts signed, and water diversions began.
1945	Madera Canal completed.
1947	Diversions from Friant Dam on the San Joaquin River to the upper portion of the Frian-Kern Canal began.
1948	COE began planning Iron Mountain Dam on Sacramento River and Pine Flat Dam on Kings River.
1948	Contra Costa Canal completed.
1949	Friant Kern Canal completed.
1950	CVP signs water rights contracts with riparian and senior appropriate water rights holders on Sacramento and American rivers.
1950	Keswick Dam completed on the Sacramento River downstream of Shasta Dam.
1951	Delta Cross Channel (DCC), Delta-Mendota Canal, and Tracy Pumping Plant completed, allowing for delivery of Delta water to San Joaquin River Exchange Contractors. Releases from Friant Dam reduced.
1951	Pine Flat Dam completed on Kings River.
1954	Isabella Dam completed on Kern River.

TABLE II-2. CONTINUED

Year	Event
1954	Congress adopted Grassland Development Act to add fish and wildlife purposes as authorized purposes for CVP and to authorization for cooperation with the state to supply water to Grasslands for waterfowl cooperation.
1955	Nimbus Dam and Powerplant on the American River completed.
1955	Sly Park Dam and Sly Park-Camino Conduit completed on Sly Park Creek.
1955	Congress adopted Trinity River Act to authorize Trinity River Division to allow for preservation and propagation of fish and wildlife.
1956	Congress reauthorized Reclamation Project Act including provision for right of renewal for long-term CVP agricultural user contracts for terms not to exceed 40 years.
1956	Folsom Dam completed on the American River.
1956	Cherry Valley Dam completed on Cherry Creek.
1957	State Water Plan completed.
1957	Beardsley Dam on Middle Fork Stanislaus River.
1957	Donnel Dam on Middle Fork Stanislaus River.
1957	Wishon Dam completed on North Fork Kings River.
1958	Tulloch Dam on Stanislaus River.
1958	Courtright Dam completed on Helms Creek.
1958	Congress adopted Fish and Wildlife Coordination Act to integrate Fish and Wildlife Conservation programs with federal water resources facilities, to authorize facilities to mitigate CVP-induced damages to fish and wildlife resources, and to require consultation for CVP facilities with Fish and Wildlife Service (Service).
1959	State legislature adopted State Water Plan.
1959	Putah South Canal diversions began.
1959	Mammoth Pool Dam completed on San Joaquin River.
1959	COE adopted flood control regulations for Folsom operations.
1960	Congress adopted San Luis Authorization Act to authorize the San Luis Unit and provide for Reclamation participation in recreation facilities.
1960	Sacramento Ship Channel under construction (Authorized in 1946).
1960	Burns-Porter Act approved to finance SWP.
1961	DWR establishes Interagency Delta Committee to evaluate solutions to Delta problems.
1961	Little Grass Valley Dam completed on South Fork Feather River.
1961	Success Dam completed on Tule River.
1962	Terminus Dam completed on Kaweah River.
1962	South Bay Aqueduct completed.
1962	Union Valley Dam completed on Silver Creek.
1963	Congress reauthorized the Reclamation Project Act including provisions for right of renewal for long-term municipal and industrial (M&I) contracts.
1963	Black Butte Dam completed on Stony Creek.
1963	Whiskeytown Dam completed on Clear Creek.
1963	Camp Far West Dam completed on Bear River.
1963	Loon Lake Dam completed on Gerle Creek.
1963	New Hogan Dam completed on Calaveras River.
1963	Camanche Dam completed on Mokelumne River.
1963	Lewiston Dam, Carr PowerPlant, and Clear Creek Tunnel completed.

TABLE II-2. CONTINUED

Year	Event
1964	Trinity Dam completed on the Trinity River.
1964	Corning Canal and Pumping Plant completed.
1964	Red Bluff Diversion Dam completed on the Sacramento River.
1965	Congress adopted Auburn-Folsom South Unit Authorization Act to authorize the Auburn-Folsom South Unit including participation in development of recreation facilities.
1965	Anderson Dam completed on Middle Fork American River.
1965	Los Banos Dam completed on Los Banos Creek.
1966	Grizzley Valley Dam completed on Big Grizzley Creek.
1966	Little Panoche Detention Dam completed on Little Panoche Creek.
1966	O'Neill Dam completed.
1967	San Luis Canal and Dam completed.
1967	New Exchequer Dam completed on Merced River.
1967	Whiskeytown Conduit completed.
1967	SWRCB adopted Water Quality Control Plan for Sacramento-San Joaquin Delta pursuant to Federal Water Pollution Control Act of 1965.
1967	SWP Delta Pumps and California Aqueduct completed.
1967	Bella Vista Conduit and Pumping Plant completed on Sacramento River.
1967	Oroville Dam completed on the Feather River.
1967	Pit River Dams 6 and 7 completed.
1967	Reclamation and PG&E signed agreements to allow excess CVP power and capacity to be sold to PG&E, and for PG&E to deliver power to CVP customers.
1969	Congress adopted the National Environmental Policy Act (NEPA).
1969	New Bullards Bar Dam completed on the Yuba River.
1970	New Don Pedro Dam completed on the Tuolumne River.
1970	Council on Environmental Quality published CEQ regulations for compliance with NEPA.
1971	SWRCB adopted Water Rights Decision (D-)1379 establishing Delta water quality standards.
1971	Tehama Colusa Canal and Pumping Plant completed.
1973	Congress adopted Endangered Species Act.
1973	First phase of Folsom South Canal completed.
1974	Congress adopted Clean Water Act.
1975	Cross Valley Canal completed.
1975	Buchanan Dam completed on Chowchilla River.
1976	Funks Dam completed on Funks Creek.
1976-1977	Drought.
1977	COE adopted flood control regulations and flood control diagram to describe flood potential and ratings for Shasta Dam operations.
1978	SWRCB adopted D-1485 to guarantee water quality protections for agricultural, municipal M&I, and fish and wildlife uses.
1978	New Melones Dam completed on the Stanislaus River.
1979	Hidden Dam completed on Fresno River.
1980	COE adopted flood control regulations for New Melones Dam operations.
1981	Sugar Pine Conduit and Dam completed on Shirttail Canyon.

TABLE II-2. CONTINUED

Year	Event
1981	Secretary of the Interior allocated CVP yield for minimum Trinity River flows of 340,000 acre-feet per year in normal water years, 220,000 acre-feet per year in dry years, and 140,000 acre-feet per year in critically dry years.
1982	COE adopted flood control diagrams with flood potential and ratings for New Melones Dam operations.
1982	Congress adopted Reclamation Reform Act.
1986	COE adopted flood control diagrams with flood potential and ratings for Folsom Dam operations.
1986	Congress adopted Public Law 99-546 to ensure repayment of plant-in-service costs of the CVP by 2030, and to include total costs of water supply, distribution, and service costs in the capital and operation costs in the CVP contracts.
1986	Coordinated Operations Agreement (COA) adopted by Congress and the California legislature to identify the water supplies of the CVP and SWP, allow for a negotiated sharing of Delta excess outflows, meet in-basin obligations between the CVP and SWP.
1986	Extreme rainfall.
1987	San Felipe Unit facilities completed.
1987	North Bay Aqueduct completed.
1987-1992	Drought.
1989	Sacramento River winter-run chinook salmon listed as endangered species by the State of California and as threatened by the federal government.
1990	SWRCB adopted Water Rights Order 90-05 to modify CVP water rights by incorporating temperature control objectives in upper Sacramento River.
1991	SWRCB adopted Water Rights Order 91-01 to modify Water Rights Order 90-05 to incorporate updated data and schedules.
1991	Secretary of the Interior amended previous decision to increase Trinity River minimum flows to 340,000 acre-feet per year for all years except critically dry, and for 340,000 acre-feet per year for critically dry years if at all possible.
1992	National Marine Fisheries Service (NMSF) issued interim Biological Opinion to protect winter-run chinook salmon.
1992	SWRCB issued draft Decision 1630 with updated Bay-Delta water quality standards.
1992	CVPIA enacted.
1993	NMFS issued final Biological Opinion to protect winter-run chinook salmon.
1993	Service issued interim Biological Opinion to protect Delta smelt.
1993	SWRCB withdrew draft Decision 1630 to concentrate on long-term solution for the Bay-Delta water quality problems.
1993	Service issued updated draft interim Biological Opinion to protect Delta smelt with provisions for Sacramento splittail.
1993	U.S. Environmental Protection Agency (USEPA) issued draft Bay-Delta water quality standards in response to court orders following withdrawal of Decision 1630 by the SWRCB.
1994	The Bay-Delta Plan Accord established a set of water quality goals for the Delta and tributary watersheds, including an interim agreement that provided for the CVP and SWP to meet the water quality goals until a final solution was developed that could involve participation by other upstream water users.
1995	The CALFED program was established to develop a solution provided for under the Bay-Delta Plan Accord. SWRCB D-95-06 included provisions to meet the requirements of the biological opinions for winter-run chinook salmon and delta smelt. Based upon these requirements, the Service and NMFS found that the operations under D-95-06 would not cause additional jeopardy to the winter-run chinook salmon and delta smelt.

1700s TO 1850

Water supply development, which has had a profound effect on the history of California, began well before the state was admitted into the Union. In 1772, construction of the first water storage and diversion project was begun, consisting of a dam on the San Diego River and 6 miles of canals to provide irrigation water to fields surrounding the San Diego Mission. As other missions were established, similar water supply and irrigation projects were also developed. By 1815, irrigation diversion systems had also been constructed for San Juan Capistrano, San Fernando, San Luis Rey, Pala, and San Bernardino missions. These projects were relatively small by today's standards, but firmly established the practices of diversion, storage, and conveyance of water for irrigation purposes.

The discovery of gold at Sutter's Mill on the American River at Coloma in 1848 prompted an influx of settlers to the Central Valley. This event, as well as several subsequent developments, began a trend of westward expansion that continued and grew through several decades.

By the signing of the Treaty of Guadalupe Hidalgo in 1848, what is now California was ceded from Mexico to the United States. All property rights under Mexican law, including private riparian water rights and public water rights attached to the pueblos, were preserved with the cession. As a result, the cities of Los Angeles and San Diego possess pueblo rights.

1850 TO 1920

After California was granted statehood in 1850, the first state legislature adopted the common law of England which, much like the Spanish/Mexican system, included the doctrine of riparian rights. At the same time, the miners had developed a system of "posting notice" at their points of diversion to substantiate their rights to take and transport water. This custom marked the birth of right by priority of appropriation, often referred to as "first in time, first in right," from which grew California's system of appropriative water rights. Appropriative water rights were given statutory recognition in 1872, 22 years after California was granted statehood. Also in the 1850s, the first legislature recognized the importance of water in the state's development and established the Office of Surveyor General to study the problems of navigation, drainage, and irrigation. As more settlers moved to California during ensuing years, the number of farms and extent of irrigated lands in the Central Valley continued to increase, as many of the miners abandoned their diggings and began irrigation farming to provide food for the increasing population.

The early irrigators were mostly individuals who relied on small water supply facilities that provided little long-term storage or flood control, and as a result crops were often ruined by devastating droughts and floods. In the San Joaquin Valley during the period from 1850 to 1870, water was diverted and conveyed through crude ditches for the irrigation of pasture lands and to provide feed in the dry summer and fall periods. During this period, demands for agricultural irrigation increased as the mining boom provided a nearby market for agricultural products. This demand was further stimulated by completion of the transcontinental railroad, which enabled exports of fruits and vegetables from California to markets elsewhere in the nation. By the 1870s, construction of larger irrigation works was well under way in the San Joaquin and Sacramento valleys, particularly in the vicinity of the Kings River. Substantial wooden and stone diversions were built in the rivers, and miles of canals were scraped out by farmers. Flows in most of the San Joaquin Valley rivers dwindled rapidly after June or July, however, often leaving crops with insufficient moisture to mature.

In the Delta, irrigation supplies for reclaimed lands were obtained through diversions from adjoining channels. In dry years, summer inflows to the Delta from the Sacramento and San Joaquin rivers were not sufficient to supply the large quantities of water consumed through irrigation, evaporation, and the growth of riparian vegetation and still maintain a positive outflow through the Delta. As a result, ocean water often encroached into the Delta, forcing irrigation to cease because of crop damage.

As early as the last quarter of the 19th century, the need for coordinated water development began to emerge as a critical element to sustain existing and growing water demands in the Central Valley. Following a severe drought of 1870, Congress in 1873 authorized the Alexander Commission to study the water supply of the Sacramento and San Joaquin rivers, and to develop solutions for water management. In his report, Alexander outlined a system of large-scale irrigation-water supply works, and suggested that federal assistance would be required to accomplish these recommendations.

The development of the gasoline engine in the 1890s, and the availability of electricity by the early 1900s, permitted economical pumping of groundwater from considerable depths. This capability was exploited extensively in the eastern San Joaquin Valley to provide either primary or supplemental water supplies for irrigated lands. The use of groundwater for domestic, municipal and agricultural uses resulted in the depletion of groundwater reserves in excess of annual recharge from streams and precipitation, and marked the beginning of groundwater overdraft conditions in the Central Valley. By the early part of the 20th century, after a series of very dry years, the groundwater in the San Joaquin Valley had become seriously depleted and many farmers and ranchers had left the land. It had become apparent that individual and local planning efforts would no longer be sufficient to resolve the water supply and management problems that affected local areas, the Central Valley, and California as a whole.

Federal assistance to western irrigation planning was authorized by Congress with the adoption of the Reclamation Act of 1902, creating the Reclamation Service, which later became the U.S. Bureau of Reclamation. Federal involvement in the development of California water facilities focused on two fundamental goals: water conservation and flood control. Reclamation was assigned responsibility for the development of water supply projects that would include mechanisms for repayment in accordance with reclamation law. The responsibility for navigation and flood control along major rivers in the Central Valley was assigned to the COE. In recognition of the protective nature of flood control and navigation, these types of projects did not include repayment provisions. Because of the opportunity to accomplish water supply, flood control, and navigation benefits with individual projects, the federal government coordinated the development of flood control and reclamation projects to the greatest extent possible, and federal reservoirs were designed to serve multiple purposes. During the next 30 years, the federal government (Reclamation and COE) and the State of California cooperated in surveys of the Central Valley to coordinate water supply planning activities.

1920 TO 1940

In 1920, Col. Robert Marshall, chief geographer for the USGS, proposed a major water storage and conveyance plan to transfer water from northern California to meet urban and agricultural needs of central and southern California. Under the Marshall Plan, a dam would be constructed on the San Joaquin River near Friant and water would be diverted to areas north and south in the eastern portion of the San Joaquin Valley. The diverted water would provide a supplemental supply to relieve some of the dependency on groundwater that had led to overdraft conditions in areas of the eastern San Joaquin Valley. In addition, surplus water in the Sacramento Valley would be collected, stored, and transferred to the San Joaquin Valley by a series of reservoirs, pumps, and canals. The main storage facility would be Shasta Dam, on the Sacramento River at its confluence with the McCloud and Pit rivers. Hydroelectric power generated at Shasta Dam would provide the power to lift project water from the Delta to irrigated lands in the San Joaquin Valley. A portion of this water would be delivered to San Joaquin River water rights holders, in exchange for water diverted at Friant Dam.

Initial Authorization of the Central Valley Project

During the 1920s, the California state legislature commissioned a series of investigations to further evaluate the Marshall Plan, and in 1933, approved the Central Valley Project Act. This Act authorizated for the construction of initial features of the CVP, including Shasta Dam and powerplants on the Sacramento River; Friant Dam on the San Joaquin River; power transmission facilities from the Shasta dam site to Tracy; and the Contra Costa, Madera, and Friant-Kern canals. The Act authorized the sale of revenue bonds to construct the project, but during the Great Depression the bonds could not be sold. The state therefore appealed to the federal government for assistance in the construction of the CVP. With the passage of the Rivers and Harbors Act of 1935, Congress appropriated funds and authorized construction of the CVP by the COE. When the act was reauthorized in 1937, the construction and operation of the CVP was assigned to Reclamation, and the CVP became subject to reclamation law. Construction of the CVP began on October 19, 1937, with the Contra Costa Canal. Construction of Shasta Dam was begun in 1938.

Other Water Supply Projects

Also during the 1920s, several large reservoirs were constructed in Northern California, mainly for municipal water supplies or the generation of hydroelectric power. The most significant of these projects include water supply projects for the City of San Francisco and the East Bay Municipal Utility District (EBMUD). The City of San Francisco’s Hetch Hetchy Project, completed in 1923, brought water from the Tuolumne River to residents of San Francisco and San Mateo counties. Pardee Reservoir on the Mokelumne River and the Mokelumne Aqueduct began serving water to East Bay communities in 1929. In addition to these municipal water supply developments, other local water supply and hydroelectric generation projects were constructed on rivers tributary to the Sacramento and San Joaquin rivers. Neither the development nor the operation of these projects, however, had been coordinated on the basis of integrated water resource management for the basin.

1940 TO 1970

The period between 1940 and 1970 witnessed the most extensive development of water projects in California. This period of rapid expansion of water supply and flood control projects coincided with explosive growth in population and development of infrastruture in the years following World War II. During this period, most of the current features of the CVP and SWP were constructed, several other federal dams and reservoirs were constructed, and several locally owned and operated dams and reservoirs were constructed or expanded.

Expansion of the Central Valley Project

In the early 1940s, during World War II, construction of the initial features of the CVP continued, with the completion of Shasta Dam in 1944, followed by the completion of Friant Dam, and the Madera, Friant-Kern and Contra Costa canals between 1945 and 1949. Completion of the Delta Cross Channel, Tracy Pumping Plant, and Delta-Mendota Canal in 1951 enabled initial operation of Delta export facilities and delivery of water to the San Joaquin River Exchange Contractors.

By the late 1940s, it had become apparent that California's rapid urban, agricultural, and industrial growth would quickly increase demands for water and power to levels that exceeded the initial CVP system capacity. In response to this increase in projected demand, the COE and Reclamation evaluated an enlargement of Folsom Dam and Reservoir (originally authorized for construction by the COE as a flood control facility in 1944) to also provide water supply and hydroelectric power and be integrated into the CVP. In 1949, Congress passed the American River Act, which authorized the American River Division of the CVP and provided for the construction of Folsom and Nimbus dams, lakes, and powerplants. This action converted the single-purpose authorization of a flood control reservoir into a substantially enlarged multiple-purpose project integrated into the CVP. The act authorized the financial integration of the American River Division into the CVP, enabling coordination of water releases between Shasta and Folsom for flood protection and water supply, and the optimization of power accomplishments.

Through the 1950s and 1960s, the CVP service area and water storage capability continued to expand with the authorization and construction of additional divisions and units. In 1950, legislation was enacted to reauthorize the entire CVP to include the Sacramento River Division, which includes facilities to divert and deliver water from the Sacramento River to lands in the western Sacramento Valley. In 1955, the Trinity River Division was authorized for construction and integration to the CVP. Facilities were authorized to collect and store water in the Trinity River Basin, to transfer stored water to the Sacramento River Basin to increase supply available for irrigation in the Central Valley, and to generate hydroelectric energy.

The Flood Control Act of December 22, 1944, provided the original authorization for construction of New Melones Dam and Reservoir on the Stanislaus River by the COE to help alleviate serious flooding problems along the Stanislaus and lower San Joaquin rivers. In 1962, Congress expanded and reauthorized the project (PL 87-874) for operation by the Secretary of the Interior as an integral part of the CVP. Construction of New Melones was completed in

1979, and the facility was turned over to Reclamation in 1980 for operation as part of the Eastside Division of the CVP.

The San Luis Unit, in the western San Joaquin Valley, was authorized by Congress in 1960 as either a separate federal project or a joint federal-state undertaking. Following additional study, a contract between the federal government and the State of California was executed in 1961 for the joint construction and use of certain San Luis Unit features, including facilities for off-stream storage and conveyance. In 1965, the Auburn-Folsom South Unit was authorized to increase the water supply available for irrigation and other beneficial uses in the Central Valley.

In 1967, the San Felipe Division was authorized as an integral part of the CVP to provide water supplies to portions of the Santa Clara and Pajaro valleys. These valleys lie outside and west of the Central Valley Basin, and are served by a pipeline from San Luis Reservoir. The San Felipe Division is the only part of the CVP that provides service to areas outside the Central Valley Basin.

California State Water Project

In addition to the expansion of the CVP, planning for the multipurpose SWP began shortly after World War II. In 1947, the state began an investigation of its water resources and needs and prepared The California Water Plan, which outlined preliminary plans to meet the state’s anticipated water needs through development of the SWP. In 1960, California voters authorized construction of the SWP by ratifying the Burns-Porter Act. At that time, the plans recognized that there would be a gradual increase in water demand and that construction of some facilities would be deferred until a later time. Initial projects included Oroville Dam and Lake Oroville on the Feather River, San Luis Dam and Reservoir, which were constructed and are jointly operated with Reclamation, the North and South Bay aqueducts, and the California Aqueduct. Deliveries from the SWP began in 1962, just two years after the start of construction.

Other Water Supply Projects

Since 1940, several major water supply projects have been constructed on Central Valley rivers. On rivers tributary to the Delta, dams and reservoirs were constructed by the COE local agencies on the Merced, Tuolumne, Calaveras, American, and Yuba rivers that affected flow conditions in these rivers, and modified inflow to the Delta. In addition, major dams and reservoirs were constructed in the Tulare Basin along the Kings, Kaweah, Tule, and Kern rivers. These facilities have reduced the incidence of flooding in the Tulare Lake Basin and have provided a more reliable local water supply to an area of extensive agricultural production.

1970 TO PRESENT

After 1970, the rate of water supply development in the Central Valley declined significantly. Most construction during this period was related to the completion of previously authorized projects. The only CVP facility constructed during this period was New Melones Dam and Reservoir on the Stanislaus River.

During the 1970s, the COE developed Hidden and Buchanan dams on the Fresno and Chowchilla rivers, respectively, to provide flood protection to downstream areas. These projects have been integrated into the CVP, and provide a portion of the water supply to CVP contractors along the Madera Canal on the east side of the San Joaquin Valley.

Currently, a total of 181 federal reservoirs in California provide a combined storage capacity of nearly 22 million acre-feet. In addition, more than 1,200 non-federal dams are under supervision by the State of California. This generally includes dams 25 feet or higher, or those that create a reservoir larger than 50,000 acre-feet. The reservoirs formed by these dams provide a cumulative storage capacity of approximately 20 million acre-feet The total combined capacity of federal and non-federal reservoirs, approximately 42 million acre-feet, represents over half of the estimated 71 million acre-feet of annual runoff throughout the state (Reclamation, 1975). A summary of major reservoirs discussed in this document, including storage capacity, watershed, owner, and year completed, is provided in Table II-3.

SURFACE WATER IN THE SACRAMENTO RIVER BASIN

The Sacramento River Basin, shown in Figure II-2, encompasses an area over 24,000 square miles in the northern portion of the Central Valley. It includes the McCloud River, Pit River, and Goose Lake basins to the north, extends from the foothills of the Coast Ranges and Klamath Mountains on the west, to the foothills of the Sierra Nevada and Cascade Range on the east. To the south, the basin is bordered by the Delta. Drainage is provided by the Sacramento River, which flows generally north to south from its source near Mount Shasta to the Delta, and receives contributing flows from numerous major and minor streams and rivers that drain the east and west sides of the basin.

Ground surface elevations in the northern portion of the Sacramento River Basin range from about 6,500 feet in the headwaters of the Sacramento River to approximately 1,065 feet at Shasta Lake. In this area, total annual precipitation averages between 60 and 70 inches, and is as high as 95 inches in the Sierra Nevada and Cascade mountains. The floor of the Sacramento Valley is relatively flat, with elevations ranging from about 60 to 300 feet above sea level. This area is characterized by hot dry summers and mild winters. Precipitation is relatively light, ranging from 15 to 20 inches per year as far north as Red Bluff, falling mostly as rain. The mountainous areas bordering the valley reach elevations of over 5,000 feet and receive much more precipitation, with snow prevalent at higher elevations. Areas at elevations above 5,000 feet receive an average of 42 inches of precipitation per year, and as much as 90 inches falls at Lassen Peak.

The upper portion of the Sacramento River is fed by tributary flows from numerous small creeks, primarily those draining the western slopes of the Cascade and Sierra Nevada mountains. The volume of flow increases as the river progresses southward, and is increased considerably by the contribution of flows from the Feather River and the American River watersheds. Accordingly, the Sacramento River is characterized in two sections: the upper section from its source to just above its confluence with the Feather River, and the lower section from the confluence with the Feather River to the Delta.

TABLE II-3
MAJOR SURFACE WATER RESERVOIRS

Reservoir (Dam)	River or Watershed	CVP Division (if applicable)	Capacity (1,000 acre-feet)	Year Complete	Owner
Trinity River Basin					
Clair Engle	Trinity	Trinity River	2,448	1962	Relamation
Sacramento River Basin					
Whiskeytown	Clear Creek	Trinity River	241	1963	Relamation
Shasta	Sacramento	Shasta	4,552	1945	Relamation
Black Butte	Stony Creek		144	1963	COE
Almanor	Feather		1,143	1927	PG&E
Bucks	Feather		106	1928	PG&E
Oroville	Feather		3,538	1968	DWR
New Bullards Bar	Yuba		966	1970	YCWA
Camp Far West	Bear		104	1963	SSWD
French Meadows (L.L. Anderson)	American		136	1965	PCWA
Hell Hole	American		208	1966	PCWA
Union Valley	American		277	1963	SMUD
Folsom Lake	American	American River	977	1956	Relamation
San Joaquin River Basin					
Edison	San Joaquin		125	1954	SCE
Mammoth Pool	San Joaquin		123	1960	SCE
Shaver	San Joaquin		135	1927	SCE
Millerton (Friant)	San Joaquin	Friant	520	1947	Relamation
Hensley (Hidden)	Fresno	East Side	90	1978	COE
Eastman (Buchanan)	Chowchilla	East Side	150	1975	COE
McClure (New Echequer)	Merced		1,024	1967	MID
Lloyd Lake (Cherry Valley)	Tuolumne		269	1956	CCSF
Hetch Hetchy (O'Shaughnessy)	Tuolumne		360	1923	CCSF
New Don Pedro	Tuolumne		2,030	1971	TID-MID
New Melones	Stanislaus	East Side	2,420	1979	Relamation
New Hogan	Calaveras		317	1963	COE
Salt Springs	Mokelumne		142	1931	PG&E
Pardee	Mokelumne		210	1929	EBMUD
Camanche	Mokelumne		417	1963	EBMUD
San Luis	N/A	West San Joaquin	2,039	1967	Relamation/ DWR
Tulare Lake Basin					
Wishon	Kings		128	1958	PG&E
Courtright	Kings		123	1958	PG&E
Pine Flat	Kings		1,000	1954	COE
Kaweah (Terminus)	Kaweah		143	1962	COE
Success	Tule		82	1961	COE
Isabella	Kern		568	1953	COE

TABLE II-3. CONTINUED

Reservoir (Dam)	River or Watershed	CVP Division (if applicable)	Capacity (1,000 acre-feet)	Year Complete	Owner

Reservoir Owners

CCSF:	City and County of San Francisco
COE:	U.S. Army Corps of Engineers
DWR:	California Department of Water Resources
EBMUD:	East Bay Municipal Utility District
MID:	Modesto Irrigation District
SCE:	Southern California Edison Company
PCWA:	Placer County Water Agency
PG&E:	Pacific Gas and Electric Company
SMUD:	Sacramento Municipal Utility District
SSWD:	South Sutter Water District
TID-MID:	Turlock Irrigation District and Modesto Irrigation District
Relamation	U.S. Bureau of Reclamation
YCWA:	Yuba County Water Agency

NOTE:
Reservoirs with capacities exceeding 100,000 acre-feet, except Hensley and Success lakes.
SOURCE:
DWR, 1995.

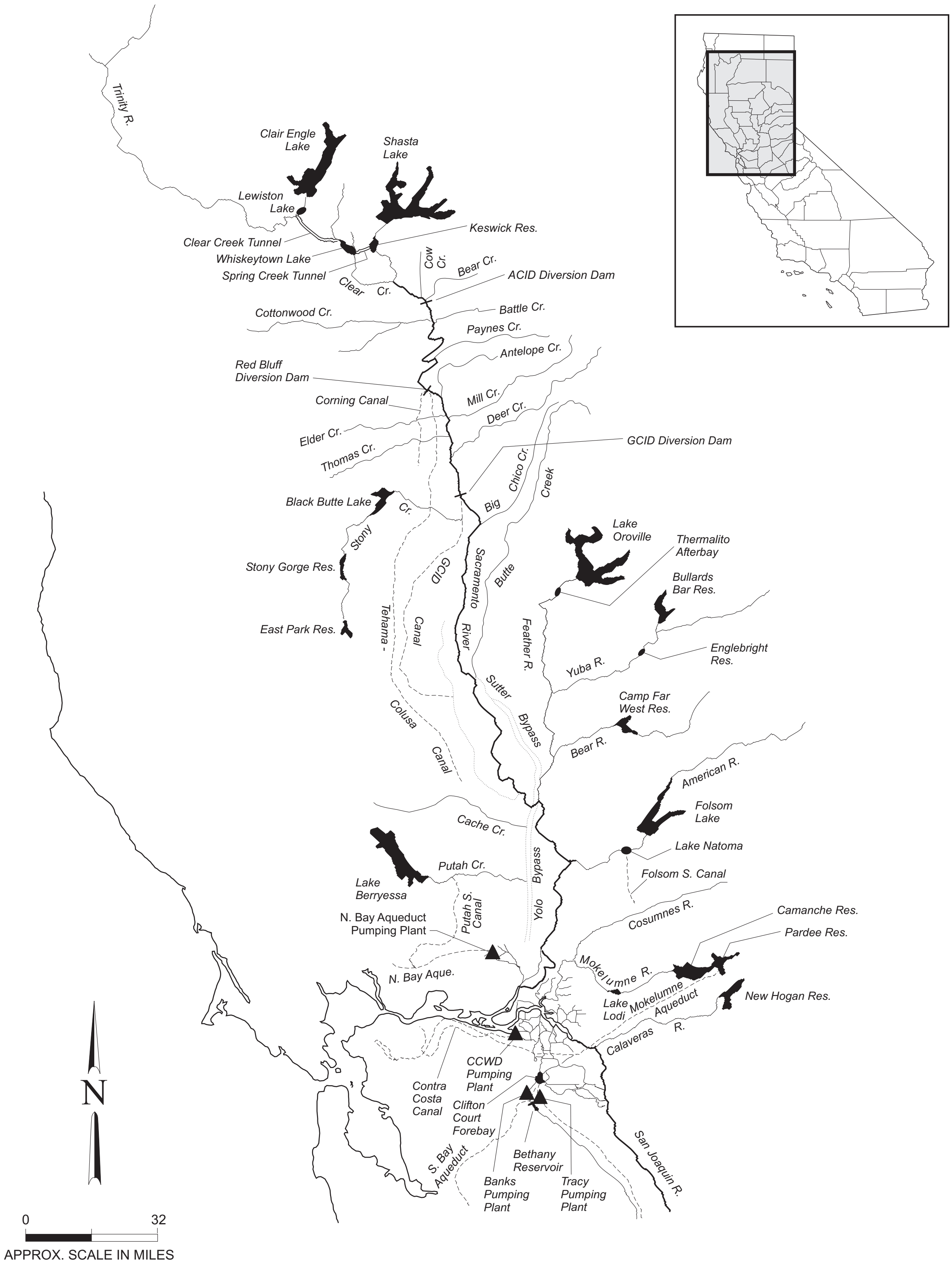


FIGURE II-2

SACRAMENTO RIVER BASIN

UPPER SACRAMENTO RIVER

Flows in the upper Sacramento River are regulated by the CVP Shasta Dam (completed in 1945) and re-regulated approximately 15 miles downstream at Keswick Dam (completed in 1950). The portion of the river above Shasta Dam drains approximately 6,649 square miles and produces average annual runoff of approximately 5.7 million acre-feet. As the Sacramento River nears Red Bluff, flows become more influenced by the inflow from major tributary streams, including Clear, Cow, Bear, Cottonwood, Battle and Paynes creeks.

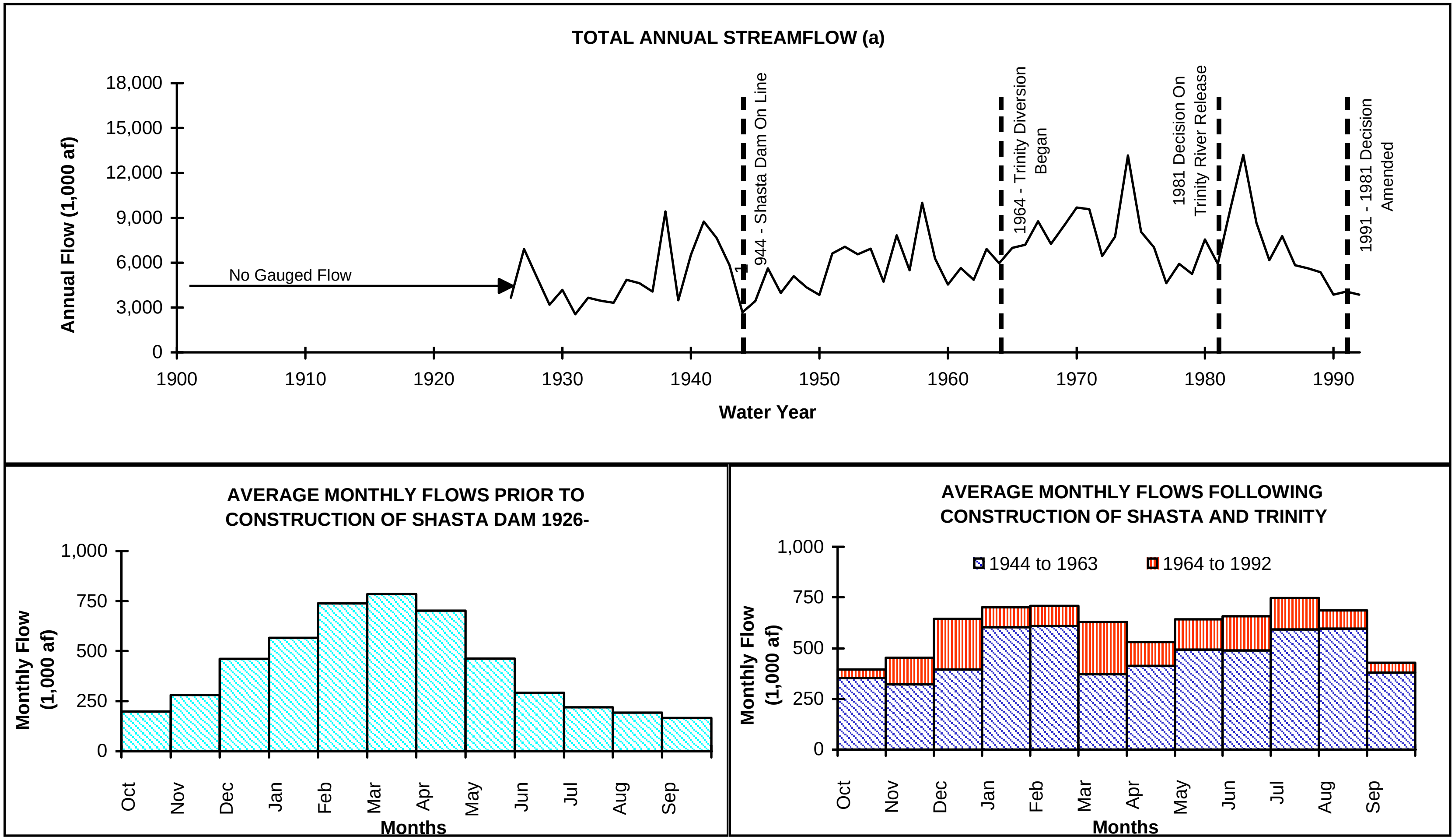
Keswick to Red Bluff

Flows in the section of the Sacramento River between Keswick Dam and the City of Red Bluff are highly regulated by the CVP Shasta Dam, and re-regulated approximately 15 miles downstream at Keswick Dam. As the river nears Red Bluff, however, flows become more influenced by tributary inflow. Major tributaries to the Sacramento River above Red Bluff include Clear, Cow, Bear, Cottonwood, Battle and Paynes creeks.

Water supply facilities that affect flow conditions on the upper Sacramento River above Red Bluff include CVP and local irrigation district facilities. The most significant feature is Shasta Lake, the largest reservoir in the CVP with a storage capacity of 4,552,000 acre-feet. Keswick Dam, completed in 1950 as part of the CVP, has a storage capacity of 23,800 acre-feet and serves as an afterbay for the Shasta and Spring Creek powerplants.

Since 1964, a portion of the flow from the Trinity River Basin has been exported to the Sacramento River Basin through CVP facilities. Water is diverted from the Trinity River at Lewiston Dam via the Clear Creek Tunnel, and passes through the Judge Francis Carr Powerhouse as it is discharged into Whiskeytown Lake on Clear Creek. From Whiskeytown Lake, water is released through the Spring Creek Power Conduit to the Spring Creek Powerplant, and into Keswick Reservoir. All of the water diverted from the Trinity River, plus a portion of Clear Creek flows, are diverted through the Spring Creek Power Conduit into Keswick Reservoir. Spring Creek also flows into the Sacramento River and enters at Keswick Reservoir. Flows on Spring Creek are partially regulated by the Spring Creek Debris Dam. Historically, an average annual quantity of 1,269,000 acre-feet of water has been diverted from Whiskeytown Lake to Keswick Reservoir (1964-1992). This annual quantity is approximately 17 percent of the flows measured in the Sacramento River at Keswick.

Figure II-3 shows the annual flows in the Sacramento River at Keswick from 1926 to 1992. Prior to the construction of Shasta Dam, monthly flows reflected the runoff patterns associated with winter precipitation and spring snow melt. Peak flows generally occurred during the months of February, March, and April. Following the construction of Shasta Dam, average monthly flows during March and April were reduced, and average monthly flows during the summer irrigation months were increased. Following the construction of the Trinity River Division of the CVP in 1964, exported water from the Trinity River Basin to the Sacramento River Basin increased average releases from Keswick Dam on an annual basis.



NOTE: (a) First full year of stream flow data for station 11370500 was 1939. Data for 1926-1963 are from Station 1136950 (Sacramento River at Kennet); data for 1964-1992 from USGS Station11370500 (National Stream Quality Network Station).

(b) Upper portion of bar represents incremental increase in average monthly flows since 1964 water year, when releases through Spring Creek Powerplant began.

FIGURE II-3

HISTORICAL STREAMFLOW IN THE SACRAMENTO RIVER BELOW KESWICK DAM

Water is diverted for agricultural and M&I uses at several locations on the Sacramento River below Keswick. The Wintu Pumping Plant downstream of Keswick began operation in 1966 as part of the CVP. This plant lifts water from the Sacramento River into the Bella Vista Conduit, which carries it to users in the area east of Redding for agricultural and M&I purposes. The Anderson-Cottonwood Irrigation District (ACID) maintains a flashboard and buttress diversion dam across the Sacramento River near Redding. Since 1916, water has been diverted into the ACID canal for irrigation along the west sides of the Sacramento River between Redding and Cottonwood. Typically, flashboards are installed during April and remain in place through October. The Red Bluff Diversion Dam, completed in 1964 as part of the CVP, is located approximately 2 miles south of the City of Red Bluff. The dam diverts water from the Sacramento River into the Tehama-Colusa and Corning canals, which deliver water to 200,000 acres in Tehama, Glen, Colusa, and Yolo counties. The Glenn-Colusa Irrigation District (GCID) supplies water from the Sacramento River near Hamilton City to about 175,000 acres. The GCID canal has been in service since the early 1900s; the existing pumping plant began operation in 1984.

The Sacramento River enters the Sacramento Valley about 5 miles north of Red Bluff. Over the 98 miles between Red Bluff and Colusa, the river is a meandering stream, migrating through alluvial deposits between widely spaced levees. Major streams entering the Sacramento Rivers in this reach include Antelope, Elder, Mill, Thomes, Deer, Stony, Big Chico, Butte creeks, and the Colusa Basin Drain.

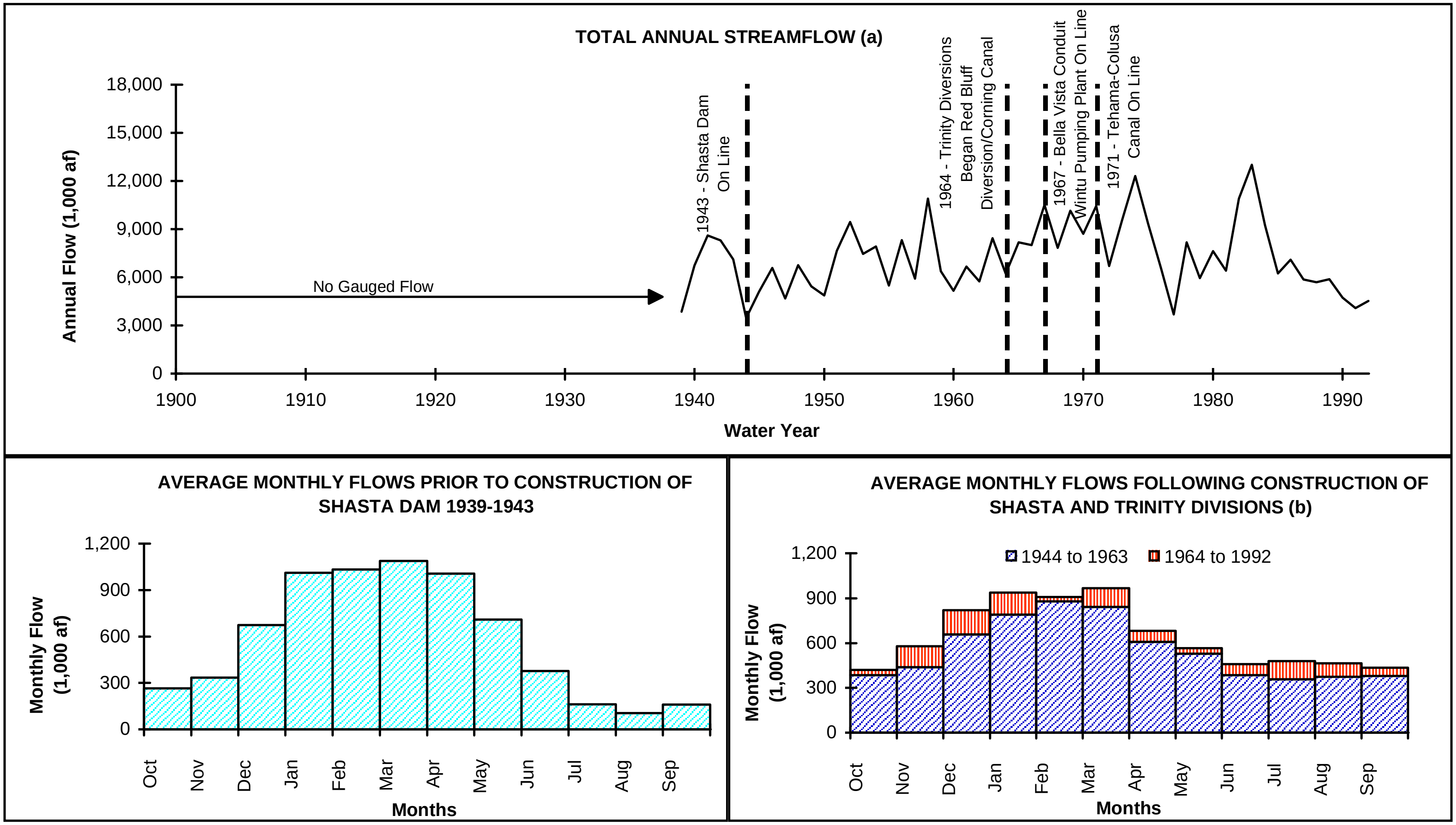
At Wilkins Slough, located above the confluence with the Feather River, the Sacramento River drains a total area of approximately 12,926 square miles. As shown in Figure II-4, a greater proportion of the annual flow at this location occurs during the months of December and January, as compared to flows below Keswick Dam (Figure II-3), because of rainfall runoff from more than 31 tributaries that enter the Sacramento River. Most of the streams tributary to the Sacramento River above the confluence with the Feather River are uncontrolled, other than by hydroelectric facilities.

Flood control along the upper Sacramento River is provided through an extensive series of levees, overflow weirs, pumping plants, and bypass channels. During periods of high flow, overflows from the Sacramento and Feather rivers are conveyed in the Sutter and Yolo bypasses.

Over 50 surface water diversions have been identified along the reach of the Sacramento River between Keswick Dam and Wilkins Slough. Riparian water use between Keswick and Red Bluff averaged 154,900 acre-feet annually between 1922 and 1980 (Reclamation et al., 1990). From Red Bluff to Knights Landing (approximately 18 miles downstream of Wilkins Slough), estimated riparian water use averaged 1,244,400 acre-feet per year.

Upper Sacramento River Tributaries

The portion of the upper Sacramento River between Keswick Dam and Knights Landing (upstream of the confluence with the Feather River) is fed by several tributaries that drain the west slope of the Sierra Nevada Mountains and the east slope of the Coast Range. Many of these



NOTE: (a) First full year of stream flow data available in 1939.

(b) Upper portion of bar represents incremental increase in average monthly flow since 1964, when diversions from Trinity River began.

FIGURE II-4

HISTORICAL STREAMFLOW IN THE SACRAMENTO RIVER BELOW WILKINS SLOUGH

streams contribute significantly to the flow in the Sacramento River. The following descriptions of tributaries follow the order in which they enter the Sacramento River from north to south.

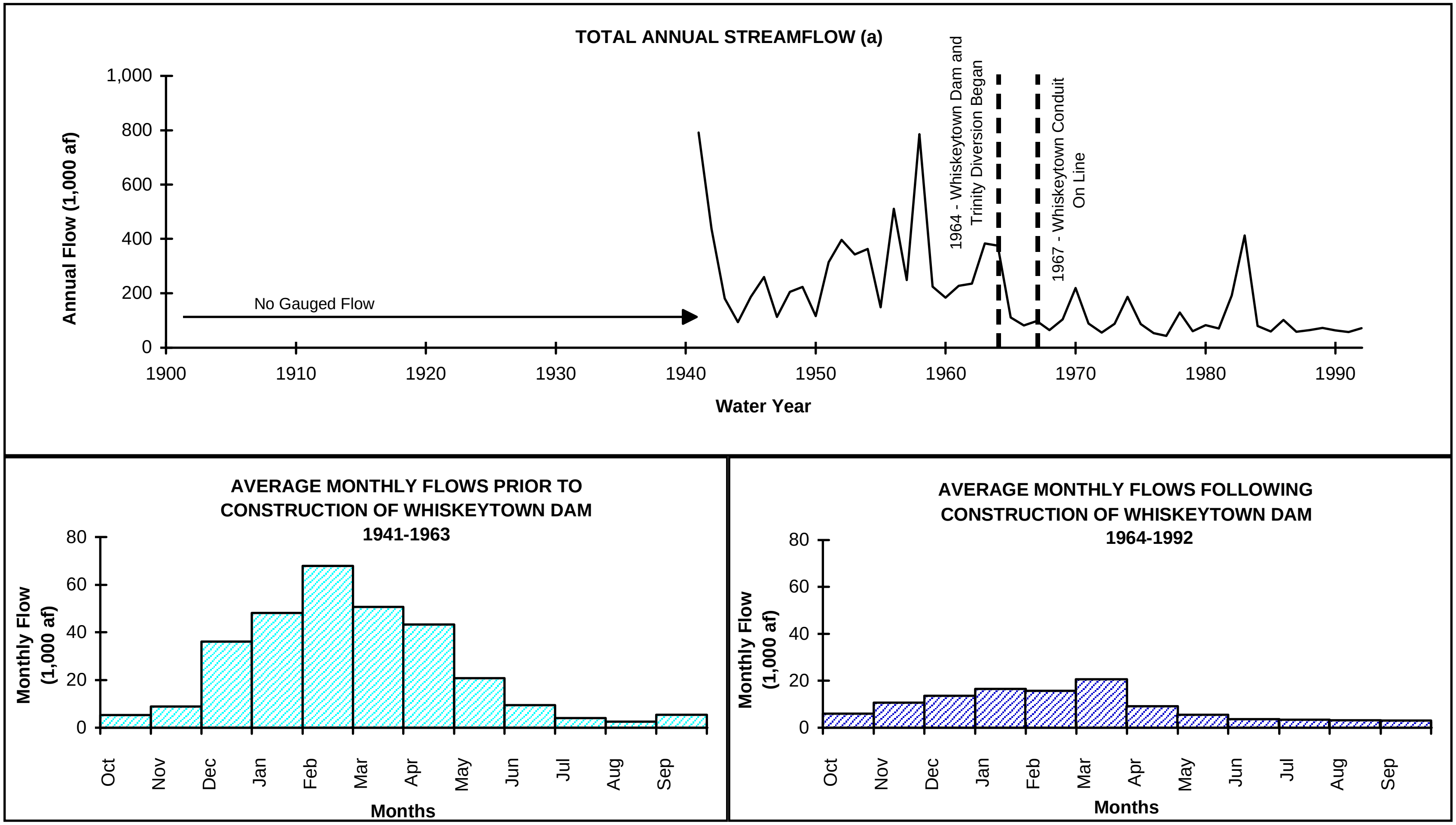
Clear Creek. Clear Creek, the northernmost major tributary to the Sacramento River below Keswick Dam, originates in the mountains between the Sacramento River and Trinity River basins and drains approximately 228 square miles. It flows southwesterly approximately 35 miles to its confluence with the Sacramento River just south of the City of Redding. The median historical unimpaired runoff is approximately 69 thousand acre-feet, with a range of 0 to 491 thousand acre-feet.

Since 1963, flow in Clear Creek has been regulated by the operation of Whiskeytown Dam, which is located approximately at river mile (RM) 16.5. This dam was constructed and is operated by Reclamation as part of the CVP. Whiskeytown Lake, which is formed by the dam, has a storage capacity of 241,000 acre-feet and regulates runoff from Clear Creek and diversions from the Trinity River Basin via the Clear Creek Tunnel. As the exported water from the Trinity River basin enters Whiskeytown Lake, it passes through the Judge Francis Carr Powerhouse. The average annual discharge into Whiskeytown Lake from the powerhouse from 1963 to 1992 was 1,025,000 acre-feet. Releases from Whiskeytown Lake are made primarily to the Spring Creek Tunnel, which conveys water through the Spring Creek Power plant and into Keswick Reservoir on the Sacramento River. Between 1964 and 1992, the average annual generation releases from the Spring Creek Powerplant were 1,269,000 acre-feet. Releases are also made from Whiskeytown Lake to Clear Creek to satisfy instream flow and downstream diversion requirements, and during flood control operations. The effect of Whiskeytown Dam operations on flows in Clear Creek is shown on Figure II-5. This figure illustrates that flows in Clear Creek have been reduced since construction of the dam, as a portion of the runoff in the watershed has been diverted to the Sacramento River along with water exported from Trinity River Basin.

In addition to releases to the Spring Creek Tunnel, water is also diverted from Whiskeytown Lake via the Whiskeytown Conduit to the Clear Creek South Unit of the CVP. This water is used for irrigation in Shasta County, and M&I purposes in the Clear Creek Community Services District of Anderson. The McCormick Saeltzer Dam, constructed in 1903 and located approximately 10 miles downstream from Whiskeytown Dam, diverts water into the Townsend Flat water ditch for irrigation uses.

Cow Creek. Cow Creek originates in the foothills of the Cascade Range, flows southwest, and enters the Sacramento River at RM 280, approximately 4 miles east of the City of Anderson. Cow Creek comprises five tributaries, and drains an area of approximately 425 square miles. Cow Creek contributes approximately 6 to 7 percent of the annual flow to the Sacramento River as measured at Bend Bridge, in response to rain events during the winter. No major storage or diversion structures have been constructed in the Cow Creek watershed, although several small diversions for irrigation, domestic use, and hydroelectric power generation are present.

Bear Creek. Bear Creek originates south of Latour Butte in Shasta County and drains a watershed of approximately 76 square miles. It enters the Sacramento River as a small tributary below the City of Anderson, approximately 4 miles north of the confluence of Battle Creek. The stream has low streamflow in spring through fall of most years, and no flow during periods of



NOTE: (a) First full year of stream flow data available in 1941.
Transbasin diversion from Trinity River into Whiskeytown Lake and diversion to Spring Creek Powerplant began in water year 1964.

FIGURE II-5

HISTORICAL STREAMFLOW IN CLEAR CREEK

below-normal rainfall. No major storage or diversion structures have been constructed in the Bear Creek watershed. During spring and summer, the limited natural streamflow is reduced by unscreened irrigation diversions in the lower reaches where the stream enters the valley floor.

Cottonwood Creek. Cottonwood Creek originates on the eastern slopes of a rugged section of the Coast Ranges in the Yolla-Bolly-Middle Eel Wilderness in Tehama County, at an elevation of approximately 4,000 feet. Cottonwood Creek comprises three tributaries, drains an area of approximately 927 square miles on west side of the Sacramento Valley, and enters the Sacramento river a short distance downstream of the Redding-Anderson area. The creek responds quickly to rainfall, and is prone to flash flooding. Typically, Cottonwood Creek contributes approximately 7 to 8 percent of the flows in the Sacramento River as measured at Bend Bridge, with measurable flows in all months, including during dry years. The ACID canal crosses Cottonwood Creek near the confluence of the North Fork and mainstem, and typically contributes flow to the creek during the irrigation season. No major storage or diversion structures have been constructed along Cottonwood Creek, however, small irrigation diversions are present.

Battle Creek. Battle Creek drains the western flank of Mount Lassen and enters the Sacramento River from the east approximately 5 miles southeast of the town of Cottonwood. It includes two main branches, the North Fork and the South Fork, that drain a water shed of approximately 360 square miles. The two forks join approximately 17 miles above the confluence with the Sacramento River. Battle Creek is the largest spring-fed tributary to the Sacramento River between the Keswick Dam and the Feather River, with a mean September flow of 275 cubic feet per second (cfs). Flows typically remain high throughout the winter and spring and decrease to about half in the summer and fall months. Battle Creek contributes 4 to 5 percent of the annual flow to the Sacramento River, as measured at Bend Bridge.

Flow in Battle Creek is affected by the operation of several facilities, including several power-generation facilities, agricultural diversions, and the Coleman National Fish Hatchery. The power generation projects include several canals that convey water between forks of the river and by-pass portions of Battle Creek. Limited storage capacity for hydropower generation has been developed, and consumptive water uses are low. Consequently, flows at the mouth of Battle Creek as it discharges into the Sacramento River are similar to unimpaired flow conditions, with minor changes resulting from limited upstream storage releases and agricultural diversions.

Paynes Creek. Paynes Creek originates in a series of small lava springs about 6 miles west of the town of Mineral in Tehama County and runs eastward until it flows into the Sacramento River at RM 253, approximately 5 miles north of the City of Red Bluff. It flows into the Sacramento River from the east, draining an area of approximately 93 square miles. Paynes Creek is the southernmost tributary to enter the Sacramento River above the Red Bluff Diversion Dam.

There are no major water storage facilities on Paynes Creek, but as many as 16 small seasonal diversions for irrigation, stock watering and fish culture are present. The largest of these diversions, located approximately 2 miles from the creek's confluence with the Sacramento River, has the capacity to divert approximately 8 cfs of water to irrigate the Bend District.

Antelope Creek. Antelope Creek originates in the Lassen National Forest in Tehama County, flows southwest, and enters the Sacramento River at RM 235, approximately 9 miles south of the City of Red Bluff. The stream flows into the Sacramento River from the east, draining an area of approximately 123 square miles. Two water diversions, located on the valley floor portion of the stream, are operated primarily during the irrigation season. The water rights for these diversions total 120 cfs, exceeding the historical average flow of 92 cfs between April and October. As a result, the lower reach of the stream is usually dry when both diversions are operating.

Elder Creek. Elder Creek begins in the foothills of the Coastal Range, runs eastward into the Central Valley, and ultimately flows into the Sacramento River at RM 230, approximately 12 miles south of the City of Red Bluff. The stream flows into the Sacramento Valley from the west, draining a watershed of approximately 142 square miles. There are no significant dams on Elder Creek, but several small water diversions are present. The stream is generally intermittent with a highly fluctuating flow regime. Flow records indicate peak flows in excess of 11,000 cfs, but the stream is normally dry from July to November.

Mill Creek. Mill Creek is a major tributary to the Sacramento River, flowing from the southern slopes of Mount Lassen and entering the Sacramento River from the east at RM 230, approximately 1 mile north of Tehama. The stream originates at an elevation of approximately 8,000 feet and descends to an elevation of approximately 200 feet near its confluence with the Sacramento River. Mill Creek runs approximately 60 miles in length and drains a watershed of approximately 134 square miles. During the irrigation season, three dams on the lower 8 miles of the stream divert most of the natural flow, particularly during dry years. Mill Creek contributes approximately 2 to 3 percent of the average total annual flow in the Sacramento River, as measured at Bend Bridge.

Thomes Creek. Thomes Creek originates in the foothills of the Coastal Range, travels eastward into the valley, and flows into the Sacramento River at RM 224 approximately 4 miles north of the city of Corning. It drains a watershed of approximately 203 square miles, and contributes 2 to 3 percent of the flows in the Sacramento River as measured at Bend Bridge, based on historical records. No significant dams are located on Thomes Creek, other than two seasonal diversion dams, one near Paskenta and one near Henleyville. In addition, several small pump diversions are operated seasonally in the stream. Below the USGS stream gauge near Paskenta, the stream is generally dry or flows intermittently from mid-summer until the first heavy fall rains.

Deer Creek. Deer Creek is a major tributary to the Sacramento River that originates from several small springs near Childs Meadows to the north and from the southern slopes of Butt Mountain to the south. It enters the Sacramento River from the east at RM 220, approximately 1.5 miles north of the Woodson Bridge State Park. The stream is approximately 60 miles in length, draining a watershed of about 210 square miles. Along the lower 10 miles of the stream, which flows through the Sacramento Valley, three diversion dams and four diversion ditches divert all of the natural flow from mid-spring to fall in some years. Deer Creek flows typically contribute approximately 2 to 3 percent of the average total flow in the Sacramento River flows as measured at Bend Bridge.

Stony Creek. Stony Creek is a westside stream that originates on the eastern slope of the Coastal Range and runs northeasterly until it joins the Sacramento River south of Hamilton City in Glenn County. The creek drains a watershed area of approximately 738 square miles.

Flows in Stony Creek are controlled by East Park Dam and Reservoir and Stony Gorge Dam, which are part of the Orland Project, and farther downstream by the Black Butte Dam. East Park and Stony Gorge reservoirs store surplus water for irrigation deliveries and are operated by Reclamation independently of the CVP. Black Butte Dam and Reservoir were constructed by, and are maintained and operated by the COE; they provide flood control and irrigation supply. Black Butte is financially integrated and operationally coordinated with the CVP.

The GCID canal, which crosses Stony Creek downstream of Black Butte Dam, includes a seasonal gravel dam constructed across the creek on the downstream side of the canal. This crossing allows the canal to convey water south of Stony Creek during the irrigation season, and captures up to the entire flow of Stony Creek during the irrigation season.

Big Chico Creek. Big Chico Creek originates on Colby Mountain in the northern Sierra Nevada at an elevation of approximately 6,000 feet. The creek flows southwest for approximately 45 miles, drains a watershed area of 72 square miles, and enters the Sacramento River from the east at RM 193, about 5 miles west of the City of Chico. Two water diversion dams are located on Big Chico Creek; Five-Mile Diversion, located upstream of the City of Chico, and One-Mile Diversion, located downstream of the City of Chico. During the summer months (June - October), the base flow in Big Chico Creek above Five-Mile Diversion is typically 20 to 25 cfs. Most of this flow is lost to infiltration in the region of the creek's outwash fan, located approximately in the City of Chico. As a result, in most years, late summer surface flow does not extend downstream of Rose Avenue.

The M&T pumping station, located near the confluence with the Sacramento River, is the main diversion on Big Chico Creek. These pumps have the capacity to divert 135 cfs from the creek for use at the M&T Ranch and on lands managed by DFG, the Service, and The Nature Conservancy.

Butte Creek. Butte Creek originates in the Jonesville Basin, Lassen National Forest, on the west slope of the Sierra Nevada at an elevation of approximately 6,500 feet. The stream drains a watershed of approximately 150 square miles, and enters the Sacramento River from the east at Butte Slough (RM 139) between Colusa Weir and Tisdale Bypass. Water in Butte Creek also enters the Sacramento River through the Sutter Bypass and Sacramento Slough at RM 80.

During flood events, peak flood flows on the Sacramento River are diverted into Butte Creek at various locations between the mouth of Big Chico Creek and the reclamation district pumps near Princeton. Two such inflow points are the Moulton Weir Bypass and the Colusa Weir Bypass.

Several small tributaries, such as Middle Butte Creek and Little Butte Creek, flow into Butte Creek in the upper watershed area. Water is imported from the Feather River Basin for hydropower generation at DeSabla Forebay on Middle Butte Creek, which receives water from the West Branch of the North Fork Feather River via the Toadtown Canal. The Feather River flows diverted into Butte Creek through Toadtown Canal averaged 42,470 acre-feet annually between 1987 and 1992. Agricultural diversions also convey water from the Feather River, Big Chico Creek, and Little Chico Creek into Little Butte Creek.

Numerous storage and diversion facilities have been constructed along Butte Creek. The major flow regulating facilities include Paradise Dam and Magalia Dams on Little Butte Creek, and the Centerville Diversion Dam on Butte Creek, which diverts a large portion of the flow to the Centerville Powerplant.

Colusa Basin Drain. The Colusa Basin Drain provides drainage for a large portion of the irrigated lands on the western side of the Sacramento Valley and supplies irrigation water to lands in this area. The drain is bounded on the west by the Coastal Range, on the east by the Sacramento River, and by Stony and Cache creeks on the north and south. The drainage area encompasses approximately 1,500 square miles in Glenn, Colusa, and Yolo counties. Of this area, approximately 570 square miles are within the watersheds of various westside tributaries, and the remainder are located in the relatively flat valley bottom. The watershed contains 67 individual streams, including forks and branches; approximately 11 of these currently flow directly into the Colusa Basin Drain.

Historically, the area within the basin was subject to periodic flooding from the Sacramento River. Flows in the basin generally discharged to the river in a southeasterly direction through a series of sloughs. Reclamation efforts begun during the 1850's eventually drained much of the wetland area and provided agricultural lands. Levees along the west bank of the Sacramento River block the natural drainage of the westside tributaries, and route these flows though the Colusa Basin Drain to the Sacramento River via outfall gates at Knights Landing. At times when Sacramento River levels are higher than those in the drain, gravity diversion of river flows into the drain is possible, supplementing irrigation supplies. The Knights Landing Ridge Cut, the lower 7 miles of the drain, provides an outlet for flood flows to the Yolo Bypass.

During the spring, summer, and fall, flows in the drain consist of natural runoff and return flows from surrounding irrigated lands. Diversions along the drain primarily supply water to agricultural lands in the area as well as to the Sacramento, Delevan, and Colusa National Wildlife Refuges (NWRs).

LOWER SACRAMENTO RIVER AND TRIBUTARIES

The lower Sacramento River is identified as the reach that extends from Knights Landing, just above the confluence with the Feather River, to Freeport, just below the point where the Sacramento River enters the legal Delta boundary. The drainage area of the Sacramento River upstream of Freeport encompasses more than 24,000 square miles. The historical average annual flow on the Sacramento River at Freeport is approximately 16.7 million acre-feet per year, more than twice the average annual flow measured below Wilkins Slough over the same time period.

The flows in this portion of the Sacramento River are increased primarily by the addition of the Feather and American river flows. The combined flows of the Feather River and Sutter Bypass enter the Sacramento River near Verona. During high flows, Sacramento River water is diverted into the Yolo Bypass via Fremont Weir near Knights Landing and the Sacramento Weir near West Sacramento. The Yolo Bypass is a low-lying area of about 40,000 acres west of the Sacramento River that conveys flood flows from the Sacramento River and local runoff from Cache and Putah creeks to the Sacramento River about 10 miles above Collinsville. Smaller contributions to this section of the Sacramento River are made by the Cross Canal, draining the area from the Feather River east to Auburn and Roseville, and the Colusa Basin Drain, which drains the west side of the Sacramento Valley from about Willows south to Knights Landing.

Feather River and Tributaries

The Feather River, with a drainage area of 3,607 square miles on the east side of the Sacramento Valley, is the largest tributary to the Sacramento River below Shasta Dam. The Feather River enters the Sacramento River from the east at Verona. The median historical unimpaired runoff of the Feather River watershed is 3.8 million acre-feet per year, with a range of 1.0 to 9.4 million acre-feet per year. This total flow is provided by the Feather River and tributaries, which include the Yuba and Bear rivers.

Flows on the Feather River are regulated by Oroville Dam, the lowermost reservoir on the river, which began operation in 1967 as part of the SWP. Oroville Reservoir, which is created by Oroville Dam at the confluence of the West Branch and the North, Middle, and South forks, has a storage capacity of approximately 3.5 million acre-feet per year. Water released from Oroville Dam is diverted approximately 5 miles downstream at the Thermalito Diversion into the Thermalito Power Canal, thence to the Thermalito Forebay, and finally into the Thermolito Afterbay. Some of the units in the Thermalito and Hyatt powerhouses are reversible, enabling pumping from the afterbay back into Lake Oroville.

Approximately 40 diversions have been identified along the Feather River. Four of the major diversions take water at the Thermalito Afterbay: Western Canal, Richvale Canal, the Pacific Gas and Electric Lateral, and the Sutter-Butte Canal. Some of the water diverted into these canals is exported to the Butte Creek watershed. These canals diverted an average of approximately 770,000 acre-feet per year for the period between water year 1968 and 1992. Riparian water use along the Feather River increased from approximately 454,000 acre-feet per year in the 1920s to an average of 890,000 acre-feet per year in the 1970s (Reclamation et al., 1990). This is a nearly twofold increase in riparian water use, or an increase from 11 percent to over 26 percent of the historical average annual flow in the river as measured at Oroville.

Between the Thermolito Diversion Dam and the Thermalito Afterbay, flows in the Feather River are maintained at a constant 600 cfs. This 8-mile section of the river is often referred to as the “low flow” section. The Thermolito Afterbay serves the dual purposes of an afterbay to re-regulate releases to the Feather River from the hydroelectric plants and a warming basin for irrigation water that will be diverted to rice fields. Consequently, the water temperatures in the approximately 14-mile section of the Feather River below Thermalito Afterbay, commonly referred to as the “high flow” section, are higher than water temperatures in the “low flow” section.

Figure II-6 shows the distribution of annual flows in the Feather River downstream from Oroville Dam for the period between 1902 and 1992. Prior to the construction of Oroville Dam, flows in the Feather River reflected natural runoff conditions, with peak flows in the months of March, April, and May. Following the construction of Oroville Dam, the average monthly flow pattern was modified to provide reduced flows during the spring months and increased flows during summer months.

The operation of several reservoirs affects the flow on the portion of the Feather River upstream of Oroville Reservoir. The largest of these is Lake Almanor on the North Fork Feather River, with a storage capacity of 1.3 million acre-feet per year. Other impoundments in the Feather River drainage area above Oroville Reservoir, including Mountain Meadows Reservoir, Bucks Lake, Little Grass Valley Reservoir, Lake Davis, Frenchman Lake, Butt Valley Reservoir, Sly Creek Reservoir, Philbrook Reservoir, and Antelope Lake, provide additional storage capacity of approximately 450,000 acre-feet per year.

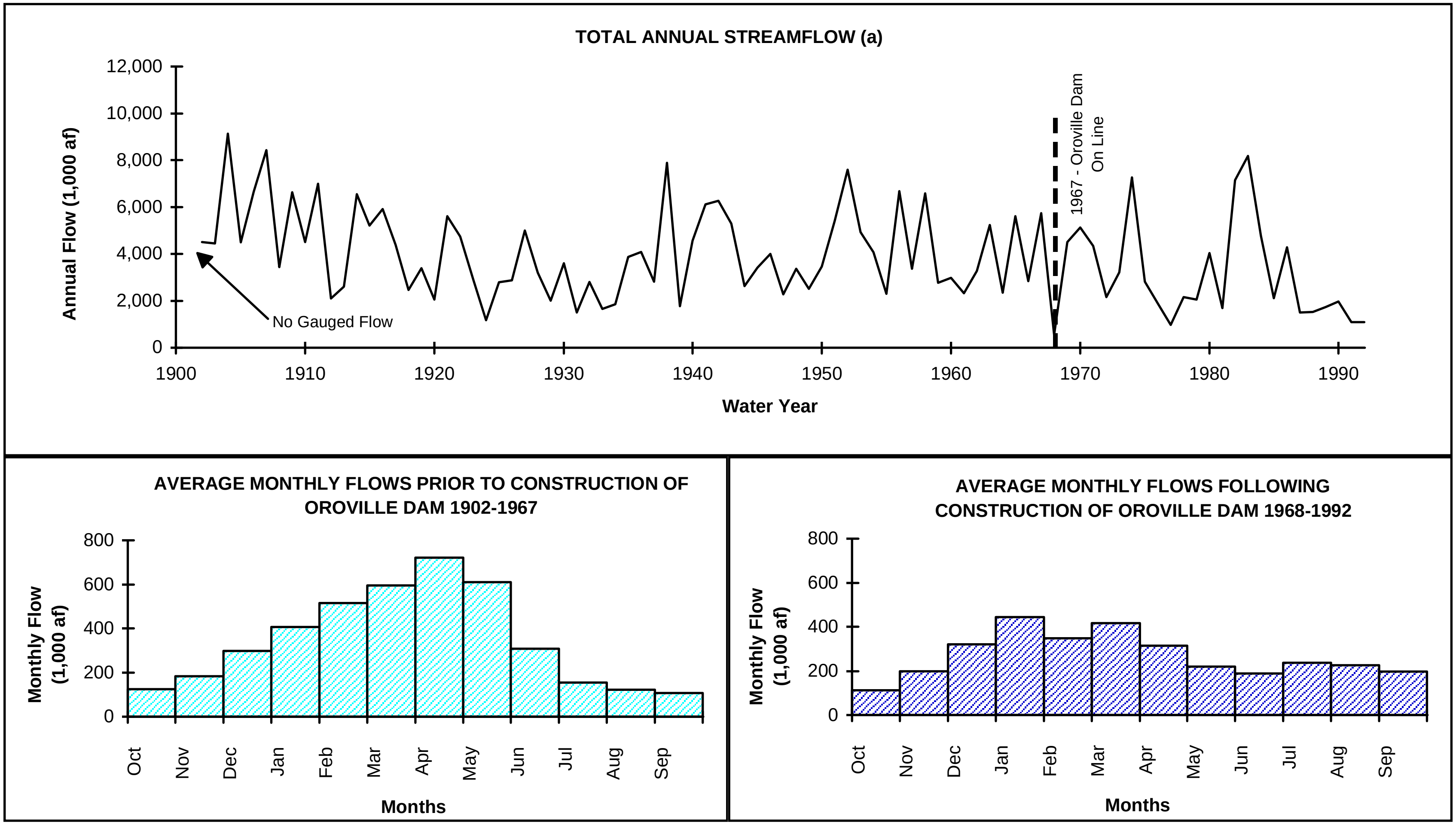
Yuba River. The Yuba River is a major tributary to the Feather River, historically contributing over 40 percent of the flow, on a total annual basis, as measured at Oroville. The Yuba River originates in the Sierra Nevada, drains approximately 1,339 square miles of the eastern Sacramento Valley, and flows into the Feather River near the town of Marysville. The North, Middle, and South forks make up its upper watershed.

The median historical unimpaired runoff in the Yuba River watershed is 2.1 million acre-feet per year, with a range from 0.4 to 4.9 million acre-feet per year. The major reservoir in the watershed, New Bullards Bar Reservoir, is operated by the Yuba County Water Agency, and has a storage capacity of just under 1 million acre-feet per year. This reservoir was completed in 1969 to replace the original Bullards Bar Reservoir, which had a capacity of 31,000 acre-feet per year. Water is diverted from New Bullards Bar through the Colgate Tunnel into the Colgate Powerhouse, located downstream on the North Yuba River. As compared to flow conditions prior to the construction of New Bullards Bar Dam, this operation has resulted in reduced flows during the spring months and increased flows during summer months. The 0.2-mile stretch of river between the dam and the two powerhouses has no flowing water except when the reservoir is spilling.

Other small- to medium-sized impoundments in the watershed, including Lake Spaulding, Bowman Lake, Jackson Meadows Reservoir, Englebright Reservoir, Lake Fordyce, and Scotts Flat Reservoir, provide an additional storage capacity of approximately 475,000 acre-feet per year.

Englebright Reservoir is impounded by Narrows Dam, which was constructed by the federal government in 1941 as part of the Sacramento River Debris Control Project. The reservoir has a capacity of 70,000 acre-feet per year and releases water for hydroelectric power generation during summer months. Daguerre Point Dam, located 12.5 miles downstream from Narrows Dam, is the major diversion point on the lower Yuba River.

Bear River. The Bear River is the second largest tributary to the Feather River, contributing approximately 16 percent of the average annual flow. The Bear River originates in the Sierra



NOTE: (a) First full year of stream flow data available in 1902. After 1967, flows recorded at gauge 11406920 (Thermalito Afterbay release) were added to give total Feather River flow below Oroville.

FIGURE II-6

HISTORICAL STREAMFLOW IN THE FEATHER RIVER BELOW OROVILLE

Nevada, drains an area of about 292 square miles, and flows southwesterly until it enters the Feather River approximately 3 miles north of the town of Nicolaus. The median historical unimpaired runoff is 272,000 acre-feet per year, with a range of 20,000 to 740,000 acre-feet per year. The largest reservoir in the watershed, Camp Far West Reservoir, is operated by the South Sutter Water District and has storage capacity of 104,000 acre-feet per year. Other smaller impoundments, including Rollins Reservoir and Lake Combie, provide an additional storage capacity of approximately 70,000 acre-feet per year. Eleven powerplants and their associated fore- and afterbays also regulate Bear River flow. Most of these powerplants are owned and operated by PG&E.

As part of the hydroelectric project operations in the Bear River, water is exchanged with the Yuba River and American River basins. Water from the South Fork Yuba River is conveyed by the Drum Canal into the Drum Forebay on the Bear River. The average annual flow through the Drum Canal for the period from 1965 to 1992 was 367,600 acre-feet per year. Water from the North Fork of the American River, diverted through Lake Valley Canal, also flows into the Drum Forebay. For the period between 1965 and 1992, the average annual flow through the Lake Valley Canal was 11,530 acre-feet per year.

From the Drum Forebay, water is diverted to two places. The first is Canyon Creek, where the water either supplies the Alta Powerhouse or flows back into the American River. Portions the Alta Powerhouse discharge may be diverted to the Bear River. The second diversion from the Drum Forebay is to Drum Powerhouses 1 and 2. All of the discharge from these powerplants flows into the Bear River.

Based on 1992 values, it is estimated that more than 90 percent of the inflow from the Drum and Lake Valley canals is diverted to Drum Powerhouses 1 and 2 and into the Bear River. The remainder is diverted to the American River or Alta Powerhouse.

American River

The American River originates in the mountains of the Sierra Nevada range, drains a watershed of approximately 1,895 square mile, and enters the Sacramento River at RM 60 in the City of Sacramento. The American River contributes approximately 15 percent of the total flow in the Sacramento River. The American River watershed ranges in elevation from 23 feet to over 10,000 feet, and receives approximately 40 percent of its flow from snowmelt.

Development on the American River began in the earliest days of the California Gold Rush, when numerous small diversion dams, flumes, and canals were constructed. Currently, 19 major reservoirs in the drainage have a combined storage capacity of 1.9 million acre-feet per year. The largest reservoir in the watershed, Folsom Lake, was formed with the completion of Folsom Dam in 1956, and has a capacity of nearly 1 million acre-feet per year. Folsom Dam, located approximately 30 miles upstream from the confluence with the Sacramento River, is operated by Reclamation as a major component of the CVP. Water released from Folsom Lake is used to generate hydroelectric power, meet downstream water rights obligations, contribute to Delta inflow requirements, and provide water supplies to CVP contractors.

Releases from Folsom Dam are re-regulated approximately 7 miles downstream by Nimbus Dam. This facility is also operated by Reclamation as part of the CVP, and began operation in 1955. Nimbus Dam creates Lake Natoma, which serves as a forebay for diversions to the Folsom South Canal. This CVP facility began operation in 1973, and serves water to agricultural and M&I users in Sacramento and San Joaquin counties.

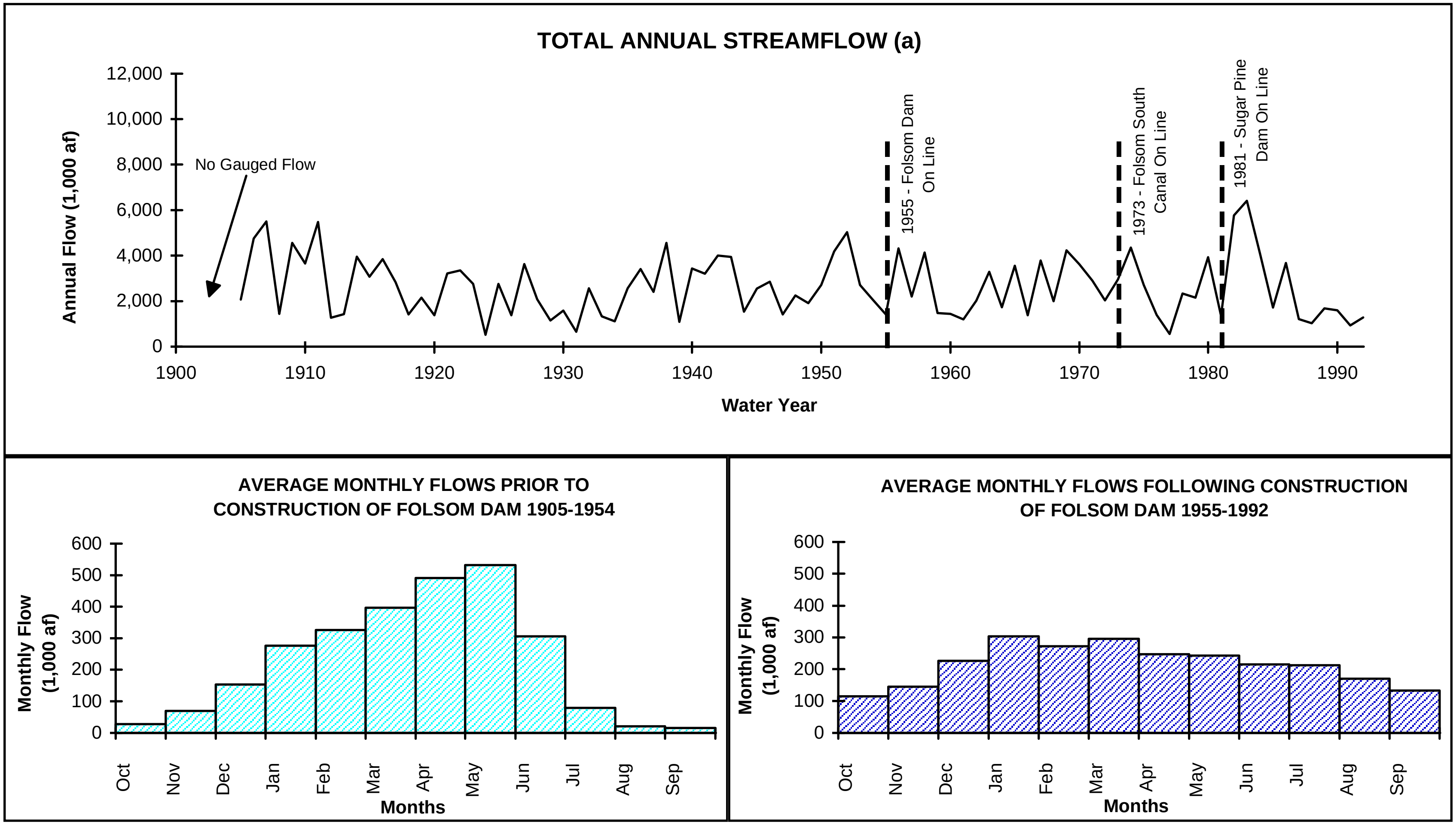
Figure II-7 shows the distribution of average monthly flows in the American River downstream from Nimbus Dam at Fair Oaks, for periods before and after the construction of Folsom Dam. As illustrated in this figure, prior to construction of Folsom Dam, monthly flows were generally highest during the months of April and May, and approached zero in the late summer. In wet years, this high spring flow often resulted in downstream flooding in the Sacramento area. Following the construction of Folsom Dam, the extreme flows in wet years have been reduced, and higher flows have been provided during dry periods. This operation has resulted in improved flood protection to downstream areas.

Although Folsom Lake is the main storage and flood control reservoir on the American River, numerous other small reservoirs in the upper basin provide hydroelectric generation and water supply. None of the upstream reservoirs have any specific flood control responsibilities. The total upstream reservoir storage above Folsom Lake is approximately 820,000 acre-feet per year. Ninety percent of this upstream storage is contained by five reservoirs: French Meadows (136,000 acre-feet per year), Hell Hole (208,000 acre-feet per year), Loon Lake (76,000 acre-feet per year), Union Valley (277,000 acre-feet per year), and Ice House (46,000 acre-feet per year).

French Meadow and Hell Hole reservoirs, located on the middle fork of the American River, are owned and operated by Placer County Water Agency (PCWA). PCWA provides wholesale water to agricultural and urban areas within Placer County. For urban areas, PCWA operates water treatment plants and sells wholesale treated water to municipalities that provide retail delivery to their customers. The cities of Rocklin and Lincoln receive water from PCWA. Loon Lake, also on the middle fork, and Union Valley and Ice House reservoirs on the south fork are all operated by SMUD.

SURFACE WATER QUALITY IN THE SACRAMENTO RIVER BASIN

The reach of the Sacramento River between Keswick Dam and Red Bluff has excellent mineral quality, and the water is therefore suitable for most uses. Most of the water can be classed as calcium-magnesium bicarbonate, and is slightly hard, but does not require softening. The water is excellent to good for irrigation use, and generally mineral levels are satisfactory for most domestic and industrial uses. Many tributaries drain to the upper Sacramento River without deteriorating water quality, indicating the excellent quality of the tributaries. Turbidity levels are generally low, but become elevated occasionally as a result of high flows on Cottonwood Creek, which is highly susceptible to sediment loading during high runoff. The development of regional wastewater treatment plants has resulted in effluent with concentrated nutrient loads from urban areas, particularly from the cities of Redding and Red Bluff. The Sacramento River downstream of Keswick Dam is a designated spawning area for anadromous fish, and has a minimum allowable dissolved oxygen (DO) level of 7 milligrams per liter (mg/l). At the Red Bluff Diversion Dam, the



NOTE: (a) First full year of stream flow data available in 1905. Flows after 1955 also affected by various upstream development activities.

FIGURE II-7

HISTORICAL STREAMFLOW IN THE AMERICAN RIVER BELOW FAIR OAKS

river maintains oxygen levels near saturation, with concentrations that have ranged from slightly below 10 mg/l to over 12 mg/l.

From Red Bluff to the Delta, the Sacramento River is generally of good quality, although water quality is periodically degraded due to the discharge of toxins, untreated sewage, and other nonpoint source contaminants. In the lower reaches of the Sacramento River, water quality is affected by intrusion of saline seawater from the Delta. The upper reaches of major tributaries to the lower Sacramento River, the Feather, Yuba, and American rivers, all have excellent water quality. In the lower Sacramento River, agricultural drainage influences water quality by contributing to increased turbidity, and substantial mineral, nutrient, and herbicide loads. The state agencies and rice growers continue to promote management practices to ensure that discharges from rice fields do not exceed performance goals established by the Central Valley Regional Water Quality Control Board.

SURFACE WATER IN THE SAN JOAQUIN RIVER BASIN

The 250-mile-long San Joaquin Valley comprises the southern two thirds of the Central Valley, and is subdivided between the San Joaquin River Basin and the Tulare Lake Basin. The San Joaquin River watershed includes lands that drain to the San Joaquin River and ultimately flow into the Delta. The Tulare Lake Basin watershed includes lands that drain into Tulare Lake bed or Buena Vista Lake bed. Watersheds in the Tulare Lake Basin are discussed in a subsequent section of this chapter.

The San Joaquin River Basin, shown in Figure II-8, extends from the Sacramento-San Joaquin Delta in the north to the north fork of the Kings River in the south, and from the foothills of the Sierra Nevada to the Coast ranges. It encompasses about 32,000 square miles in the northern part of the San Joaquin Valley, roughly from Fresno to Stockton. The climate of the San Joaquin River Basin is semiarid, characterized by hot, dry summers and mild winters, except at the highest altitudes, with distinct wet and dry seasons. Most of the precipitation falls from November to April, with rain at the lower elevations and snow in the higher regions. On the valley floor, precipitation decreases from north to south, ranging from 14 inches in Stockton to 8 inches at Mendota.

The primary sources of surface water to the basin are rivers that drain the western slope of the Sierra Nevada Range. Each of these rivers, the San Joaquin, Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Cosumnes, drain large areas of high elevation watershed that supply snowmelt runoff during the late spring and early summer months. Historically, peak flows occurred in May and June and flooding occurred in most years along all of the major rivers. When flood flows reached the valley floor, they spread out over the lowlands, creating several hundred thousand acres of permanent tule marshes and more than 1.5 million acres of seasonally flooded wetlands.

The three northernmost streams, the Calaveras, Mokelumne, and Cosumnes rivers, flow into the San Joaquin River within the boundaries of the Delta. These rivers are commonly referred to as "east side tributaries to the Delta." Streams on the west side of the basin are intermittent and

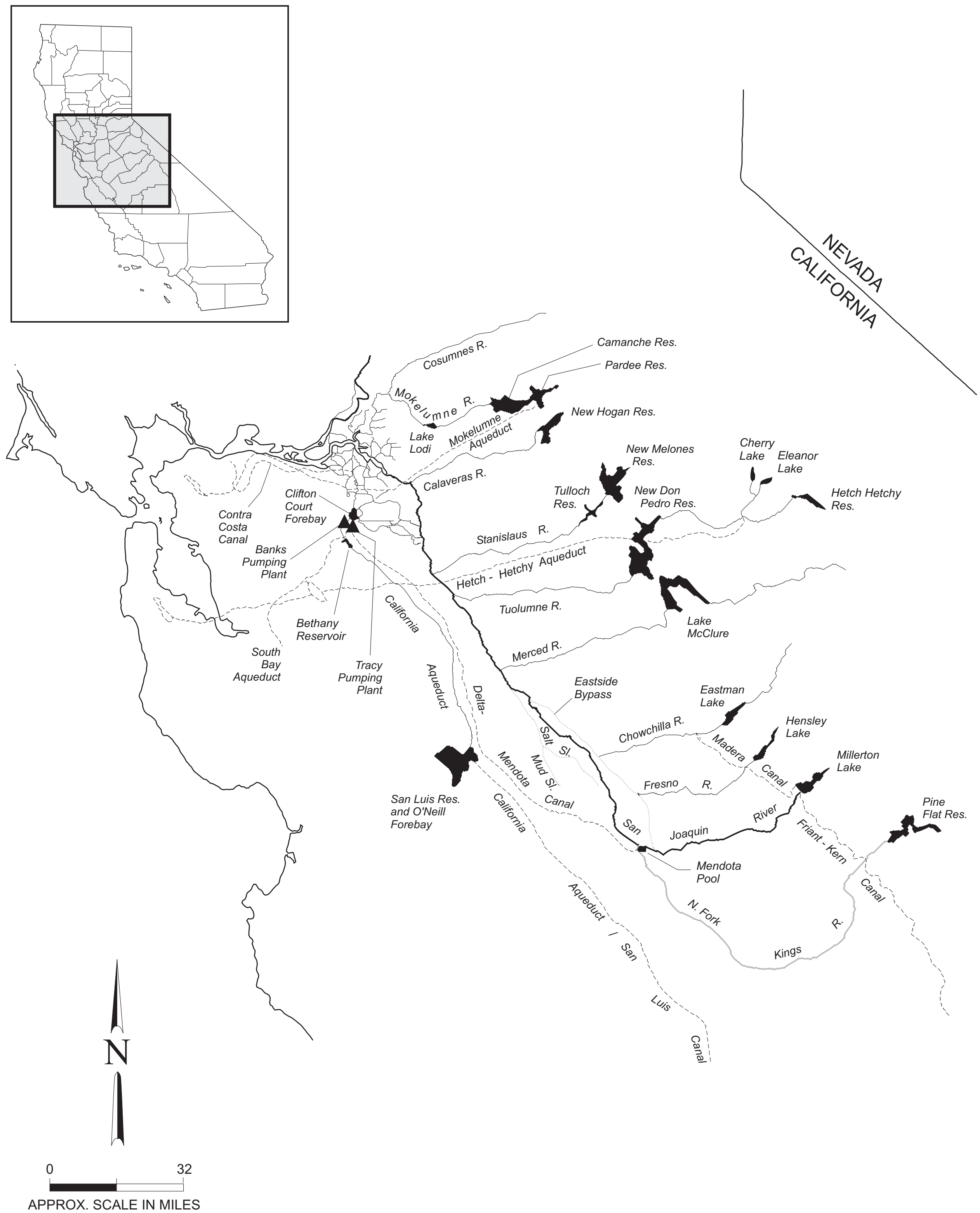


FIGURE II-8

SAN JOAQUIN RIVER BASIN

their flows rarely reach the San Joaquin River. Natural runoff from westside sloughs is augmented with agricultural drainage. The San Joaquin River originates in the Sierra Nevada at an elevation over 10,000 feet and flows into the San Joaquin Valley at Friant. The river then flows to the center of the valley floor, where it turns sharply northward and flows through the San Joaquin Valley to the Delta. Along the valley floor, the San Joaquin River receives additional flow from the Merced, Tuolumne, and Stanislaus rivers.

The San Joaquin River is characterized by two distinct sections: the upper and lower. The upper San Joaquin River section, upstream of the confluence with the Merced River, was historically characterized by the runoff of the San Joaquin River. During the past 100 years, development in this area has resulted in groundwater overdraft conditions, and the river loses much of its flow through percolation. The lower San Joaquin River, from the confluence with the Merced River to the Delta, is characterized by the combination of flows from tributary streams, major rivers, and agricultural drainage water.

UPPER SAN JOAQUIN RIVER AND TRIBUTARIES

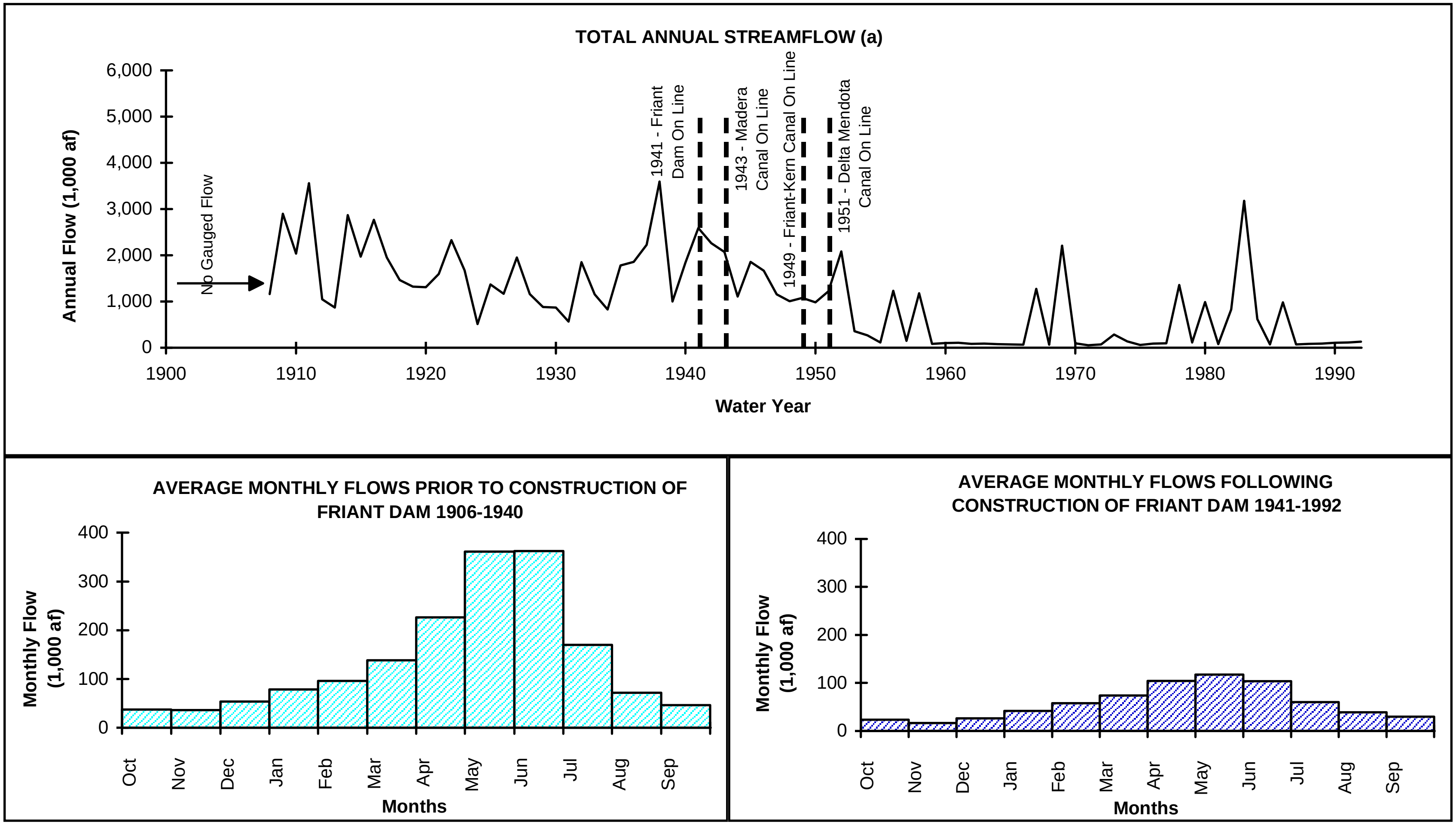
San Joaquin River Between Friant Dam and Gravelly Ford

Flows in the upper San Joaquin River are regulated by the CVP Friant Dam, which stores and diverts water to the Madera and Friant-Kern canals for irrigation and M&I water supplies in the eastern portion of the San Joaquin Valley. In the reach between Friant Dam and the Gravelly Ford, flow is influenced by releases from Friant Dam, with minor contributions from agricultural and urban return flows. Releases from Friant Dam are generally limited to those required to satisfy downstream water rights and instream flows. Millerton Lake, formed by Friant Dam, has a capacity of 520,000 acre-feet per year. Above Friant Dam, the San Joaquin River drains an area of approximately 1,676 square miles and has an annual average unimparied runoff of 1.7 million acre-feet per year. The median historical unimpaired runoff is 1.4 million acre-feet per year, with a range of 0.4 to 4.6 million acre-feet per year. Several reservoirs in the upper portion of the San Joaquin River watershed, including Mammoth Pool and Shaver Lake, are primarily used for hydroelectric power generation and have a combined storage capacity of approximately 620,000 acre-feet per year. The operation of these reservoirs affect the inflow to Millerton Lake.

Figure II-9 shows the annual flows in the San Joaquin River below Friant Dam. Since completion of the dam in 1941, the majority of the annual flow has been diverted to the Friant-Kern and Madera canals. Average monthly releases from Friant Dam to the San Joaquin River since 1941 have included minimum releases to satisfy water rights above Gravelly Ford and flood control releases. Approximately 20 small diversions are located between Friant Dam and Gravelly Ford (DWR Bulletin 130).

San Joaquin River Between Gravelly Ford and Fremont Ford

Gravelly Ford, located downstream of Friant Dam, is a sandy and gravelly section of the San Joaquin River that is subject to high losses of river flow. The section of the San Joaquin River between Gravelly Ford and the Mendota Pool, a reach of approximately 17 miles, is generally dry except when releases are made from Friant Dam for flood control.



NOTE: (a) First full year of stream flow data available in 1908.
Diversions for irrigation through Madera and Friant-Kern canals began October 1943 and March 1949, respectively.

FIGURE II-9

HISTORICAL STREAMFLOW IN THE SAN JOAQUIN RIVER BELOW FRIANT

During flood control operations, water that passes Gravelly Ford and exceeds demands at Mendota Pool is diverted from the San Joaquin River to the Chowchilla Bypass. When flow in the Chowchilla Bypass reaches its capacity of 6,500 cfs, remaining water in the San Joaquin River flows into the Mendota Pool. The Chowchilla Bypass runs northwest, intercepts flows in the Fresno River, and discharges to the Chowchilla River. The East Side Bypass begins at the Chowchilla River and runs northwesterly to rejoin the San Joaquin River above Fremont Ford. Together, the Chowchilla and Eastside bypasses intercept flows of the San Joaquin, Fresno, and Chowchilla rivers, and other lesser east side San Joaquin River tributaries, to provide flood protection for downstream agricultural lands. These bypasses are located in highly permeable soils, and much of the water recharges groundwater.

Flows in the San Joaquin River that pass the Chowchilla Bypass enter the Mendota Pool. The Mendota Pool was formed in 1871 by the construction of Mendota Dam on the San Joaquin River by water rights holders, and is the point at which the San Joaquin River turns northward. The Mendota Pool has a capacity of approximately 50,000 acre-feet per year and serves as a forebay for diversions to the Main and Outside canals. The Delta-Mendota Canal, which conveys CVP water from the Delta to San Joaquin River Exchange Contractors, terminates at the Mendota Pool. Water also enters Mendota Pool from the south, via Fresno Slough (sometimes referred to as James Bypass), which conveys overflows from the Kings River in the Tulare Lake Basin to the San Joaquin River. Reclamation uses a portion of the flow in Fresno Slough to supply water to the Mendota MWA.

Tributaries to the Upper San Joaquin River

Above Fremont Ford, the San Joaquin River drainage area covers approximately 8,247 square miles. Over 16 riparian diversions have been identified between Gravelly Ford and Fremont Ford by DWR (Bulletin 130-68). These diversions averaged 728,900 acre-feet per year between 1922 and 1980 (Reclamation et al., 1990). Most of these diversions are below Mendota Pool and are currently supplied by water from the Delta-Mendota Canal.

Historically, the San Joaquin River between Gravelly Ford and Fremont Ford received inflow from several large tributaries, including the Fresno and Chowchilla rivers. Now, most of the flow in the Fresno and Chowchilla rivers is diverted and only reaches the San Joaquin River during flooding events. The rest of the time, flow in this reach of the San Joaquin River consists primarily of imported Delta water via the Delta-Mendota Canal which is released from Mendota Pool for subsequent diversion, agricultural returns, and occasional releases from wildlife refuges. Between Sack Dam and the Salt Slough confluence, an approximate reach length of 54 miles, there is usually slight or no flow. Mud and Salt sloughs contribute irrigation return flows to the lower end of this reach. The quality of this water, however, is poor.

Salt Slough and Mud Slough. Salt Slough and Mud Slough are shallow, slow-flowing channels on the west side of the San Joaquin Valley, that primarily convey subsurface agricultural drainage water to the San Joaquin River. During the winter and spring, flows in sloughs consist primarily of a combination of subsurface agricultural drainage, precipitation runoff, and discharges from local duck clubs and wildlife refuges. Summer and fall flows consist primarily of agricultural tailwater, irrigation district spill water, and subsurface agricultural drainage. Following the closure of Kesterson Reservoir and the San Luis Drain in 1985, agricultural drainage from water users on the west side of the San Joaquin Valley was routed through Salt Slough and Mud Slough into the San Joaquin River.

Fresno River. The Fresno River is a tributary to the San Joaquin River that drains a watershed of approximately 237 square miles in foothills of the Sierra Nevada. Because of the relatively low elevation of the watershed, most of the flow in the Fresno River results from rainfall. Historically, the Fresno River has behaved as an ephemeral stream with large winter flood flows and near zero summertime flows. The Fresno River ultimately discharges into the East Side Bypass.

The only regulating reservoir on the Fresno River is Hensley Lake (formed by Hidden Dam), which was completed and operational in 1975, and has a maximum storage capacity of 85,200 acre-feet per year. Hidden Dam is operated by the COE, and releases are coordinated with Reclamation operations at Friant Dam. Madera Canal, which conveys water northwest from Friant Dam, crosses the Fresno River approximately 3 miles downstream from Hidden Dam. Deliveries from Madera Canal to CVP contractors are made via the Fresno River, as are flood spills during flood control operations.

Chowchilla River. The Chowchilla River, a tributary to the San Joaquin River, drains a watershed of approximately 236 square miles in the Sierra Nevada. Because of the relatively low elevation of the watershed, most of the flow in the Chowchilla River results from rainfall. Historically, the Chowchilla River has behaved as an ephemeral stream with large winter flood flows and near zero summertime flows. The Chowchilla River ultimately discharges into the East Side Bypass.

The only regulating reservoir on the Chowchilla River is Eastman Lake (formed by Buchanan Dam), which was completed and operational in 1976 and has a maximum storage capacity of 150,600 acre-feet per year. Buchanan Dam is operated by the COE, and releases are coordinated with Reclamation operations at Friant Dam. Generally, direct diversions from the Chowchilla River are supplemented by supplies from the Madera Canal. Releases from Buchanan Dam help meet the supplemental water demand and reduce the need for water from the Madera Canal. During flood control operations, Madera Canal spills can be released down Ash and Berenda sloughs, approximately 10 miles downstream of Buchanan Dam.

LOWER SAN JOAQUIN RIVER AND TRIBUTARIES

The lower San Joaquin River comprises the section of river from the confluence with the Merced River (below Fremont Ford) to Vernalis, which is generally considered to represent the southern limit of the Delta. The drainage area of the San Joaquin River above Vernalis includes approximately 13,356 square miles, of which approximately 2,100 square miles are drained by Fresno Slough (James Bypass). As described in the previous section, little water is contributed from the upper San Joaquin River, except during flood events. Flow patterns are therefore primarily governed by the tributary inflows from the Merced, Tuolumne, and Stanislaus rivers.

Merced River

The Merced River originates in the Sierra Nevada, and drains an area of approximately 1,273 square miles east of the San Joaquin River. Portions of the upper Merced watershed drain national park lands. The average unimpaired runoff in the basin is approximately 1 million acre-feet per year. The median historical unimpaired runoff is 0.8 million acre-feet per year, with a range of 0.2 to 2.8 million acre-feet per year.

Agricultural development in the Merced River watershed began in the 1850s, and significant changes have been made to the hydrologic system since that time. The enlarged New Exchequer Dam, forming Lake McClure with a capacity of 1,024,000 acre-feet per year, was completed in 1967 and now regulates releases to the lower Merced River. New Exchequer Dam is owned and operated by the Merced Irrigation District for power production, irrigation, and flood control.

Releases from Lake McClure pass through a series of powerplants and smaller diversions and are re-regulated at McSwain Reservoir, which serves as an afterbay to New Exchequer Dam. Below McSwain Dam, water is diverted to Merced Irrigation District's Northside Canal at the PG&E Merced Falls Dam for delivery to 4,100 acres of land within the district (USGS, 1992). The Crocker Huffman Dam, Merced ID's main diversion point located downstream of the Merced Falls Dam near the town of Snelling, diverts water into the Main Canal.

Tuolumne River

The Tuolumne River originates in the Sierra Nevada, and drains a watershed of approximately 1,540 square miles. The Tuolumne River is the largest tributary to the San Joaquin River with an annual average unimpaired runoff of approximately 1.95 million acre-feet per year. The median historical unimpaired runoff is 1.8 million acre-feet per year, with a range of 0.4 to 4.6 million acre-feet per year.

Flows in the lower portion of the Tuolumne River are controlled primarily by the operation of New Don Pedro Dam, which was constructed in 1971 jointly by TID and MID with participation by the City and County of San Francisco. The 2.0-million-acre-foot reservoir stores water for agricultural irrigation, hydroelectric generation, fish and wildlife enhancement, recreation, and flood control purposes. The districts divert water to the Modesto Main Canal and the Turlock Main Canal a short distance downstream from New Don Pedro Dam at La Grange Dam.

The City and County of San Francisco operates several water supply and hydroelectric facilities within the Tuolumne River Basin upstream of New Don Pedro Reservoir. O'Shaughnessy Dam on the main stem of the Tuolumne River, completed in 1923, impounds approximately 0.4 million acre-feet per year of water in Hetch Hetchy Reservoir. The 460-square-mile drainage area is entirely within the boundaries of Yosemite National Park. Water from Hetch Hetchy is used primarily to meet the M&I water needs of the City and County of San Francisco and to provide instream flows in the Tuolumne River below O'Shaughnessy Dam. Two other storage facilities upstream of Hetch Hetchy Reservoir, Lake Eleanor and Cherry Lake, are operated for hydropower and water supply purposes. The combined capacity of these two reservoirs is about 0.4 million acre-feet per year. The City and County of San Francisco owns 0.6 million acre-feet per year of storage in New Don Pedro Reservoir, which allows them to meet part of their release obligations to the districts by exchanging stored water for water diverted upstream at Hetch Hetchy.

Stanislaus River

The Stanislaus River originates in the Sierra Nevada and drains a watershed of approximately 900 square miles. The average unimpaired runoff in the basin is approximately 1.2 million acre-feet per year; the median historical unimpaired runoff is 1.1 million acre-feet per year, with a range of 0.2 to 3.0 million acre-feet per year. Snowmelt contributes the largest portion of the flows in the Stanislaus River, with the highest runoff occurring in the months of May and June.

Agricultural water supply development in the Stanislaus River watershed began in the 1850s, and has significantly altered the basin's hydrologic conditions. Currently, the flow in the lower Stanislaus River is primarily controlled by New Melones Reservoir, which was completed by the COE in 1978 and approved for filling in 1983 with a storage capacity of about 2.4 million acre-feet per year. New Melones Reservoir is located approximately 60 miles upstream from the confluence of the Stanislaus River and the San Joaquin River and is operated by Reclamation as part of the CVP. It is operated primarily for purposes of water supply, flood control, power generation, fishery enhancement, water quality improvement, and recreation. Flood control operations are conducted in conformance with COE operational guidelines.

Other water storage facilities in the Stanislaus River watershed include the Tri-Dam Project, a hydroelectric generation project that consists of Donnells and Beardsley dams located upstream of New Melones Reservoir on the middle fork Stanislaus River, and Tulloch Dam and Powerplant approximately 6 miles downstream of New Melones Dam on the mainstem Stanislaus River. Releases from Donnells and Beardsley dams affect inflows to New Melones Reservoir. Under contractual agreements between Reclamation and the OID and SSJID, Tulloch Reservoir provides afterbay storage to re-regulate power releases from New Melones Powerplant.

The main water diversion point on the Stanislaus is Goodwin Dam, located approximately 1.9 miles downstream of Tulloch Dam. Goodwin Dam, which was constructed by OID and SSJID in 1912, creates a re-regulating reservoir for releases from Tulloch Powerplant and provides for diversions to canals north and south of the Stanislaus River for delivery to OID and SSJID. Water impounded behind Goodwin Dam may be pumped into the Goodwin Tunnel for deliveries to Central San Joaquin Water Conservation District and the Stockton East Water District.

Twenty ungaged tributaries contribute flow to the lower portion of the Stanislaus River, below Goodwin Dam. These streams provide intermittent flows, occurring primarily during the months of November through August. Agricultural return flows as well as spills from irrigation canals receiving water from both the Stanislaus and Tuolumne rivers enter the lower portion of the Stanislaus River. In addition a portion of the flow in the lower portion of the Stanislaus River originates from groundwater accretions. As a result of these additional sources, annual streamflows measured at Ripon, approximately 35 miles downstream of Goodwin Dam, are nearly 30 percent larger than those measured below Goodwin Dam.

The original Melones Dam was constructed in 1924 and was operated in coordination with upstream storage facilities and Goodwin Dam downstream. Diversions at Goodwin Dam predate available flow data in this portion of the Stanislaus River. Figure II-10 shows the distribution of annual flows in the Stanislaus River below Goodwin from 1958 to 1992. Prior to the construction of New Melones Dam, average monthly flows were generally uniform between January and June, with peak flows in May. As a result of limited storage capacity in facilities on the river, average monthly flows in August and September approached zero in many years. The construction of New Melones Dam enhanced flood control and storage capacity on the Stanislaus River considerably. Following construction of New Melones Dam, average monthly flows included peak flows in March, with releases in all months. In 1992, in the later portion of an extended drought, storage in New Melones dropped to approximately 80,000 acre-feet per year.

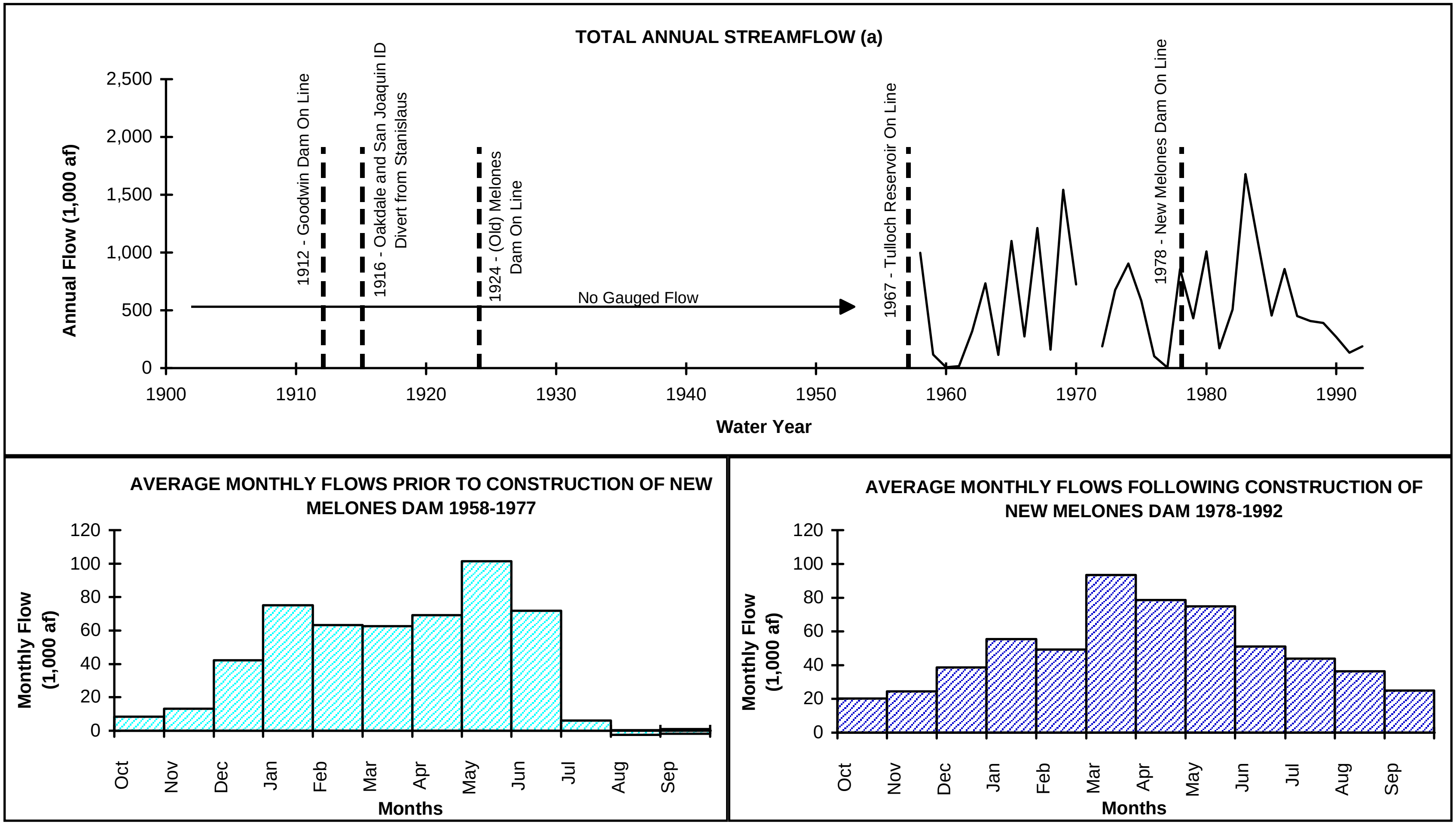
Operations of New Melones Reservoir are affected by water rights obligations, instream fishery requirements, water quality objectives in the Stanislaus and San Joaquin rivers, and CVP contracts. A description of operational criteria for New Melones Reservoir is provided with a discussion of CVP operations in a later section of this chapter.

San Joaquin River at Vernalis

Flows in the San Joaquin River at Vernalis are affected by the operation of upstream facilities on the San Joaquin, Merced, Tuolumne, and Stanislaus rivers, as well as by deliveries to the Mendota Pool from the Delta-Mendota Canal, and overflows from the Kings River in the Tulare Lake Region. Figure II-11 shows the annual flows at this location between 1930 and 1992. Changes in flows at Vernalis are consistent with changes in flows in the upper San Joaquin, Merced, Tuolumne, and Stanislaus rivers. In general, average monthly flows prior to 1940 included peak flows during the months of May and June, which correspond to the largest snowmelt flows in the San Joaquin River Basin. Following 1940, the flow in the San Joaquin River Basin was affected by the construction of Friant, New Exchequer, New Don Pedro, and New Melones dams. Construction of these facilities occurred between 1941 and 1978. Their effect is evident in a plot of average monthly flows from 1978 to 1992. Average monthly flows in the San Joaquin River at Vernalis during this period are more uniform throughout the year, with maximum flows less than historical levels.

Calaveras River

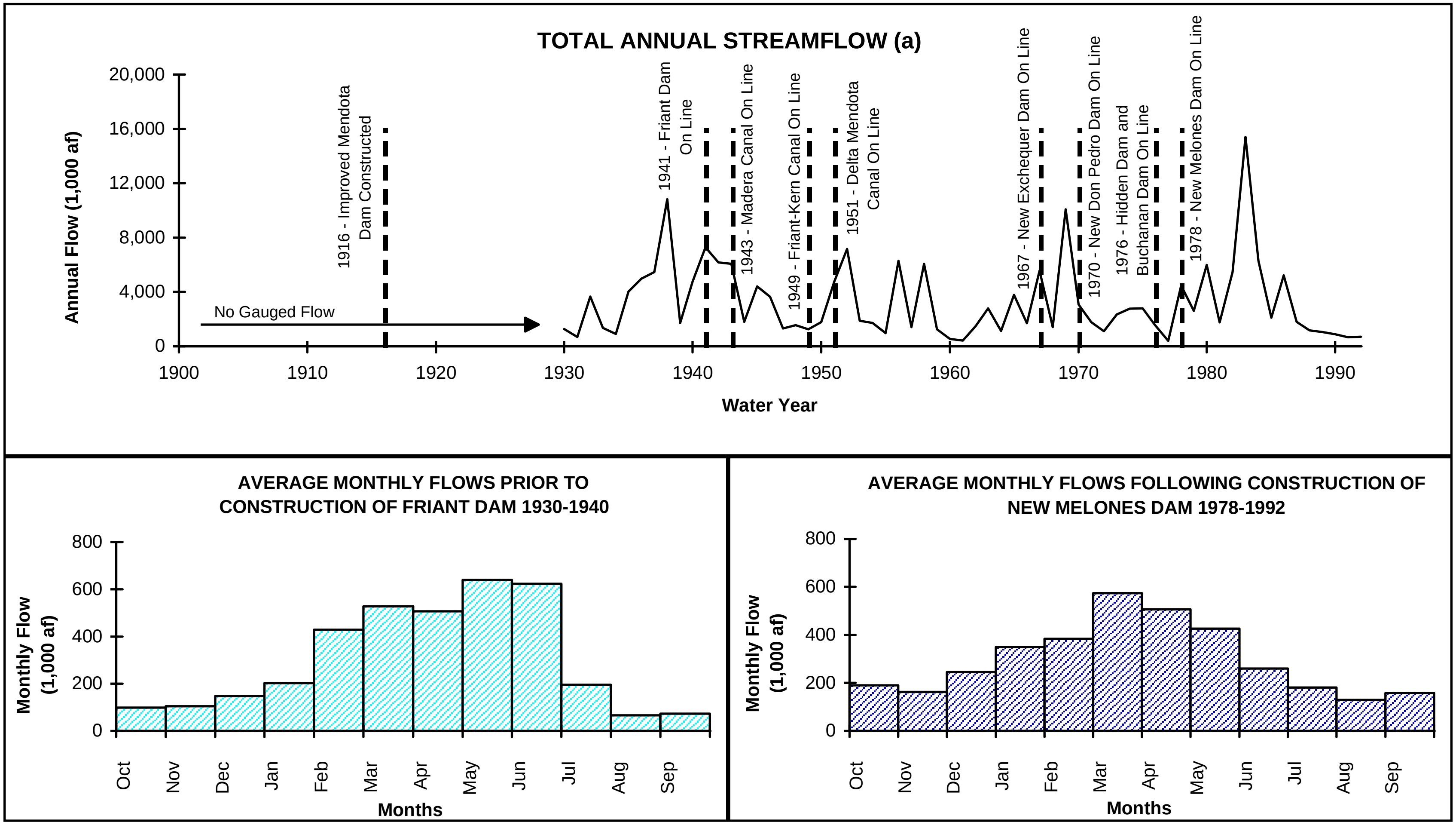
The Calaveras River originates in the Sierra Nevada, drains an area of approximately 363 square miles, and enters the San Joaquin River near the City of Stockton. The Calaveras River watershed is almost entirely below the effective average snowfall level (5,000 feet), and receives nearly all of its flow from rainfall. As a result, nearly all of the annual flow occurs between November and April. The median historical unimpaired runoff is 130,000 acre-feet per year, with a range of 8,000 to 600,000 acre-feet per year. Seepage from the north fork of the Stanislaus River also enters the basin from diversion canals and reservoirs. The portion of the river in the valley is commonly subject to periods of low or no flow for many days or weeks in the late summer and early fall.



NOTE: (a) First full year of stream flow data available in 1958. No data were recorded for WY 1971.
Flow regulated by Tulloch Reservoir since 1957, and by New Melones Dam since 1978.

FIGURE II-10

HISTORICAL STREAMFLOW IN THE STANISLAUS RIVER BELOW GOODWIN DAM



NOTE: (a) First full year of stream flow data available in 1924. Data for the period from 1924 to 1929 are not shown because only low-flow records are available for that period. Pre-1900 development on the San Joaquin River: 1869-Main and Outside canals constructed; 1871-Mendota Dam (Weir) constructed; 1872-Miller-Lux Canal constructed. USGS Station 11303500 is a National Stream Quality Accounting Network Station.

FIGURE II-11

HISTORICAL STREAMFLOW IN THE SAN JOAQUIN RIVER NEAR VERNALIS

The major water management facility on the Calaveras River is New Hogan Dam and Lake. It was constructed in 1963 by the COE and is operated by the COE and Stockton East Water District. New Hogan Lake has a storage capacity of 317,000 acre-feet per year. New Hogan Dam is operated primarily for flood control purposes, with the specification that flows at Bellota remain below 6,000 cfs.

Mokelumne River

The Mokelumne River originates at an elevation of approximately 10,000 feet in the Sierra Nevada and drains a watershed of approximately 661 square miles. It is a major tributary to the Delta, entering the lower San Joaquin River northwest of Stockton. The median historical unimpaired run-off is 696,000 acre-feet per year, with a range of 129,000 to 1.8 million acre-feet per year.

Three major reservoirs influence streamflow in the Mokelumne River. The uppermost reservoir, Salt Springs Reservoir, is owned by PG&E and is located on the North Fork of the Mokelumne River. It has a storage capacity of 141,900 acre-feet per year and began operation in 1963. Pardee and Camanche reservoirs are located on the main stem of the Mokelumne and are both owned and operated by the EBMUD. Pardee, completed in 1929, has storage capacity of 209,900 acre-feet per year. Water is exported from the Mokelumne River watershed to the EBMUD service area via the Mokelumne River Aqueduct, which receives water directly from Pardee Reservoir. Camanche Reservoir, with a storage capacity of 430,800 acre-feet per year, is located downstream of Pardee Dam. Water is released from Camanche Reservoir to maintain downstream water requirements and to provide flood protection on the Mokelumne River.

Approximately 82 diversions were identified along the Mokelumne River (DWR Bulletin 130-68). Except for the Mokelumne Aqueduct diversion, the most significant diversion in the watershed occurs at Woodbridge Dam, which diverts water into the Woodbridge Canal for irrigation of land south and west of the Town of Woodbridge.

Cosumnes River

The Cosumnes River originates in the lower elevations of the Sierra Nevada, drains a watershed of approximately 537 square miles, and enters the Mokelumne River within the Delta near the Town of Thornton. Because of the low elevation of its headwaters, the Cosumnes River receives most of its water from rainfall.

The only major water supply facilities in the Cosumnes River watershed are components of the Sly Park Unit of the CVP. The Sly Park Unit includes Jenkinson Lake, formed by Sly Park Dam on Sly Park Creek, with a storage capacity of 41,000 acre-feet per year. Water is diverted from the lake into the Camino Conduit for delivery to the El Dorado Irrigation District (EID) for irrigation and municipal uses by the City of Placerville and neighboring communities. A small diversion dam on Camp Creek diverts water through the Camp Creek Tunnel into Jenkinson Lake. These facilities were originally constructed as part of the CVP, and upon completion, operations were transferred to the EID under contract with Reclamation. The water supply provided by the Sly Park Unit is used by EID and is not integrated into the CVP operations.

SURFACE WATER QUALITY IN THE SAN JOAQUIN RIVER BASIN

Surface water quality in the San Joaquin River Basin is affected by several factors, including natural runoff, agricultural return flows, biostimulation, construction, logging, grazing, operations of flow regulating facilities, urbanization, and recreation. In addition, irrigated crops grown in the western portion of the San Joaquin Valley have accelerated the leaching of minerals from soils, which has altered water quality conditions in the San Joaquin River system.

The upper reaches of the rivers draining to the San Joaquin River Basin originate in large drainage areas high on the west side of the Sierra Nevada. The water in these rivers is generally soft with low mineral concentrations. As these streams flow from the Sierra Nevada foothills across the eastern valley floor, their mineral concentration steadily increases. This increase in concentration is fairly uniform for each of the east side streams.

In the western part of the San Joaquin Valley, soils are derived mainly from the marine sediments that make up the Coast Range and are high in salts and trace elements such as selenium, molybdenum, arsenic, and boron. As the San Joaquin Valley has undergone extensive land development, erosion and drainage patterns have been altered, thereby accelerating the rate at which these trace elements have been dissolved from the soil to accumulate in shallow groundwater, streams, and the San Joaquin River. The term “shallow groundwater” refers to as the highest zone of saturation down to a depth of approximately 20 feet below ground surface.

The primary area of subsurface drainage problems extend along the western side of the San Joaquin Valley from the Delta to south of Bakersfield. Shallow semi-impermeable clay layers lie beneath the land surface, preventing adequate drainage of irrigation water. This impediment to downward flow has resulted in high groundwater levels in the shallow groundwater zone and requires subsurface drainage of low lying fields to prevent waterlogging and salt buildup in the root zone. The subsurface drainage water is characterized by high salt concentrations and elevated levels of trace elements.

Wildlife refuges and duck clubs also contribute water of degraded quality to the San Joaquin River. The refuges begin flooding operations in the fall to maintain habitat for migratory waterfowl, primarily with water delivered from the Delta via the Delta-Mendota Canal. The salinity of the water in the ponds may increase during the fall due to evaporation and following winter seasons with low precipitation, often contributing poor quality water to the San Joaquin River when the ponds are drained in the spring.

Water quality in the San Joaquin River varies considerably along the stream’s length. Above Millerton Lake and downstream towards Mendota Pool, water quality is generally excellent. The reach from Gravelly Ford to Mendota Pool (about 17 miles) is frequently dry except during flood control releases because all water released from Millerton Lake is diverted upstream to satisfy water rights agreements, or percolates to groundwater. During the irrigation season, most of the water released from the Mendota Pool to the San Joaquin River is imported from the Delta via the Delta-Mendota Canal, and generally has higher concentrations of total dissolved solids (TDS) than water in the upper reaches of the San Joaquin River. Most of the water released from the Mendota Pool to the San Joaquin River is diverted at or above Sack Dam for agricultural uses.

Between Sack Dam and the confluence with Salt Slough, the San Joaquin River is often dry. From Salt Slough to Fremont Ford, most of the flow in the San Joaquin River is derived from irrigation returns carried by Salt and Mud sloughs. This reach typically has the poorest water quality of any reach of the river.

As the San Joaquin River progresses downstream from Fremont Ford, water quality generally improves at successive confluences, specifically at those with the Merced, Tuolumne, and Stanislaus rivers. In the relatively long reach between the Merced and Tuolumne rivers, however, mineral concentrations tend to increase due to agricultural drainage water, other waste waters, and effluent groundwater (DWR, 1965). Total dissolved solids in the San Joaquin River near Vernalis have historically ranged from 52 mg/l (at high stages) to 1,220 mg/l during the 1951-1962 period (DWR, 1965). During the mid to late 1960s, San Joaquin River water quality continued to decline. In 1972, the SWRCB) included a provision in Decision 1422 (D-1422) that Reclamation maintain average monthly concentrations of TDS in the San Joaquin River at Vernalis of 500 mg/l, as a condition of the operating permit for New Melones Reservoir on the Stanislaus River.

SURFACE WATER IN THE SACRAMENTO-SAN JOAQUIN DELTA

The Delta, Figure II-12, lies at the confluence of the Sacramento and San Joaquin rivers. It occupies the area of lowest elevation in the Central Valley, extending from the confluence of the two rivers inland as far as Sacramento and Stockton. In its original state, the Delta area included swamp and overflow lands comprising some of the most fertile peat soils in the state.

Prior to the settlement of Europeans in California, the Delta had evolved geologically and hydrologically with a network of slow-moving river channels dependent on and influenced by the confluence of the Sacramento and San Joaquin rivers, and to a lesser extent on the Mokelumne, Calaveras, and Cosumnes rivers (State Lands Commission, 1991). Cyclic river flooding helped contribute material along the stream channels forming natural levees. These levees formed around islands creating environments for tule marsh.

Much of the land within the Delta was reclaimed between 1850 and 1930 through the construction of levees around the numerous islands. This construction resulted in the creation of a network of navigable river channels, sloughs, and dredger cuts. During the 1850s through 1880s, extensive hydraulic gold mining contributed sediment loads to the major northern California rivers, which consequently carried this material into the Delta. The increased sedimentation in the Delta caused extensive flooding and led to the construction of levees at greater heights to reduce flooding. By 1900, approximately 50 percent of Delta lands had been reclaimed. By 1930, essentially all Delta islands had been reclaimed. These transformations were followed by the construction of major water diversions for agricultural and urban water needs. Currently, the Delta includes 57 major reclaimed islands and nearly 800 unleveed islands, and encompasses approximately 1,153 square miles. Much of the land in the Delta lies below sea level.

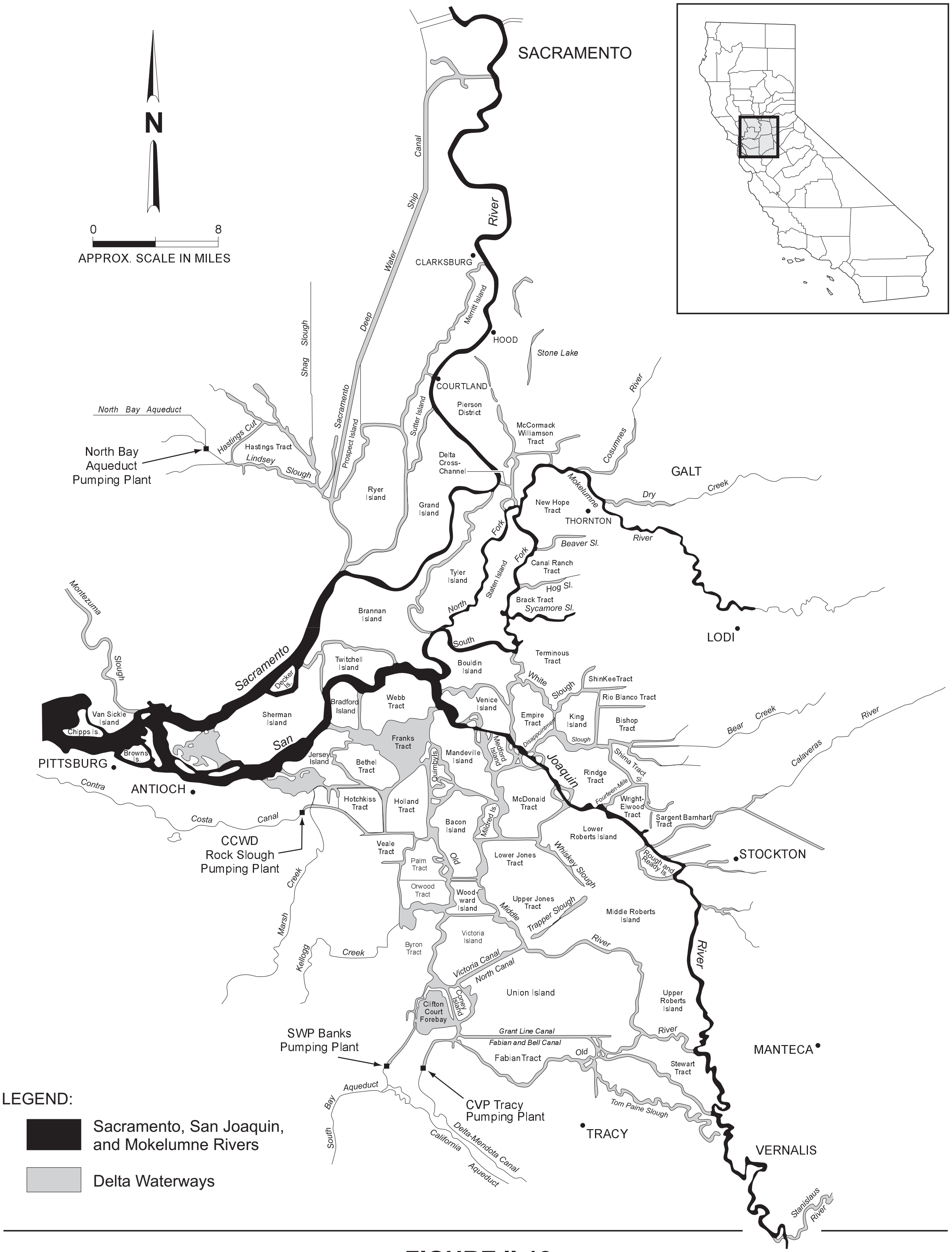


FIGURE II-12

SACRAMENTO-SAN JOAQUIN DELTA

On the average, about 21 million acre-feet per year of water, or about 42 percent of the surface water in California, reaches the Delta. Actual flow varies widely from year to year, and within the year as well. In 1977, a year of extraordinary drought, inflow to the Delta totaled 5.9 million acre-feet per year. In 1983, an extremely wet year, annual inflow was about 70 million acre-feet per year. Approximately 50,000 acres of the Delta is covered by surface water, and approximately 520,000 acres of Delta land is used for agriculture.

Delta channels have been modified to allow transport of this water and to reduce the effects of pumping on the direction of flows and salinity intrusion. The conveyance of water from the Sacramento River southward through the Delta is aided by the Delta Cross Channel (DCC), a man-made gated channel that conveys water from the Sacramento River to the Mokelumne River. Water diversions in the Delta include the CVP Tracy Pumping Plant, the State Water Project Banks Pumping Plant, the Contra Costa Canal Pumping Plant, the North Bay Aqueduct, and over 1,800 agricultural diversions for in-Delta use.

The hydraulic characteristics of the Delta are influenced by inflows from tributary streams, tidal influence from the Pacific Ocean, and water diversions within the Delta. Accordingly, water quality in the Delta is highly variable. It is strongly influenced by inflows from the rivers, as well as by intrusions of seawater into the western and central portions of the Delta during periods of low outflow that may be affected by high export pumping. The concentrations of salts and other materials in the Delta are affected by river inflows, tidal flows, agricultural diversions, drainage flows, wastewater discharges, water exports, cooling water intakes and discharges, and groundwater accretions.

Seawater intrusion into the Delta is dependent on tidal conditions, inflows to the Delta, and Delta channel geometry. Delta channels are typically less than 30 feet deep, unless dredged, and vary in width from less than 100 feet to more than 1 mile. Although some channels are edged with riparian and aquatic vegetation, steep mud or rip-rap covered levees border most channels. To enhance flow and aid in levee maintenance, vegetation is often removed from the channel margins. The tidal currents carry large volumes of seawater back and forth through the San Francisco Bay-Delta Estuary with the tide cycle. The mixing zone of salt and fresh water can shift 2 to 6 miles daily depending on the tides, and may reach far into the Delta during periods of low inflow.

Major CVP facilities in the Delta include the Tracy Pumping Plant, completed in 1951, which pumps water from Old River to the Delta-Mendota Canal; the Contra Costa Pumping Plant, which pumps water from Rock Slough into the Contra Costa Canal; and the DCC, which was completed in 1951 and permits the diversion of water from the Sacramento River to the Mokelumne River, facilitating efficient transfer of water across the Delta to project pumps in the southern Delta. The SWP also operates and maintains facilities in the Delta. These include the Barker Slough Pumping Plant in the north Delta, which pumps water into the North Bay Aqueduct and the Harvey O. Banks Delta Pumping Plant, which pumps water from Clifton Court Forebay in the southern Delta into the California Aqueduct.

Currently, salinity problems occur primarily during years of below normal runoff. In the western Delta, elevated salinity levels result primarily from the intrusion of saline waters from the San Francisco Bay system. Salinity concentrations in the southern portion of the Delta results partially from elevated concentrations of salts in the San Joaquin River as it flows into the Delta. The operations of the state and federal export pumping plants near Tracy draw higher quality Sacramento River water southward across the Delta. These conditions result in higher salinity concentrations in the southeast portion of the Delta. Localized problems resulting from irrigation returns occur elsewhere such as in dead-end sloughs.

SURFACE WATER IN THE TULARE LAKE BASIN

The Tulare Lake Region is defined generally by the Tulare Lake Basin, which is hydrologically separate from the San Joaquin River Basin, except under certain hydrologic and operational conditions where water from the Kings River overflows into the San Joaquin River. As shown in Figure II-13, four major rivers drain the Tulare Lake Basin: the Kings, Kaweah, Tule, and Kern. The three northern rivers (Kings, Kaweah, and Tule) historically drained to the Tulare Lake Bed, a vast lowland area that covers approximately 200,000 acres in Kern and Kings counties. The Kern River historically flowed into the Kern, Buena Vista, and Goose lake beds. The development and operation of flood control and water supply projects on these rivers has significantly reduced flow to the lake beds, which now remain dry except during periods of high flows in wet years. The lake beds are connected through a series of sloughs that allow transport of overflows during wet weather. Kern Lake empties into Buena Vista Lake and Tulare Lake. In addition, the north fork of the Kings River overflows into the San Joaquin River, via the Fresno Slough. Under most condition, streams in the Tulare Lake Basin are not tributary to the Delta and do not support anadromous fisheries.

KINGS RIVER

The Kings River originates in the southern Sierra Nevada. The upper watershed includes the North, Middle, and South forks of the Kings River, all of which converge in the foothills above Pine Flat Reservoir. Downstream of the reservoir, the river bifurcates at Crescent Wier into the South Fork, which flows into Tulare Lake, and the North Fork/Fresno Slough, which flows north into Mendota Pool. The Kings River drainage area above Pine Flat Dam covers approximately 1,545 square miles.

The main flow-regulating facility on the Kings River is Pine Flat Dam, which was completed by the COE in 1954. The reservoir is used for flood control and conservation storage and has a usable storage capacity of 1 million acre-feet per year. Four reservoirs upstream of Pine Flat Dam supply water to hydropower projects on the North Fork. Below Pine Flat Dam, the Friant-Kern Canal crosses the Kings River. There are 14 diversions located on the mainstem of the river between Pine Flat Dam and Crescent Weir, one agricultural diversion on the North Fork/Fresno Slough, and eight diversions on the South Fork.

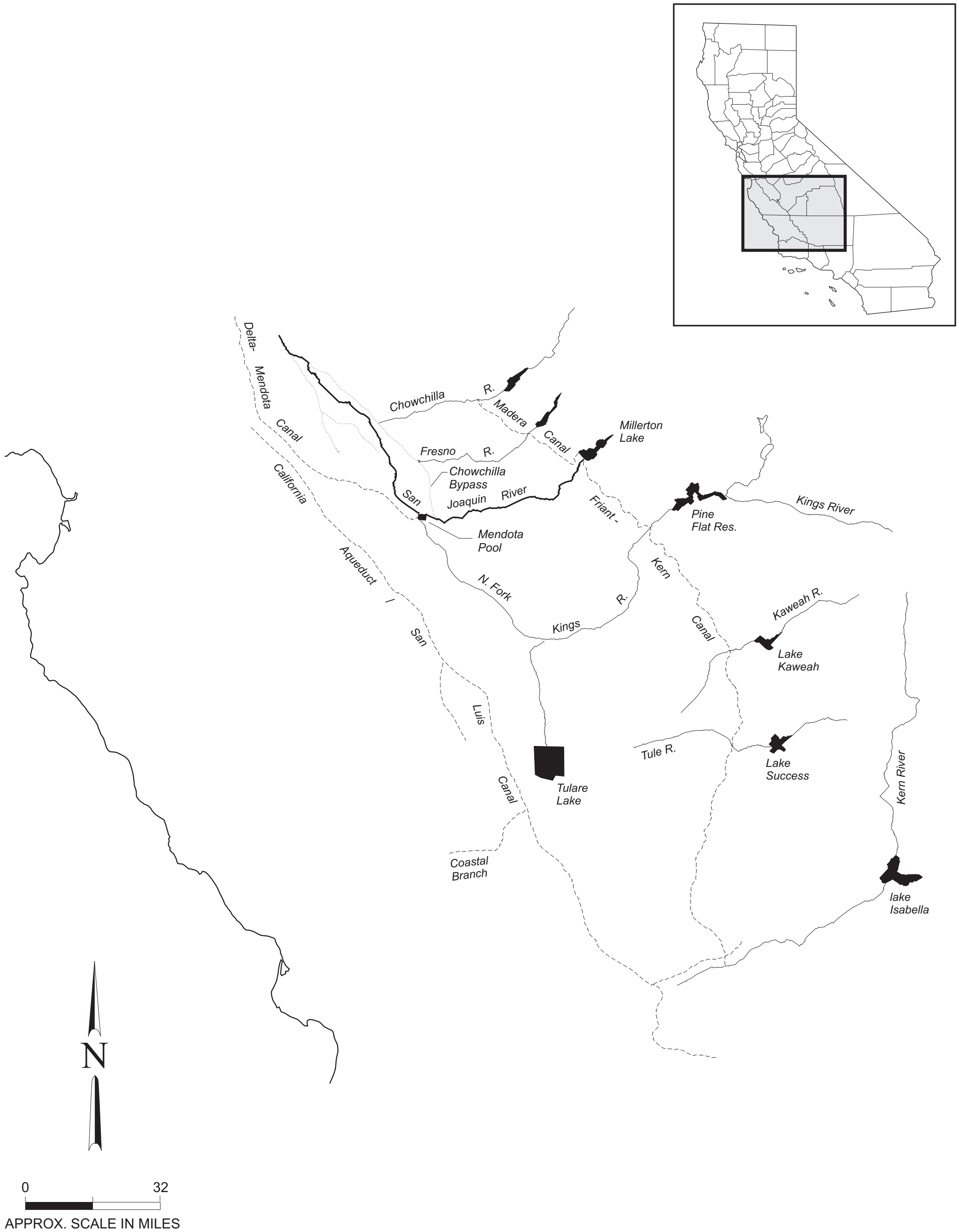


FIGURE II-13

TULARE LAKE BASIN

KAWEAH RIVER

The headwaters of the Kaweah River lie in the southern Sierra Nevada. The upper watershed includes the North, Marble, Middle, East, and South forks of the Kaweah River, all of which converge in the foothills above Lake Kaweah. Downstream of the lake the main stem of the Kaweah meanders southwest past Visalia and on to the valley floor. The Kaweah River drainage area above Terminus Dam extends over approximately 561 square miles.

The main regulating facility on the Kaweah River is Terminus Dam, completed by the COE in 1962. The lake is used for flood control and water supply and has a usable storage capacity of 149,600 acre-feet per year. Three hydropower diversions above Lake Kaweah return all of the diverted water to the river. Approximately 12 diversions below Lake Kaweah supply water for agricultural purposes.

TULE RIVER

The Tule River originates in the southern Sierra Nevada. The upper watershed includes the North, Middle, and South forks of the Tule River, which converge in the foothills above Lake Success. Downstream of the lake the main stem of the Tule meanders west through Porterville and across the valley floor until it drains into Tulare Lake, which is generally dry. The Tule River drainage area above Success Dam covers approximately 393 square miles.

The main regulating facility on the Tule River is Success Dam, completed by the COE in 1961. The reservoir is used for flood control and water supply and has usable storage capacity of 82,000 acre-feet per year plus an additional 120,000 acre-feet per year of surcharge flood control storage. Above Lake Success, two hydropower diversions return most of the diverted water to the river. Some water for agricultural purposes is diverted from one of the hydropower projects after passing through the powerhouse. There are other small agricultural diversions above the lake. Between Lake Success and Tulare Lake are eight notable agricultural diversions that averaged from 500 to 21,400 acre-feet per year from 1961 to 1977.

KERN RIVER

The headwaters of the Kern River are located high in the Sierra Nevada. The upper watershed includes the South Fork of the Kern River and the main stem of the Kern River. The main stem flows south through the mountains and directly into Isabella Lake. Below the lake, the river flows southwest towards Bakersfield, where it enters the valley floor and continues to the Buena Vista lake bed. The Kern River drains approximately 2,074 square miles above Isabella Lake.

The main regulating facility on the Kern River is Isabella Dam, completed by the COE in 1953. The reservoir created by Isabella Dam has a capacity of 570,000 acre-feet per year. West of Bakersfield, the Friant-Kern Canal terminates at the Kern River. From 1961 to 1977, the Friant-Kern Canal delivered about 18,000 acre-feet per year of water per year to the river. Above Isabella Lake are one hydropower diversion and two agricultural diversions. Three more hydropower diversions are located downstream of the lake. All the hydropower diversions on the Kern River return the water to the river. There are 14 agricultural diversions from the Kern River. From 1961 to 1977 the total annual diversion from all 14 ranged from 175,000 to 2 million acre-feet per year and averaged 427,000 acre-feet per year.

SURFACE WATER QUALITY IN THE TULARE LAKE REGION

In general, the Tulare Lake Region has not had major surface water quality problems. The perennial streams (Kings, Kaweah, Tule, and Kern rivers) are not directly subject to significant man-made waste loads because most effluents are applied to the land. Irrigation return water flows do contribute a major portion of the summer base flow in the lower reaches of the larger streams. In addition, saline water from oil wells contributes to upper reaches of the Kern River, increasing the basin salt load.

Evaporation ponds are used for disposal of drainage water in the Tulare Lake Region. The waters in the ponds are typically brackish, so they are not used for any beneficial purposes. However, waterfowl frequently use these ponds. Fish and wildlife agencies periodically monitor levels of trace elements in the vegetation and the wildlife that use the ponds. High selenium concentrations pose a particular threat to waterfowl breeding and feeding in these waters.

Streams in the Tulare Lake Region are similar to streams in the San Joaquin River Region in that water quality is generally excellent upstream of the valley floor and the surface water supply reservoirs in the foothills. Water of the four main streams in the Tulare Lake Region is generally calcium carbonate in character. The headwaters of these streams are generally characterized by higher TDS levels than streams that flow into the San Joaquin River Region.

Surface waters in the Tulare, Buena Vista, and Kern lake beds are strongly affected by drainage water flows. These water bodies tend to have extremely high levels of TDS, selenium, boron, arsenic, and molybdenum.

THE CENTRAL VALLEY PROJECT OPERATIONS

The CVP is the largest surface water storage and delivery system in California, with a geographic scope covering 35 of the state's 58 counties. The project includes 20 reservoirs, with a combined storage capacity of approximately 11 million acre feet; 8 powerplants and 2 pumping-generating plants, with a combined capacity of approximately 2 million kilowatts; 2 pumping plants; and approximately 500 miles of major canals and aqueducts. The CVP supplies water to more than 250 long-term water contractors in the Central Valley, and Santa Clara Valley and the San Francisco Bay Area. Figure II-14 shows the locations of CVP facilities, rivers that are controlled or affected by the operation of CVP facilities, and the CVP service area.

Historically, approximately 90 percent of the CVP water has been delivered to agricultural users, including prior water rights holders. Total annual contracts exceed 9 million acre-feet per year, including over 1 million acre-feet per year of Friant Division Class II supply, which is generally available only in wet years. At present, increasing quantities of water is being provided to municipal customers, including the cities of Redding, Sacramento, Folsom, Tracy, and Fresno; most of Santa Clara County; and the northeastern portion of Contra Costa County.

As discussed previously in this chapter, the CVP was authorized through a series of legislative actions, beginning with the Rivers and Harbors Act of 1935 (Act), which authorized construction of initial features of the CVP. Additional facilities, which increased the storage and delivery capacity of the CVP, were authorized in successive congressional acts. In general, facilities were authorized for construction and operation as divisions or units, which are components of divisions. The CVP facilities include reservoirs on or near the Trinity, Sacramento, American, Stanislaus, and the San Joaquin rivers, as shown in Figure I-1.

Water from the Trinity River is stored, reregulated, and diverted through a system of dams, reservoirs, tunnels, and powerplants in the Sacramento River for use in water deficient areas of the Central Valley Basin. Water is also conveyed in the Sacramento River to and through the Delta to the Tracy Pumping Plant at the southern end of the Delta. The Tracy Pumping Plant lifts the water into the Delta-Mendota Canal which delivers water to CVP contractors and exchange contractors on the San Joaquin River and other water right contractors on the Mendota Pool. CVP water may continue to be conveyed via the San Luis Reservoir and Pacheco Tunnel to the San Felipe Division contractors and via the San Luis Canal to San Luis contractors.

The CVP also delivers water from the San Joaquin River to CVP contractors and water right holders located near the Madera and Friant Kern canals. Water from New Melones Reservoir is used by water rights holders in the Stanislaus River watershed and CVP contractors located in the northern San Joaquin Valley. Some of the CVP Contractors divert directly from or just below the outlet works from Whiskeytown, Folsom, and Millerton Reservoirs. In addition, water is conveyed via the Sacramento and American rivers to CVP contractors, water rights holders along the Sacramento and American rivers.

Other CVP smaller reservoir and rivers that are financially integrated in the CVP include the Hidden and Buchanan reservoirs on the Fresno and Chowchilla rivers respectively; the Sly Park Reservoir and the Consumnes River; Black Butte Reservoir on the Stony Creek.

This section summarizes the operations of the CVP, beginning with a description of factors that influence operations decisions. It includes a summary of project-wide decision criteria used to determine when and where water should be stored or released. This is followed by descriptions of operating constraints and objectives for specific facilities in CVP divisions. The section concludes with a discussion of CVP contract types and criteria used to determine annual water delivery levels to the various types of contractors.

GENERAL CRITERIA FOR THE OPERATION OF CVP FACILITIES

Decisions related to the operation of the CVP must consider a wide variety of project-wide, regional, and site-specific factors. In the development of operations decisions, criteria related to reservoir operations, downstream conditions, and water rights in the Delta must be considered. This section describes how these issues generally influence CVP operational decisions.

FIGURE II-14

CENTRAL VALLEY PROJECT AND OTHER RELATED FEDERAL FACILITIES

Regulatory requirements that affect operations, and operational considerations at specific facilities are described in later sections of this chapter.

Reservoir Operating Criteria

Factors that influence the operation of CVP reservoirs include inflow, release requirements, flood control requirements, carryover storage objectives, lake recreation, power production capabilities, cold water reserves, and pumping costs. Operational decisions must consider conditions at an individual reservoirs, as well as conditions at other project reservoirs. The possibility of using multiple water sources to meet some requirements provides flexibility to project operations and adds complexity to operational decisions. For example, storage space south of the Delta that can only be filled with water exported from the Delta is a major operational consideration involving the geographic distribution of water in storage.

The COE is responsible for determining flood control operational requirements at most CVP reservoirs. If CVP reservoir storage exceeds COE requirements, water must be released at rates of flow defined in the COE's flood control manuals. These manuals require lower reservoir storage levels in the fall in anticipation of winter rains. To avoid excess releases at the end of the summer, Reclamation often schedules releases in excess of minimum flow requirements over the course of the summer. This practice generally results in end of water year reservoir storage levels at or below flood control thresholds so that space is available to regulate reservoir inflows.

Because future hydrologic conditions are difficult to predict for the coming water year, CVP operators must anticipate conditions ranging from drought to flood. Reservoirs are operated with consideration for some degree of protection for future supplies in the event of dry conditions. Carryover storage at the end of September forms an initial basis for the following year's operating conditions and is an integral part of the process of allocating CVP water supplies. Carryover objectives consider flood protection or Safety of Dams criteria, existing water demands, forecasted water supply, cold water supplies, power system requirements, risk of drought conditions, possible impacts beyond the end of the current water year, and other operational factors.

As a water year progresses, carryover storage projections help guide CVP operations. During the fall months, carryover storage is the only indicator of CVP capabilities, until winter precipitation or lack of winter precipitation can be assessed. By April or May, when the wet season is essentially over, CVP operational objectives are generally known and CVP storage may be used as necessary to efficiently meet these objectives. Carryover storage may be affected by contingencies affecting CVP operations, unusual hydrologic events, and variations from forecasted inflows. During the summer, if carryover storage is expected to be less than next season’s maximum allowed flood control Safety of Dams criteria, releases may be shifted among project reservoirs to achieve the desirable carryover objective at individual reservoirs, given all the CVP’s operational objectives.

Water temperatures in CVP reservoirs vary by geographic location, time of the year, depth of water, and temperature stratification characteristics of the reservoirs. Water temperatures in high-altitude reservoirs are typically lower than at reservoirs at low altitudes and are less affected by the of the ambient air. Also, reservoirs with a relatively low surface area per unit volume experience less warming than reservoirs with a larger surface in relation to volume.

Temperature stratification is more common in large reservoirs than in smaller reservoirs and occurs when deep water is cooler than water at or near the surface. Stratification most commonly occurs in the summer and fall and is generally absent in winter and spring. This presents a challenge to operations, when cool water is needed for releases during the summer and fall for downstream fisheries. CVP operators attempt to preserve cold water pools in Clair Engle, Shasta, and Folsom reservoirs for the benefit of salmon and steelhead in the Trinity, Sacramento, and American rivers.

Full, or nearly full, reservoirs provide optimal recreation opportunities. CVP operations staff attempt to achieve reservoir levels that maintain good recreation opportunities through the prime recreation season (Memorial Day through Labor Day).

To maximize the opportunity for power production, storage levels should be at the highest levels allowable to increase hydraulic head, and releases should not exceed the capacities of CVP powerplants. As described above, CVP operators often release water during the summer to avoid large releases at the end of the summer to achieve flood control storage limits. This practice increases electrical energy generation during the summer, but it also reduces electrical capacity by decreasing head. To the extent possible, CVP operators attempt to pass all releases through the powerplants. During flood operations, however, releases from CVP reservoirs often exceed powerplant capacities. Because power production is subordinate to other project purposes and obligations, CVP facilities are operated to optimize power only when more critical water operations would not be affected.

The quality of water released from CVP reservoirs is generally excellent. Releases from CVP facilities are made to maintain water quality conditions both instream and in the Delta in order to provide conditions consistent with fish and wildlife requirements and to protect M&I and agricultural beneficial uses.

Streamflow Criteria

Streams below CVP dams support both resident and anadromous fisheries. While resident fisheries are affected by release fluctuations, the anadromous fisheries (e.g., salmon and steelhead) are usually more sensitive and are present in some CVP streams year round. Maintaining water conditions favorable to spawning, incubation, rearing, and outmigration of the young anadromous fish is one of the main concerns of CVP operators. During spawning and incubation life stages, an attempt is made to establish project releases that can be sustained until the eggs hatch. If releases are reduced and the redds are dewatered, the eggs often may die. However, if the initial release levels are too low and large increases in flow are required, scouring of the channel can wash away the redd. CVP activities are coordinated to anticipate and avoid streamflow fluctuations during spawning and incubation whenever possible.

After the eggs have hatched and the juveniles are ready to begin the outmigration to the ocean, their migration can be assisted with increased flows, which can result from increased releases from

CVP and non-CVP reservoirs. Reclamation coordinates the operation of CVP reservoirs with DFG and the Service to schedule releases that create pulse flows to help "push" the fish downstream. Outmigration pulse flows are believed to reduce predation and minimize entrainment at Delta pumping plants.

In the management of releases prescribed by the COE for flood control, CVP operators have some latitude in controlling the magnitude and duration of the releases, based on concerns for downstream public safety and levee stability. Flood control releases are typically accomplished through a series of stepped increases defined by such factors as powerplant capability, minor flooding of adjacent lands, erosion, and channel capacity. Flood releases are established at the lowest step of the progression that will satisfy the requirements for evacuating storage, maximizing public safety, and minimizing the downstream effect of flood releases. When the threat of flooding subsides, releases are decreased according to specific rates prescribed by the COE to avoid sloughing of levee embankment materials and potential levee failure. Although high releases can effectively block access for fishing on the Trinity and American rivers and may make rafting on the American River unsafe, flood control operations and other constraints limit the opportunity to modify CVP operations strictly for recreation purposes.

Seepage can be a problem on the Sacramento and Stanislaus rivers but is typically not a concern on the Trinity or American rivers. During periods of prolonged elevated flows, which can result from flood control releases from CVP dams, downstream subsurface water can seep from the channel, causing high groundwater levels and sometimes surface-water flooding on adjacent lands. Prolonged periods of high groundwater in agricultural areas can diminish yield and can drown a crop. During wet years, seepage problems are difficult to avoid. To avoid exacerbating the situation in the Sacramento River Basin, imports of water from the Trinity River to the Sacramento River are minimized during periods of flood control releases unless public safety on the Trinity River is threatened.

Cold water conservation is particularly important during periods of drought, because water temperatures are higher when reservoir storage levels and streamflows are low, and warm water releases from reservoirs can have an adverse effect on reproduction of salmon. The SWRCB established temperature criteria in 1990 for the Sacramento River between Keswick Dam and the Red Bluff Diversion Dam. The RWQCB established water temperature criteria between Lewiston Dam and the confluence of the North Fork of the Trinity River.

In 1993, NMFS in formal consultation issued a Long-term Winter-Run Chinook Salmon Biological Opinion that specifies flow and temperature requirements in the Sacramento River and provides guidelines for the operation of CVP facilities. CVP operations meet Sacramento River temperature criteria by mixing Shasta Lake and Clair Engle Lake water and/or regulating quantities to be released.

Water Rights in the Delta

Riparian water rights in the Delta total approximately 1.3 million acre-feet annually. Monthly diversions typically follow a pattern of minimum diversions in the winter and maximum diversions in the summer. Use of water pursuant to these rights varies from year to year and peak in July at approximately 270,000 acre-feet per year. Releases from both CVP and SWP reservoirs are required to meet these diversions when uncontrolled runoff cannot satisfy them.

REGULATIONS AND AGREEMENTS THAT AFFECT CVP OPERATIONS

The operation of the CVP is, and has historically been, affected by the provisions of several regulatory requirements and agreements. Prior to the passage of CVPIA, the operation of the CVP was affected by SWRCB Decisions 1422 and 1485, and the Coordinated Operations Agreement (COA). Decisions 1422 and 1485 identify minimum water flow and water quality conditions at specified locations, which are to be maintained in part through the operation of the CVP. The COA specifies the responsibilities between the CVP and SWP for meeting the requirements of D-1485. Regulation and agreements that affect the operations of specific CVP facilities are discussed in a later section of this document.

Beginning in 1987, a series of actions by the SWRCB, EPA, NMFS, and the Service affected interim water quality standards in the Delta. However, at the time CVPIA was enacted (October, 1992), the water quality standard in the Delta remained D-1485, and the CVP and SWP were operated in accordance with the COA to maintain this requirement.

In 1993, NMFS in formal consultation issued a Long-term Winter-Run Chinook Salmon Biological Opinion, which addresses modifications to the long-term CVP operational plan to avoid jeopardizing the continued existence of the Sacramento River winter-run chinook salmon. Also in 1993, the Service released a biological opinion on the effects of operational actions by the CVP and SWP on Delta Smelt and associated habitat. This biological opinion was revised in 1994 and in 1995.

In December 1994, representatives of the State and Federal governments and urban, agricultural and environmental interests agreed to the implementation of a Bay-Delta protection plan through the California State Water Resources Control Board (SWRCB), in order to provide ecosystem protection for the Bay-Delta Estuary. The Draft Bay-Delta Water Control Plan, released in May 1995, superseded D-1485.

SWRCB Decision 1422

D-1422, issued in 1973 and SWRCB Order 83-3, issued in 1983, hereinafter collectively referred to as D-1422, provided the primary operational criteria for New Melones Reservoir on the Stanislaus River and included a provision for water quality conditions on the San Joaquin River at Vernalis. In addition, D-1422 permitted Reclamation to appropriate water in New Melones Reservoir for purposes of agricultural irrigation, M&I uses, fish and wildlife enhancement, flood control, and maintenance of water quality conditions on the Stanislaus River. A detailed discussion of D-1422, and its affects on the operations of New Melones Reservoir, is provided in the decision of Eastside Division facilities and operations.

SWRCB Decision 1485

In 1978, the SWRCB adopted D-1485 for protection of beneficial uses in the Delta and to outline the responsibilities of the two largest exporters in the Delta, the CVP and the SWP. The SWRCB concurrently issued a Delta Water Quality Control Plan (Delta Plan) and an Environmental Impact Report on the Delta Plan. The basis for the D-1485 and the Delta Plan is that water quality is to be maintained at least to a level that would have existed if the CVP and SWP were not implemented. D-1485 includes flow, water quality, and export standards to protect the beneficial uses in the Delta. These standards are implemented by the SWRCB by including them in the water rights permits of the CVP and SWP.

Because of the hydraulic characteristics of the Delta, some D-1485 standards are managed more efficiently through export curtailments, while others are managed more efficiently through flow increases. Typically, operations to meet the water quality standards specified by D-1485 and D-1422 result in Delta water quality conditions that satisfy the requirements specified in CVP contracts (known as the Tracy Standards).

Coordinated Operations Agreement

The CVP and SWP use the Sacramento River and the Delta as common conveyance facilities, and therefore the operations of both of these projects can affect water quality conditions in the Delta. The 1986 COA between Reclamation and the DWR established the rationale for the coordination of reservoir releases and Delta exports between the CVP and SWP. The COA defines conditions under which existing in-basin and in-Delta demands are met, and establishes shared responsibilities of the CVP and SWP in meeting these requirements. The purpose of the COA is to ensure that each project receives its share of the available water supply and bears its share of the joint responsibilities to protect beneficial uses. The COA was established based on the water quality objectives specified in D-1485, and serves as technical reference for review and modification of sharing principles if and when Delta standards are modified by the SWRCB or new facilities or projects affect the hydrologic conditions in the Delta.

Balanced water conditions are defined in the COA as periods when the two projects agree that releases from upstream reservoirs plus unregulated flows approximately equal the water supply needed to meet Sacramento Valley in-basin uses plus exports. During balanced conditions, the two projects share in meeting in-basin uses. Two sharing arrangements are possible under the COA, depending on whether water from upstream CVP/SWP storage is required to meet Sacramento Valley in-basin uses, or if water associated with non-CVP/SWP regulated flow plus unregulated flow into the Delta is available for export. When water must be withdrawn from reservoir storage to meet Sacramento Valley in-basin requirements, 75 percent of the water is provided by the CVP, and 25 percent is provided by the SWP. When water from non-CVP/SWP sources and unregulated flow into the Delta is available for export in the Delta, the sum of CVP storage gains, SWP storage gains, and the available flow for export in the Delta is apportioned on a 55 percent to CVP and 45 percent to SWP basis. The COA further specifies that if one party cannot use its share of available water, the other party may use the available water.

When the Delta is out-of-balance, i.e., the Delta has excess water under the COA, there is, by definition, sufficient water to meet all Delta beneficial use standards. The COA provides that under these conditions the CVP and SWP can store and export as much water as possible within physical and contractual limits.

Winter-Run Chinook Salmon Biological Opinion

In 1992, the NMFS, in formal consultation with Reclamation, issued a specific one-year biological opinion for the protection of Sacramento River winter-run chinook salmon. In 1993, NMFS in formal consultation issued a long-term Winter-Run Chinook Salmon Biological Opinion, which addresses modifications to the long-term CVP operational plan to avoid jeopardizing the continued existence of the Sacramento River winter-run chinook salmon. In the development of both of these opinions, NMFS coordinated with DWR, the Service, DFG, and the SWRCB.

As a condition of the 1993 Long-Term Biological Opinion, Reclamation maintains a minimum flow of 3,250 cfs in the Sacramento River below Keswick Dam from October 1 through March 31. This minimum instream flow is required to provide safe rearing and downstream passage of winter-run chinook salmon, and to protect against the stranding of juveniles. When drought conditions threaten human health and safety, NMFS would consider variation from this requirement through reconsultation on a case-by-case basis. Under such circumstances, NMFS would consider how well accretions from tributary streams would preclude stranding of juvenile fish under reduced flows.

In accordance with the Biological Opinion, Reclamation attempts to maintain the daily average water temperature in the Sacramento River at no more than 56 degrees Fahrenheit within the winter-run chinook salmon spawning grounds below Keswick Dam. This temperature is required because winter-run chinook eggs and pre-emergent fry require temperatures at or below 56 degrees Fahrenheit for survival during the late June through August incubation period. The time period and exact river location are dependent upon operational environmental conditions, as calculated by Reclamation. At times when Reclamation cannot maintain temperature at the desired location, NMFS reinitiates consultation.

The Biological Opinion specifies that, beginning in September 1994, gates at the Red Bluff Diversion Dam must be in the raised position between September 15 and May 14. This mode of operation results in reduced diversions to the Tehama-Colusa Canal during the spring, summer, and fall. On April 1, 1996, the SWRCB issued a water rights order permitting the release of up to 38,293 acre-feet annually from Black Butte Reservoir for re-diversion through the constant head orifice to the Tehama-Colusa Canal from April 1 to May 15, and from September 15 and October 29.

In accordance with requirements in the 1993 Long-term Winter-Run Chinook Salmon Biological Opinion, Reclamation maintains the DCC gates in the closed position from February 1 through April 30 to reduce the diversion of juvenile winter-run chinook salmon emigrants into the Delta. Studies by the Service have indicated that the diversion of juvenile chinook salmon into the central portion of the Sacramento-San Joaquin Delta via the DCC and Georgiana Slough has a significant adverse impact on their survival.

Bay-Delta Plan Accord

In December 1994, representatives of the State and Federal governments and urban, agricultural and environmental interests agreed to the implementation of a Bay-Delta protection plan through the California State Water Resources Control Board (SWRCB), consistent with a set of Principles for Agreement, to provide ecosystem protection for the Bay-Delta Estuary. The purpose of the Bay-Delta Plan Accord is to establish water quality control measures that contribute to the protection of beneficial uses in the Bay-Delta Estuary, including objectives for salinity, water project operations, and dissolved oxygen. The protected beneficial uses include M&I, agriculture, and fish and wildlife. The CVP and SWP are operated under the Bay-Delta Plan Accord as defined in SWRCB Order 95-06.

The May 1995 Draft Water Quality Control Plan (WQCP) includes water quality objectives for the reasonable protection of M&I uses from salinity intrusion. These objectives are year-type based maximum chloride concentration standards for various compliance locations within the Delta. Water quality objectives are also included for the reasonable protection of agricultural uses from salinity intrusion and agricultural drainage in the western, interior, and southern Delta. These objectives are year-type based maximum salinity concentration standards at various compliance locations within the Delta.

The WQCP also includes water quality objectives in the WQCP are for the protection of fish and wildlife uses in the Bay-Delta estuary. Objectives are established for dissolved oxygen, salinity, Sacramento and San Joaquin river flows, Delta outflow, export limits, and Delta Cross Channel gate operations. Delta outflow objectives are for the protection of estuarine habitat for anadromous fishes and other estuarine-dependent species. Sacramento and San Joaquin river flow objectives are to provide attraction and transport flows and suitable habitat for various life stages of aquatic organisms, including Delta smelt and chinook salmon.

Objectives for export limits are included to protect the habitat of estuarine-dependent species by reducing the entrainment of various life stages by the major export pumps in the southern Delta. An objective for closure of the Delta Cross Channel gates is included to reduce the diversion of aquatic organisms into the interior Delta where they are more vulnerable to entrainment by the major export pumps and local agricultural diversions.

In 1995, following release of the WQCP, NMFS issued an amendment to the long-term winter run chinook salmon biological opinion. The QWEST requirements in the NMFS opinion were converted to export/inflow ratios to give equivalent protection for winter-run chinook salmon. The Service issued a similar revision to the 1994 delta smelt biological opinion, and further determined that the long-term combined CVP and SWP operations as modified by the winter-run biological opinion, the Principles for Agreement and WQCP are not likely to jeopardize the continued existence of the delta smelt or modify the critical habitat for delta smelt.

OPERATIONS OF CVP DIVISIONS AND FACILITIES

The facilities included in CVP divisions north of the Delta, including the Trinity, Shasta, and Sacramento River divisions, are shown schematically in Figure II-15. These divisions are known collectively as the Northern CVP System. Facilities in CVP divisions south of the Delta are shown in Figure II-16. Of these, the Delta, West San Joaquin, and San Felipe divisions are known collectively as the Southern CVP System. Both the East Side and Friant divisions, also shown in Figure II-15, are operated independently of the remainder of the CVP, due to the nature of their water supplies and service areas. The Northern and Southern CVP Systems are operated as an integrated system, and demands for water and power can be met by releases from any one of several facilities. Demands in the Delta and south of the Delta can be met by the export of excess water in the Delta, which can result from releases from northern CVP reservoirs. As a result, operational decisions are based on a number of physical and hydrological factors that tend to change depending on conditions.

Trinity River Division

The Trinity River Division, completed in 1964, includes facilities to collect and regulate water in the Trinity River, as well as facilities to transfer portions of the collected water to the Sacramento River Basin. Specific facilities in the Trinity River Division include Trinity Dam and Powerplant; Clair Engle Lake; Lewiston Dam, Lake, and Powerplant; Clear Creek Tunnel; Whiskeytown Dam and Lake; Spring Creek Debris Dam and Reservoir; and the Cow Creek Unit.

Trinity Dam is located on the Trinity River and regulates the flow from a drainage area of approximately 720 square miles. The dam was completed in 1962, forming Clair Engle Lake, with a maximum storage capacity of approximately 2.4 million acre-feet per year. All releases from Trinity Dam are re-regulated downstream at Lewiston Lake to meet downstream flow, in-basin diversion, and downstream temperature requirements. Lewiston Reservoir provides a forebay for the trans-basin transfer of water through the Clear Creek Tunnel and the Judge Francis Carr Powerplant into Whiskeytown Lake on Clear Creek.

Water stored in Whiskeytown Lake includes exports from the Trinity River as well as runoff from the Clear Creek drainage area. Releases from Whiskeytown Lake are either passed through the Spring Creek Powerplant and discharged into Keswick Reservoir on the Sacramento River or released to Clear Creek to meet downstream flow and diversion requirements.

The mean annual inflow to Clair Engle Lake from the Trinity River is about 1.2 million acre-feet per year, a large percentage of which is diverted to the Central Valley. Clair Engle Lake is operated to satisfy required fishery releases to the Trinity River, while attempting to fill the lake by the end of June to maximize power production during the summer and fall. During the winter months, Clair Engle Lake storage is regulated within the capacity of Trinity, Lewiston, Spring Creek, Judge Francis Carr, and Keswick powerplants, as well as Reclamation's Safety of Dams criteria.

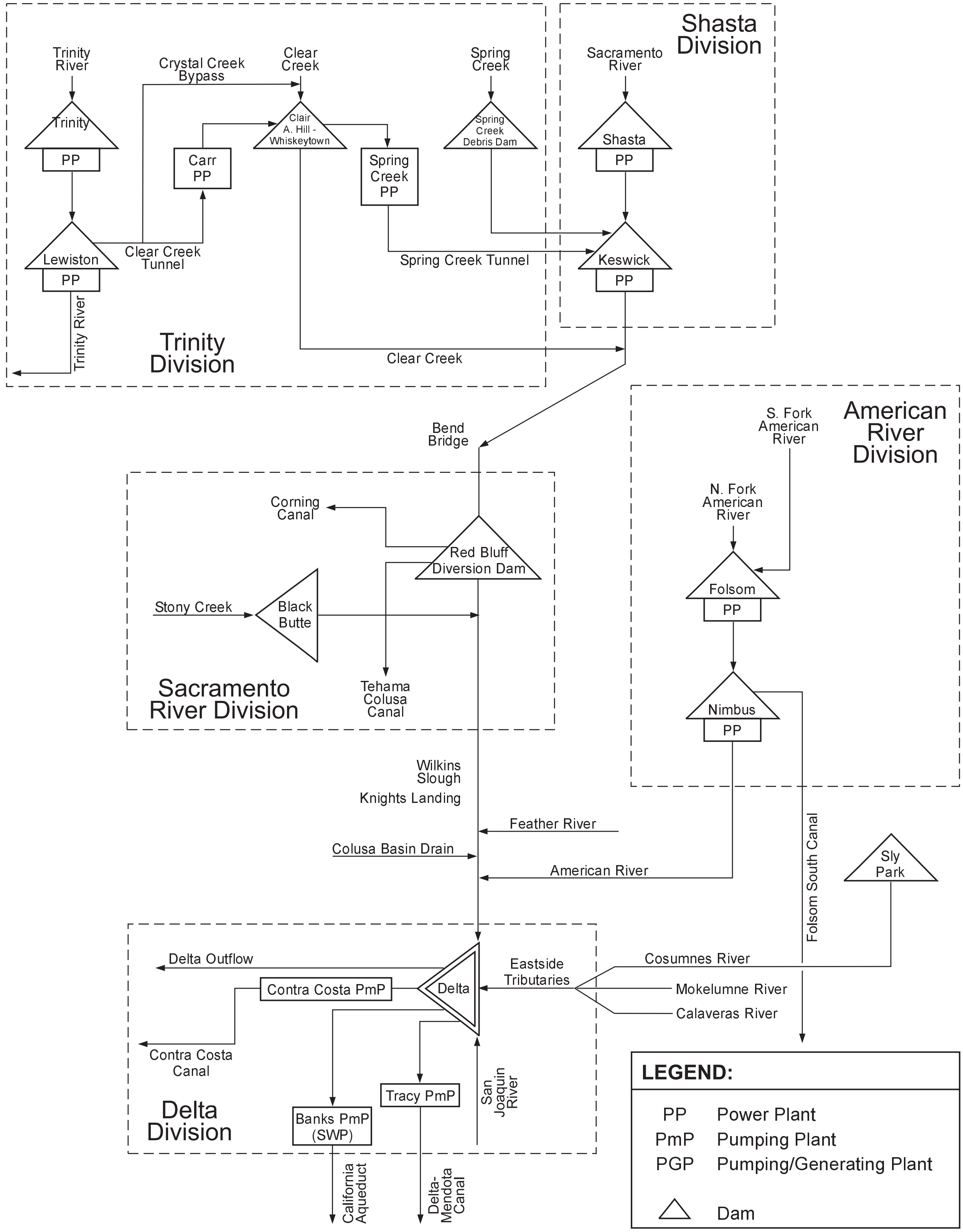


FIGURE II-15

CENTRAL VALLEY PROJECT FACILITIES NORTH OF THE DELTA

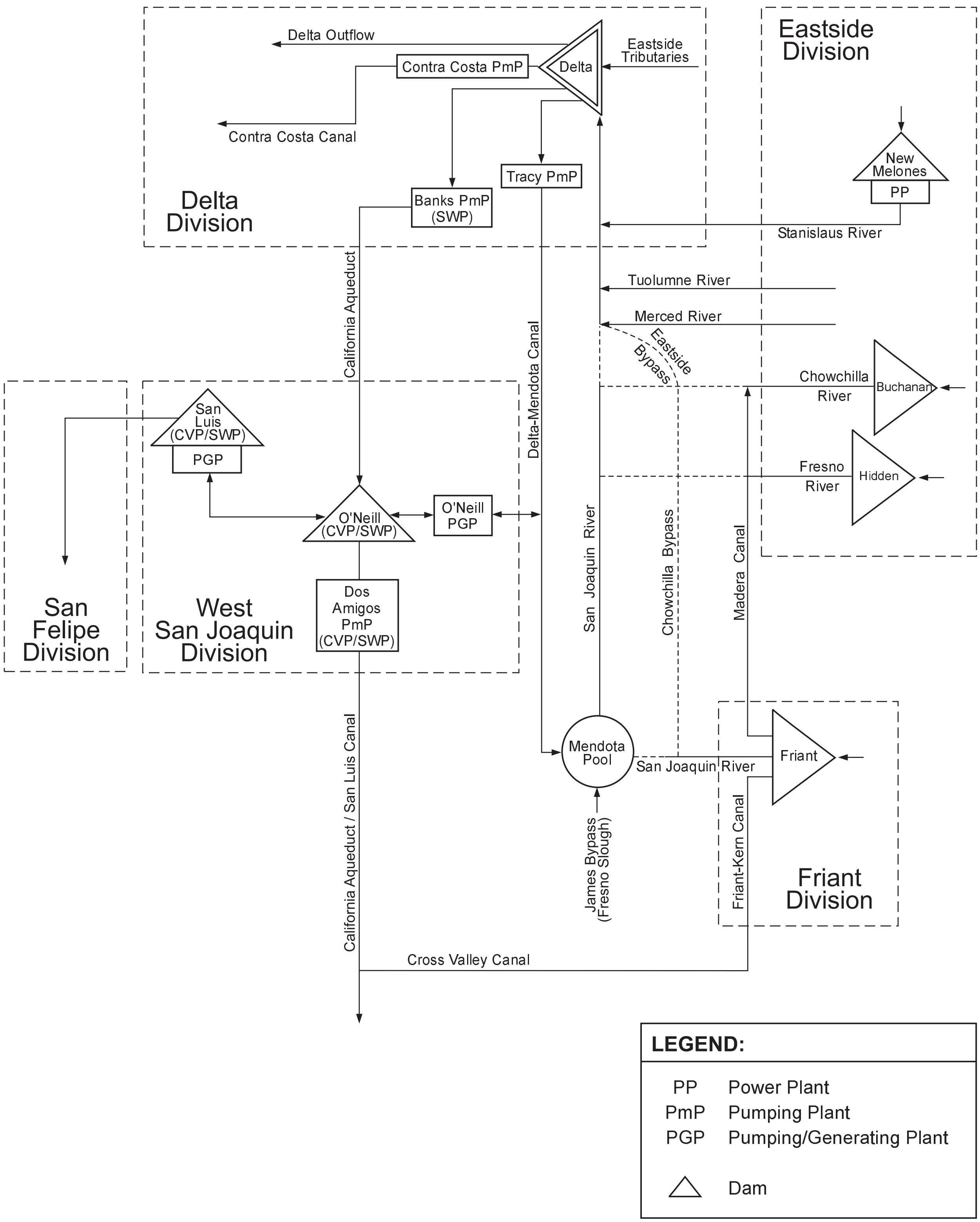


FIGURE II-16

CENTRAL VALLEY PROJECT FACILITIES SOUTH OF THE DELTA

Fish and Wildlife Requirements on the Trinity River. The Secretary of the Interior has authority under the Trinity River Act of 1955 to mitigate losses of fish resources and habitat. The legislation mandates that the operation of the Trinity Division be integrated and coordinated with the operation of other CVP features to realize the fullest, most beneficial, and most economic use of the water resources. When Trinity Reservoir began operations in 1963, total annual releases downstream from Lewiston Dam were to be at a minimum of 120,500 acre-feet per year Since 1963, salmon and steelhead runs in the Trinity River have severely declined.

On May 8, 1991, the Secretary of the Interior endorsed a position statement developed by the Assistant Secretaries for Fish, Wildlife, and Parks; Indian Affairs; and Water and Science. This position statement required releases from Lewiston Dam to the Trinity River flows as follows.

- in water year 1991, releases between 240,000 and 340,000 acre-feet per year, based on inflow into Shasta Lake and a ramping formula; and

- in water years 1992 through 1996, releases of at least 340,000 acre-feet per year in dry or wetter water years and 340,000 acre-feet per year in critical dry years, if possible.

Release schedules are developed annually in consultation with the Service, based on conditions as of February 1.

Temperature objectives for the Trinity River vary by reach and by season. Between Lewiston Dam and Douglas City Bridge, the daily average temperature cannot exceed 60 degrees Fahrenheit from July 1 to September 14 and 56 degrees Fahrenheit from September 15 to October 1. From October 1 to December 31, the average daily temperature cannot exceed 56 degrees Fahrenheit between Lewiston Dam and the confluence of the North Fork Trinity River.

Fish and Wildlife Requirements on Clear Creek. Water Rights permits issued by SWRCB for diversions from Trinity River and Clear Creek specify minimum downstream releases from Lewiston and Whiskeytown dams, respectively. Two agreements govern releases from Whiskeytown Lake.

- A 1960 Memorandum of Agreement (MOA) with DFG establishing the following minimum flows to be released to Clear Creek at Whiskeytown Dam.

January 1 through February 28,29	50 cfs
March. 1 through May 31	30 cfs
June 1 through September 30	0 cfs
October 1 through October 15	10 cfs
October 16 through October 31	30 cfs
November 1 through December 31	100 cfs

- A 1963 release schedule from Whiskeytown Dam developed and implemented (but never formalized) with the Service to enhance fishery and recreational values for the Whiskeytown National Recreation Area.

January 1 through October 31	50 cfs (normal year), and 30 cfs (critical year)
November 1 through December 31	100 cfs (normal year), and 70 cfs (critical year)

Hydropower. Power production as a result of cross-basin diversion of Trinity River water through Trinity powerplants is approximately three to five times as efficient as power production at Shasta and Sacramento River Division powerplants. Clair Engle Lake usually reaches its greatest storage level at the end of June annually. This allows the maximum volume and head possible can be used too generate power at the Trinity, Carr, and Spring Creek powerplants when it is most needed. This operation affects releases into Keswick Reservoir and therefore also affects Shasta operations.

Recreation. Though not an authorized purpose of the Trinity Division, recreational use of Clair Engle Lake, Lewiston Reservoir, and Whiskeytown Lake, and on the Trinity River is significant. Recreational considerations are factored into operational decisions that may result in abnormal reservoir levels or river flows. In general, the use of recreational facilities is typically constrained during dry or critically dry conditions only.

Flood Control. Flood control is not an authorized purpose of the Trinity River Division, although flood control benefits are provided through normal operations. Trinity Dam was not authorized for flood control and has limited release capacity below the spillway crest elevation. Studies completed by COE in 1974 and Reclamation in 1975 showed that the spillway and outlet works at Trinity Dam are not sufficient to safely pass the inflow design flood. Therefore, Safety of Dams criteria stipulate that drawdown and controlled filling of Clair Engle Lake are necessary to keep the storage from exceeding the total storage capacity. The regulation of storage is accomplished with releases that are within Trinity and Carr powerplant capacities and by minimizing releases to the Trinity River that exceed the requirements for fisheries.

A minimum storage reservation of 348,000 acre-feet per year is maintained in Clair Engle Lake from November through March. During a major flood, releases from Trinity Dam are restricted to the combined capacity of the powerplant and outlet works until a spill occurs. The release to the Trinity River at Lewiston Dam is reduced by diversions through Clear Creek Tunnel to Whiskeytown Lake, unless flood conditions on Clear Creek or on the Sacramento River require the diversion to be suspended.

Whiskeytown Lake is operated to maintain approximately 35,000 acre-feet per year of storage space during the flood season. Whiskeytown Lake operations during major floods are complicated by its relationship with the Trinity, Shasta, and Sacramento River operations. A number of specific operating guidelines have been developed to guide operations during this period.

Shasta and Sacramento River Divisions

The Shasta Division of the CVP includes facilities that conserve water on the Sacramento River for flood control, navigation maintenance, conservation of fish in the Sacramento River, protection of the Delta from intrusion of saline ocean water, irrigation and M&I water supplies, and hydroelectric generation. The Shasta Division includes Shasta Dam, Lake, and Powerplant; Keswick Dam, Reservoir, and Powerplant; and the Toyon pipeline.

The Sacramento River Division, which was authorized after completion of the Shasta Division, includes facilities for the diversion and conveyance of water to CVP contractors on the west side of the Sacramento River. The division includes the Sacramento Canals Unit, which was authorized in 1950 and consists of the Red Bluff Diversion Dam, the Corning Pumping Plant, and the Corning and Tehama-Colusa canals. The unit was authorized to supply irrigation water to over 200,000 acres of land in the Sacramento Valley, principally in Tehama, Glenn, Colusa, and Yolo counties. Black Butte Dam, operated by the COE, also provides supplemental water to the Tehama-Colusa Canal, as it crosses Stony Creek. The operations of Shasta and Sacramento River divisions are presented together because of their operational inter-relationships.
Shasta Dam is located on the Sacramento River at the confluence of the Sacramento, McCloud, and Pit rivers, and regulates the flow from a drainage area of approximately 6,649 square miles. The dam was completed in 1945, forming Shasta Lake, with a maximum storage capacity of 4,552,000 acre-feet per year. Water in Shasta Lake is released through or around the Shasta Powerplant to the Sacramento River, where it is re-regulated downstream by Keswick Dam. A small amount of water is diverted directly from Shasta Lake for M&I use by local communities.

Keswick Reservoir, formed by the completion of Keswick Dam in 1950, has a capacity of approximately 23,800 acre-feet per year and serves as an afterbay for releases from Shasta Dam, and for discharges from the Spring Creek Powerplant. All releases from Keswick Reservoir are made to the Sacramento River at Keswick Dam. The dam has a migratory fish trapping facility that operates in conjunction with the Coleman National Fish Hatchery on Battle Creek.

During the construction of Shasta Dam, the Toyon Pipeline was constructed to supply water from the Sacramento River to the camp used to house the workers at Toyon. The pipeline remains in use today, supplying municipal water to small communities in the area.

The Red Bluff Diversion Dam, located on the Sacramento River approximately 2 miles southeast of Red Bluff, diverts water to the Corning and Tehama-Colusa canals. Completed in 1964, the dam is a gated structure with fish ladders at each abutment. The gates are lowered during the spring to impound water for diversion, and raised in the fall to allow the river flow through. When the gates are lowered, the impounded water creates Lake Red Bluff. Since 1988, the dam gates have been raised during winter months to allow passage of the winter-run chinook salmon, and diversions have been made through a pilot pumping plant. Recently (after October 1992), at times when this pumping capacity was not adequate to meet water demands, some water has been made available from Black Butte Reservoir.

Construction of the Tehama-Colusa Canal began in 1965. The canal extends 113 miles southerly from the Red Bluff Diversion Dam to provide irrigation service on the west side of the Sacramento Valley in Tehama, Glenn, Colusa, and northern Yolo counties, and is operated by the Tehama-Colusa Canal Authority. The Corning Pumping Plant lifts water approximately 56 feet from the Tehama-Colusa Canal into the 21-mile-long Corning Canal. The Corning Canal was completed in 1959 to serve water to CVP contractors in Tehama County that cannot be served by gravity from the Tehama-Colusa Canal. A portion of the water delivered in the Tehama Colusa

Canal service area is provided through the South Canal, which conveys water released from the COE Black Butte Dam to Stony Creek.

Construction of the Temperature Control Device (TCD) at Shasta Dam was completed in 1997. This device is designed to allow greater flexibility in the management of cold water reserves in Shasta Lake while enabling hydroelectric power generation. The TCD is designed to enable releases of water from varying lake levels through the power plant to attempt to maintain adequate water temperatures in the Sacramento River downstream of Keswick Dam. Prior to construction of the Shasta TCD, reclamation had made releases from Shasta Dam's low-level powerplants bypass outlet to provide cooler water and alleviate high water temperature during critical periods of the spawning and incubation life stages of the winter-run chinook stock. Releases through the low-level outlets bypass the powerplant and result in a loss of hydroelectric generation at the Shasta Powerplant. Because the temperature control device was under construction during the preparation of the PEIS, there has been no operational experience to evaluate its effectiveness. For the purposes of the PEIS, it is assumed that the device will operate as designed, and will thereby allow Reclamation to more effectively meet the temperature requirements of the winter run chinook salmon biological opinion.

Fish and Wildlife Requirements on the Sacramento River. Reclamation operates the Shasta, Sacramento River, and Trinity River divisions of the CVP to meet, to the extent possible, the provisions of SWRCB Order 90-05 and the winter-run chinook biological opinion. Flow objectives in the Sacramento River had been previously established in an April 5, 1960 Memorandum of Agreement (MOA) between Reclamation and DFG, for the protection and preservation of fish and wildlife resources in the Sacramento River. The agreement provided for minimum releases into the natural channel of the Sacramento River at Keswick Dam for normal and critical dry years.

Historically, elevated water temperature in the upper Sacramento River has been recognized as a key factor in the decreasing population of chinook salmon stocks that inhabit the river. Temperature on the Sacramento River system is influenced by several factors, including the relative temperatures and ratios of releases from Shasta Dam and from the Spring Creek Powerplant. The temperature of water released from Shasta Dam and the Spring Creek Powerplant is a function of the total storage at Shasta and Clair Engle lakes, the depths from which releases are made, the percent of total releases from each depth, ambient air temperatures and other climatic conditions, tributary accretions and temperatures, and residence time in Keswick and Lewiston reservoirs, and in the Sacramento and Trinity rivers.

SWRCB Water Rights Orders 90-05 and 91-01. In 1990 and 1991, SWRCB issued Water Rights Orders 90-05 and 91-01 modifying Reclamation's water rights for the Sacramento River. The orders include temperature objectives for the Sacramento River and state that Reclamation shall operate Keswick and Shasta dams and the Spring Creek powerplants to meet a daily average water temperature of 56 degrees Fahrenheit at Red Bluff Diversion Dam in the Sacramento River during periods when higher temperature would be harmful to the fishery. Under the orders, the compliance point may be changed when the objective cannot be met at the Red Bluff Diversion Dam. In addition, Order 90-05 modified the minimum flow requirements in the Sacramento River below Keswick Dam initially established in the MOA.

Since October 1981, Keswick Dam has been operated based on a minimum release of 3,250 cfs for normal years from September 1 through the end of February, in accordance with an agreement between Reclamation and DFG. This release schedule was included in Order 90-05, which maintains a minimum release of 3,250 cfs at Keswick Dam and Red Bluff Diversion Dam from September through the end of February in all water years except critical dry years. A summary of minimum flows below Keswick Dam for normal years and critical dry years, as specified in the MOA and modified by Order 90-05 is shown in Table II-4.

The 1960 MOA provides that releases from Keswick Dam from September 1 through December 31 are made with a minimum of fluctuation or change if protecting the salmon is compatible with other operations requirements. Releases from Shasta and Keswick dams are gradually reduced in September and early October during the transition from meeting Delta export and water quality demands to operating the system for flood control from October through December.

Reclamation usually attempts to reduce releases from Shasta and Keswick dams to the minimum fishery release requirement by October 15 each year and to minimize changes in releases from Keswick Dam between October 15 to December 31. Releases may be increased during this period to meet unexpected downstream needs, such as higher outflows in the Delta to meet water quality requirements or to meet flood control requirements. Releases from Keswick Dam may be reduced when downstream tributary inflows increase to a level that will meet flow needs. To avoid release fluctuations, the base flow is selected to achieve the desired target storage levels in Shasta Lake from October through December.

TABLE II-4

MINIMUM FLOW REQUIREMENTS ON THE SACRAMENTO RIVER BELOW KESWICK DAM

Period	MOA Normal Years	WR 90-05 Normal Years	MOA and WR 90-05 Critical Dry Years
January 1 through February 28	2,600 cfs	3,250 cfs	2,000 cfs
March 1 through August 31	2,300 cfs	2,300 cfs	2,300 cfs
September 1 through November 30	3,900 cfs	3,250 cfs	2,800 cfs
December 1 through December 31	2,600 cfs	3,250 cfs	2,000 cfs

Recreation. Although not an authorized purpose, recreational use of Shasta Lake is significant with the prime recreation season extending from Memorial Day through Labor Day. It is desirable to have Shasta Lake full by Memorial Day and no less than elevation 1,017 feet on Labor Day. This elevation corresponds to a drawdown of 50 feet below the top of the conservation pool and is just below the bottom of the flood control storage envelope. The drawdown rate varies but is typically high during July in response to irrigation demands and during August in response to irrigation demands and temperature control operations. Customary patterns of storage and release typically result in acceptable water levels during the prime recreation season. Storage typically peaks in May, and significant drawdown usually does not occur until July and August. During drought periods, recreation opportunities at Shasta Lake are reduced because of the drawdown required to meet CVP uses.

The seasonal operation patterns at Keswick Dam typically are sufficient to satisfy river recreation needs. During flood control operations, little recreational use occurs along the river. In the spring and fall, marinas in the Sacramento area have occasionally reported shallow water problems at low flows.

Flood Control. Flood control objectives for Shasta Lake require that releases be restricted to quantities that will not cause downstream flows or stages to exceed specified levels. These include:

- a flow of 79,000 cfs at the tailwater of Keswick Dam
- a stage of 39.2 feet in the Sacramento River at Bend Bridge gauging station, which corresponds to a flow of approximately 100,000 cfs

Flood control operations are based on regulating criteria developed by the COE pursuant to the provisions of the Flood Control Act of 1944. Maximum flood space reservation is 1.3 million acre-feet per year, with variable storage space requirements based on the current flood hazard. Flood control operations at Shasta Lake require forecasts of flood runoff both upstream and downstream from Shasta as far in advance as possible.

The most critical CVP flood forecast for the Sacramento River is that of local runoff entering the Sacramento River between Keswick Dam and Bend Bridge. The travel time required for release changes at Keswick Dam to affect Bend Bridge flows is approximately 8 to 10 hours. If flow at Bend Bridge is projected to exceed 100,000 cfs, the release from Keswick Dam is decreased so that the 100,000 cfs flow at Bend Bridge is not exceeded. As the flow at Bend Bridge is projected to recede, the Keswick Dam release is increased to evacuate water stored in the flood control space at Shasta Lake. Changes to Keswick Dam releases are scheduled to minimize rapid fluctuations in the flow at Bend Bridge.

Navigation Minimum Flow. Historical commerce on the Sacramento River resulted in the requirement to maintain minimum flows of 5,000 cfs at Chico Landing to support navigation. There is currently no commercial traffic between Sacramento and Chico Landing, and the COE has not dredged this reach to preserve channel depths since 1972. However, over time, water users diverting from the river have set their pump intakes just below this level. Therefore, the CVP is operated to meet the navigation flow requirement of 5,000 cfs at Wilkins Slough under all but the most critical water supply conditions to facilitate pumping.

Seepage and Drainage Problems in the Sacramento River. Reclamation has completed numerous studies, concluding that high stages in the river can result in seepage flow under levees. While other factors, including flood-plain topography and stratigraphy, can influence seepage, the height and duration of the river stage above the level of the adjacent land are major contributors to the extent and severity of the seepage. Because the operations of Shasta and Keswick dams regulate a substantial portion of flow in the Sacramento River, these operations can affect seepage potential. In most years, Shasta Dam operations provide some degree of seepage control. However, because Shasta was not authorized specifically for controlling seepage, these benefits are considered incidental.

Widespread seepage damage might be expected to occur in those very wet years when inflow to Shasta Lake exceeds the 10-percentile level, particularly in years that have major flood events shortly before or during the irrigation season. When releases from Keswick Dam can be reduced in March and April to lessen seepage potential during those months, the threat of damage to crops is significantly reduced.

The effect of high flows in the Sacramento River can be intensified as a result of Trinity River Division operations. Because power is an authorized purpose of the CVP, and Trinity River Division in particular, diversions to the Sacramento River Basin are made when runoff cannot be stored in Clair Engle Lake. During the flood season, water is diverted to regulate storage in Clair Engle Lake while minimizing spills to the Trinity River. The diversion is minimized whenever the Sacramento River approaches or reaches flood stage, although during these periods the amount of water diverted from the Trinity River Basin is normally a small percentage of the total flow in the Sacramento River. If a spill is already occurring at Moulton and Colusa weirs, an increase in the release at Keswick Dam will have little impact downstream. If a spill is not occurring, the impact on increased stages will vary, depending on the width of the river channel. In exceptionally wet periods, the diversion is minimized during the spring as Clair Engle Lake is filled.

During September and October, farmers in the Sacramento Valley drain their rice fields. High stages in the Sacramento River can impede this drainage. The timing and amount of drainage flows entering the Sacramento River during rice field drainage is regulated by the RWQCB to limit the impact of pesticides and other chemical constituents in the drainwater. Drainage from the Colusa Basin Drain enters the Sacramento River near Knights Landing through a regulated outfall structure. When the Sacramento River is high, flows from the outfall structure can be restricted and water can back up in the drain causing flooding of agricultural lands.

Anderson-Cottonwood Irrigation District Diversion Dam Operations. The ACID Diversion Dam in Redding diverts water from the Sacramento River. Because this dam is a flashboard dam that is installed for seasonal use only, close coordination is required between Reclamation and ACID for regulation of river flows to allow safe installation and removal of the flashboards. ACID installs flashboards in the dam around April 1 each year and removes them around November 1. Installation and removal cannot be safely done when flows from Keswick Dam are greater than 6,000 cfs.

American River Division

The American River Division was authorized for construction by the COE and integration into the CVP by the American River Basin Development Act of 1949. The American River Division includes facilities that provide conservation of water on the American River for flood control, fish and wildlife protection, recreation, protection of the Delta from intrusion of saline ocean water, irrigation and M&I water supplies, and hydroelectric generation. Initially authorized features of the American River Division include Folsom Dam, Lake and Powerplant; Nimbus Dam, Powerplant and Lake Natoma; and the Sly Park Unit, which provides water from the Cosumnes River to EID. The Sly Park Unit includes Sly Park Dam, Jenkinson Lake, the Camino Conduit, and the EID Distribution System. The Auburn-Folsom South Unit of the American River Division was authorized in 1965 by Public Law 89-161 and includes the Foresthill Divide sub-unit and the Folsom South Canal. The Foresthill Divide sub-unit includes facilities for the storage and delivery of water to the town of Foresthill.

Folsom Dam was turned over to Reclamation for coordinated operation with other CVP facilities upon completion of construction by the COE in 1956. The dam and eight other dikes create Folsom Lake, with a total storage capacity of 972,000 acre-feet per year. Approximately 7 miles downstream, Nimbus Dam forms Lake Natoma, an afterbay used to re-regulate releases from Folsom Dam and to provide a diversion to the Folsom South Canal. The Folsom South Canal was designed to deliver water from Lake Natoma to M&I and irrigation users in Sacramento, San Joaquin, and Stanislaus counties. The first two reaches of the canal, extending to the Sacramento/San Joaquin county line just south of Highway 104, were completed in 1973. Construction of the remainder of the canal has been suspended pending reconsideration of alternatives. Releases from Nimbus Dam to the American River pass through the Nimbus Powerplant.

Fish and Wildlife Requirements on the American River. The Nimbus Fish Hatchery and the American River Trout Hatchery were constructed to compensate for the loss of riverine habitat caused by the construction of Folsom Dam. To help maintain natural fish production in the American River below Nimbus Dam, the American River Division facilities are operated to maintain minimum fishery flows and attempt to meet temperature objectives.

Releases from Nimbus Dam to the lower American River for minimum fish and recreation flows are variable, and are determined based on the available storage in Folsom Lake and hydrologic forecasting. This historical operational practice has been termed “Modified D-1400” operations because of the strategic desires to meet D-1400 minimum flow objectives when hydrologic conditions are supportive and to limit releases to D-893 minimum fish flow objectives during adverse hydrologic conditions. Minimum flows can range from 250 cfs in months with low Folsom Lake storage to 3,000 cfs in months with high Folsom Lake storage and hydrologic projections of ample runoff.

To provide stable flows for salmon spawning and incubation, fall flows in the lower American River are set in mid-October at a level that is expected to be maintainable, as a minimum, through February. Typically, fall and winter releases are set at levels between 1,000 cfs and 1,750 cfs, depending on Folsom Lake storage at the end of September and expected inflows from upstream reservoirs. These flows exceed current required minimum flows, as specified in D-893, which defines the current minimum flow on the American River at H Street to be 500 cfs from September 15 through December 31.

Temperature control problems are greatest at Folsom Lake, when the cold water pool is not large enough for either instream fishery needs or for the fish hatcheries downstream of Nimbus Dam. During some years, water temperatures are too high for both instream spawning and hatchery operations. When this occurs, hatchery production is transferred to other state hatcheries. Recently, operations of Shasta Dam to maintain required temperature conditions for the winter-run chinook salmon in the Sacramento River have reduced the operational flexibility to establish a substantial cold water reserve in Folsom Reservoir. This flexibility loss is particularly evident in dry years when efforts to create a cold water reserve at Shasta Lake during the spring results in lower-than-normal Keswick releases and higher-than-normal Nimbus releases to meet Delta obligations. Under this circumstances, Folsom storage in the fall may be lower than normal with a smaller cold water reserve and less capability to provide cold water releases.

Recreation. Both the lower American River and the lakes behind Folsom and Nimbus dams provide significant recreation opportunities, principally boating and fishing in the lakes and rafting and fishing in the river. If available water supplies allow, lake levels are maintained through Labor Day to provide access to boat launching ramps and marina facilities. In 1990, Folsom Lake was excavated in the vicinity of Brown's Ravine Marina to allow its use under lower storage conditions.

Flood Control. Flood control requirements and regulating criteria are specified by the COE and described in the Folsom Dam and Lake, American River, California Water Control Manual (COE, 1987).

From June 1 through September 30, no flood control storage restrictions exist. From October 1 through November 16 and from April 20 through May 31, reserving storage space for flood control is a function of the date only, with full flood reservation space required from November 17 through February 7. Beginning February 8 and continuing through April 20, flood reservation space is a function of both date and wetness.

In normal years, the focus of Folsom operations is on filling Folsom Lake near the end of May when flood control restrictions are lifted. In drier years, Folsom may be permitted to fill earlier as flood control restrictions are gradually eased.

Delta Division

Delta Division facilities provide for the transport of water through the Sacramento and San Joaquin rivers and the San Francisco Bay-Delta Estuary, and the conveyance of exported water through the San Joaquin Valley. The main features of the Delta Division are the Delta Cross Channel (DCC), the Contra Costa Canal, the Tracy Pumping Plant, and the Delta-Mendota Canal. Delta Division facilities are operated to supply water to CVP contractors served by the Contra Costa and Delta-Mendota canals. The Delta Division is also operated in conjunction with the SWP through the COA to meet the requirements of in-Delta riparian water rights holders and Delta water quality standards imposed by the SWRCB to protect beneficial uses of the Delta.

The DCC is a controlled diversion channel located between the Sacramento River and Snodgrass Slough, a tributary of the Mokelumne River in the Delta. Two gates control the flow of water from the Sacramento River through a short, excavated channel near Walnut Grove into the slough. From there it flows through natural channels in the central Delta to the Tracy Pumping Plant. The DCC gates are operated for water quality, fishery, recreation, and flood control purposes.

The Contra Costa Canal, one of the first CVP facilities, was completed in 1948. The canal was originally constructed to serve agricultural users in eastern and central Contra Costa County; however, urban growth and municipal demands have replaced nearly all of the original agricultural uses. As the uses of water changed, the canal was modified to improve service to contractors.

The Tracy Pumping Plant, completed in 1951, consists of an inlet channel, pumping plant, and discharge pipes that convey water from the Delta to the Delta-Mendota Canal. Fish salvaged at the Tracy Fish Screen, located in the intake channel, are transported by truck to release points at various locations in the Delta. The Delta-Mendota Canal, also completed in 1951, conveys CVP water from the Tracy Pumping Plant to the Mendota Pool on the San Joaquin River west of Fresno. The Delta-Mendota Canal operates at capacity for much of the year. The canal delivers water to San Joaquin River Exchange Contractors and CVP water service contractors in the San Joaquin Valley. A portion of the water conveyed through the Delta-Mendota Canal is pumped into the O'Neill Forebay and then into San Luis Reservoir. Water in San Luis Reservoir is held in storage to meet contract requirements for agricultural irrigation on the west side of the San Joaquin Valley and to deliver water to CVP contractors in the San Felipe Division.

Beneficial uses in the Delta are protected by the water quality standards of SWRCB Bay-Delta WQCP. DCC gate operations are also specified in the NMFS 1993 Long-term Winter-Run Chinook Salmon Biological Opinion. To accomplish these objectives, CVP and SWP operators must consider the current water supply and hydrologic conditions and current water quality conditions as well as potential impacts to fisheries, recreation, and power when making operational decisions. Operational actions to maintain Delta water quality are based on operational knowledge and past experience, current water quality and hydrodynamic conditions, and empirical studies. Operations are changed based on these data in an attempt to prevent non-compliance.

Delta Cross Channel Gate Operations. Closing the DCC gate increases the flow on the Sacramento River and can help meet downstream water quality standards. However, this action also reduces the amount of fresh water that passes south through the Delta toward the export pumping facilities. Without this additional water, reverse flow conditions can occur on the San Joaquin River, resulting in increased salinity intrusion near the Tracy Pumping Plant when the CVP and SWP export facilities are in operation. For this reason, the DCC gate can usually be closed for a couple of days only before deteriorating water quality on the San Joaquin River side of the Delta requires that it be reopened. In accordance with requirements in the 1993 Long-term Winter-Run Chinook Salmon Biological Opinion, Reclamation maintains the DCC gate in the closed position from February 1 through April 30 to reduce the diversion of juvenile winter-run chinook salmon emigrants into the Delta. Studies by the Service have indicated that the diversion of juvenile chinook salmon into the central portion of the Sacramento-San Joaquin Delta via the Cross Channel and Georgiana Slough has a significant adverse impact on their survival.

Tracy Pumping Plant Operations. The Tracy Pumping Plant, consisting of six constant speed units is operated to meet water demands south of the Delta. Changes in pump operations are typically performed early in the day to allow adequate time for operation and maintenance personnel to adjust check gates on the Delta-Mendota Canal during daylight hours. Partly because of the time involved in changing pump operations and the additional wear on the pumping units, frequent cycling of the units is normally avoided. The capacity of Tracy Pumping Plant is 4,600 cfs, which frequently unrealized because constraints along the Delta-Mendota Canal and at the relift pumps to O'Neill Forebay restrict export capacity to 4,200 cfs at that point.

West San Joaquin Division

The West San Joaquin Division of the CVP consists of the San Luis Unit, and includes federal as well as joint federal and State of California water storage and conveyance facilities that provide for delivery of water to CVP contractors in the San Joaquin Valley and in the San Felipe Division. Facilities in the West San Joaquin Division include San Luis Dam and Reservoir, O'Neill Dam and Forebay, the San Luis Canal, Coalinga Canal, Los Banos and Little Panoche detention dams and reservoirs, and the San Luis Drain.

San Luis Dam and Reservoir is located on San Luis Creek near Los Banos. The reservoir, with a capacity of 2.0 million acre-feet per year, is a pumped-storage reservoir primarily used to store water exported from the Delta. It is a joint federal and State of California facility that stores CVP and SWP water. Water from San Luis Reservoir is released to:

- the joint federal and state San Luis Canal to serve CVP and SWP contractors;
- through the Pacheco Tunnel to serve the San Felipe Unit of the CVP; and
- the Delta-Mendota Canal to serve CVP and exchange contractors on the east side of the San Joaquin Valley.

O'Neill Dam and Forebay are located on San Luis Creek downstream of San Luis Dam along the California Aqueduct. The forebay is used as a hydraulic junction point for state and federal waters. CVP water is lifted from the Delta-Mendota Canal to the O'Neill Forebay by the O'Neill Pumping-Generating Plant. CVP/SWP water from O'Neill Forebay is lifted to San Luis Reservoir by the joint CVP/SWP William R. Giannelli Pumping-Generating Plant. The forebay provides re-regulation storage necessary to permit off-peak pumping and on-peak power generation by the plant. When CVP water is released from O'Neill Forebay to the Delta-Mendota Canal, the units at the O'Neill Pumping-Generating Plant operate as generators.

The San Luis Canal, the joint federal and state (CVP/SWP) portion of the California Aqueduct, conveys water southeasterly from O'Neill Forebay along the west side of the San Joaquin Valley for delivery to CVP and SWP contractors. The Coalinga Canal conveys water from the San Luis Canal to the Coalinga area, where it serves the southern San Joaquin River Region. Water from the San Luis Canal is lifted at the Pleasant Valley Pumping Plant to the Coalinga Canal. Los Banos and Little Panoche detention dams and reservoirs protect the joint CVP/SWP San Luis

Canal by controlling flows of streams crossing the canal. These facilities do not supply water to the CVP or SWP.

The San Luis Drain was designed to carry agricultural return flows from collector drains along the west San Joaquin Valley and transport them to the Delta for discharge to the ocean, as specified in the authorization for the San Luis Unit. Initially the drain was planned as a joint state-federal facility; however, the state later declined to participate in the project. From 1975 to 1985, the San Luis Drain discharged to Kesterson NWR. During that time, selenium in soil sediments from upstream agricultural drainages was incidentally accumulated through biologic reduction at the Kesterson Reservoir. In 1982, the Service discovered high levels of selenium in fish collected from the reservoir. During the following year, waterfowl deformity was discovered at the reservoir. Subsequent investigations revealed that selenium concentrations were high in groundwater near the reservoir and in reservoir sediments, and the drain was closed. The operation of San Luis Drain ceased by June 1986, and the reservoir remains closed to drainage disposal. Reclamation began clean-up activities and waterfowl hazing shortly after the inflows to Kesterson ceased.

The management of San Luis Unit facilities is influenced by, and has substantial influence on, the management of northern CVP facilities. About half of the CVP's annual water supply is delivered through the Delta-Mendota Canal and San Luis Unit. To accomplish the objective of providing water to CVP contractors in the San Joaquin Valley, three conditions must be considered:

- water demands for CVP water service contractors and exchange contractors must be determined;

- a plan to fill and draw down San Luis Reservoir must be made; and

- plans for coordination of Delta pumping and San Luis Reservoir operations must be established.

State and Federal Coordination. The CVP operation of the San Luis Unit requires coordination with the SWP because some of the facilities are joint state and federal facilities. Similar to the CVP, the SWP also has water demands it must meet with limited water supplies and facilities. Coordinating the operations of the two projects avoids inefficient situations such as one entity pumping water into San Luis Reservoir at the same time the other is releasing water.

During spring and summer, water demands generally exceed the capability to pump water at these two facilities, and water stored in San Luis Reservoir is used. Because San Luis Reservoir has very little natural inflow, water is stored there when the Tracy and Banks pumping plants can export more water from the Delta than is needed for contracted water needs.

Adequate storage must be maintained in San Luis Reservoir to ensure delivery capacity to the San Felipe Division through the Pacheco Pumping Plant. During dry years when the SWP and CVP portions of San Luis storage are near their low points at generally the same time of the year, the water quality moving through the Pacheco Pumping Plant can create operation concerns.

San Felipe Division

The San Felipe Division provides CVP water to Santa Clara and San Benito counties, through conveyance facilities from San Luis Reservoir. Specific facilities include the Pacheco Tunnel and Conduit, the Hollister Conduit, San Justo Dam and Reservoir, Coyote Pumping Plant, and the Santa Clara Conduit. The Pajaro Valley, in southern Santa Cruz County, was originally authorized to receive irrigation water to reduce seawater intrusion caused by groundwater pumping. Although studies to reduce seawater intrusion and determine conveyance requirements have continued, facilities have not yet been constructed in the Pajaro Valley to receive the authorized water deliveries.

The Pacheco Tunnel and Pacheco Conduit convey water from the San Luis Reservoir to the upper ends of the Santa Clara and Hollister conduits. The Santa Clara Conduit conveys water primarily to urban service areas in the Santa Clara Valley. A portion of the water is delivered through the Santa Clara Conduit to local storage facilities, including Anderson Lake and Calero Reservoir. The Hollister Conduit conveys irrigation water to the Hollister service area.

Eastside Division

The Eastside Division of the CVP includes water storage facilities on the Stanislaus River (New Melones Dam, Reservoir, and Powerplant), Chowchilla River (Buchanan Dam and Eastman Lake), and Fresno River (Hidden Dam and Hensley Lake). These rivers drain the western slope of the Sierra Nevada and flow into the San Joaquin River. All of the dams and reservoirs in the Eastside Division were constructed by the COE. Upon completion in 1980, the operation of New Melones was assigned to Reclamation to provide flood control, satisfy water rights obligations, provide instream flows, maintain water quality conditions in the Stanislaus River and in the San Joaquin River at Vernalis, and provide deliveries to CVP contractors. Both Buchanan and Hidden dams are operated by the COE, and their operations are coordinated with CVP operations in the Friant Division to satisfy portions of the CVP contractual requirements on the Madera Canal.

The operating criteria for New Melones Reservoir are governed by water rights, instream fish and wildlife flow requirements, instream water quality, Delta water quality, CVP contracts, and flood control considerations. Water released from New Melones Dam and Powerplant is re-regulated at Tulloch Reservoir, an is either diverted further downstream at Goodwin Dam, or released from Goodwin Dam to the lower Stanislaus River. Flows in the lower Stanislaus River serve multiple purposes. These include provision of water for riparian water rights, instream fishery flow objectives, and instream DO. In addition water from the Stanislaus River enters the San Joaquin River, where it contributes to flow and helps to improve water quality conditions at Vernalis.

Requirements for New Melones Operations. D-1422, issued in 1973, provided the primary operational criteria for New Melones Reservoir, and permitted Reclamation to appropriate water from the Stanislaus River for irrigation and M&I uses. D-1422 requires that the operation of New Melones Reservoir include releases for existing water rights, fish and wildlife enhancement, and the maintenance of water quality conditions on the Stanislaus and San Joaquin rivers.

***Water Rights Obligations*.** When Reclamation began operations of New Melones Reservoir in 1980, the obligations for releases to meet downstream water rights were defined in a 1972 Agreement and Stipulation among Reclamation, OID, and SSJID. The 1972 Agreement and Stipulation required that Reclamation release annual inflows to New Melones Reservoir of up to 654,000 acre-feet per year of water for diversion at Goodwin Dam by OID and SSJID, in recognition of their water rights. Actual historic diversions prior to 1972 varied considerably, depending upon hydrologic conditions. In addition to releases for diversion by OID and SSJID, water is released from New Melones Reservoir to satisfy riparian water rights totaling approximately 48,000 acre-feet annually downstream of Goodwin Dam.

In 1988, following a year of low inflow to New Melones Reservoir, the Agreement and Stipulation among Reclamation, OID, and SSJID was superseded by an agreement that provided for conservation storage by OID and SSJID. The new agreement required Reclamation to release inflows of up to 600,000 acre-feet each year to New Melones Reservoir for diversion at Goodwin Dam by OID and SSJID. In years when inflows to New Melones Reservoir are less than 600,000 acre-feet per year, Reclamation provides all inflows plus one-third the difference between the inflow for that year and 600,000 acre-feet per year. The 1988 Agreement and Stipulation created a conservation account, in which the difference between the entitled quantity and the actual quantity diverted by OID and SSJID in a year may be stored in New Melones Reservoir for use in subsequent years, provided that the CVP contractors have received their supply in that year.

Instream Flow Requirements. Under D-1422, Reclamation is required to release up to 98,000 acre-feet per year of water per year from New Melones Reservoir to the Stanislaus, on a distribution pattern to be specified each year by DFG, for fish and wildlife purposes. In 1987, an agreement between Reclamation and DFG provided for increased releases from New Melones to enhance fishery resources for an interim period, during which habitat requirements were to be better defined, and a study of chinook salmon fisheries on the Stanislaus River would be completed. During the study period, releases for instream flows would range from 98,300 to 302,000 acre-feet per year. The exact quantity to be released each year was to be determined based on storage, projected inflows, projected water supply and water quality demands, and target carryover storage. Because of dry hydrologic conditions in the 1987 to 1992 drought period, the ability to provide increased releases was limited. In 1993, the Service published the results of the study which recommended a minimum instream flow on the Stanislaus River of 155,700 acre-feet per year (Service, 1993).

Water Quality Requirements. D-1422 requires that water be released from New Melones to maintain DO concentrations in the Stanislaus River. The 1975 revision to the Water Quality Control Plan established a minimum DO concentration of 7 mg/l, as measured on the Stanislaus River near Ripon.

D-1422 specifies that New Melones Reservoir be operated to maintain an average monthly level of conductivity, commonly measured as TDS, on the San Joaquin River at Vernalis, as it enters the Delta. The original permit specifies an average monthly concentration of 500 parts per million (ppm) TDS for all months. Historically, releases have been made from New Melones Reservoir for this standard, but due to shortfalls in water supply, Reclamation has not always been successful in meeting this objective. In the past, when sufficient supplies were not available to meet the water quality standards for the entire year, the emphasis for use of the available water was during the irrigation season, generally from April through September.

As part of Order 95-06, the operational water quality objectives at Vernalis were modified to include the irrigation and non-irrigation season objectives contained in the May WQCP. The revised standards are average monthly concentrations of 0.7 micromhos/cm conductivity (approximately 455 ppm TDS) during the months of April through August, and 1 micromhos/cm (approximately 650 ppm TDS) during the months of September through March.

Hydropower Operations. New Melones Powerplant operations began in 1979. Power generation occurs when reservoir storage is above the minimum power pool of 300,000 acre-feet per year. Reservoir levels are maintained, if possible, to provide maximum energy generation. Tulloch Reservoir, owned by OID and SSJID, serves as an afterbay for the New Melones Powerplant.

Flood Control. New Melones Reservoir flood control operation is coordinated with the operation of Tulloch Reservoir. The flood control objective is to maintain flood flows at the Orange Blossom Bridge at less than 8,000 cfs. When possible, however, releases from New Melones Dam are maintained at levels that would not result in downstream flows in excess of 1,500 cfs, because of seepage and flooding problems associated with flows above this level. Of the 2.4 million acre-feet per year storage volume of New Melones Reservoir, up to 450,000 acre-feet per year is dedicated for flood control, and 10,000 acre-feet per year of Tulloch Reservoir storage is set aside for flood control. Based upon the flood control diagrams prepared by COE, part or all of the dedicated flood control storage may be used for conservation storage, depending on the time of year and the current flood hazard.

CVP Contracts. Reclamation has entered into water service contracts for the delivery of water from New Melones Reservoir, based on a 1980 hydrologic evaluation of the long-term availability of water in the Stanislaus River Basin. Based on this study, Reclamation entered into a long-term water service contract for up to 49,000 acre-feet per year of water annually based on a firm water supply, and two long-term water service contracts totaling 106,000 acre-feet per year, based on an interim water supply. Because diversion facilities were not yet fully operational and water supplies were not available during the 1987 to 1992 drought, no water was made available from the Stanislaus River for delivery to CVP contractors prior to 1992.

Friant Division

The Friant Division includes facilities to collect and convey water from the San Joaquin River to provide a supplemental water supply to areas along the east side of the southern San Joaquin River Basin and the Tulare Basin. The delivery of CVP water to this region augments groundwater and local surface water supplies in an area that has historically been subject to groundwater overdraft. The Friant Division is an integral part of the CVP, but is hydrologically independent and, therefore, operated separately from the northern and southern CVP systems. The water supply to this division was made available through an agreement with San Joaquin River water rights holders, who entered into exchange contracts with Reclamation for delivery of water through the Delta-Mendota Canal. Major facilities of the Friant Division include Friant Dam and Millerton Lake, the Madera Canal, and the Friant-Kern Canal.

The Friant Division was designed to support the conjunctive use of surface water and groundwater that has long been a major component in the management of water supplies in the San Joaquin River and Tulare Lake basins. To support the management of conjunctive use, a two-class system of water service contracts is employed. Class I contracts relate to "dependable supply," typically assigned users with limited access to good quality groundwater. Class II contracts are generally held by water users with access to good quality groundwater that can be used during periods of surface water deficiency. Groundwater recharge and recharge/exchange agreements are frequently employed in the management of Class II water supplies (Friant Water Users Authority, n.d.).

Friant Dam and Millerton Lake are located on the San Joaquin River below a drainage area of approximately 1,630 square miles. With a capacity of approximately 0.5 million acre-feet per year, Millerton Lake diverts water north to the Madera Canal and south to the Friant-Kern Canal, and makes releases to the San Joaquin River to satisfy riparian water rights between the dam and Gravelly Ford.

The Madera Canal extends north from Friant Dam and Millerton Lake to Ash Slough of the Chowchilla River in Madera County. A portion of the water supply to the Madera Canal service area is supplied through the integrated operation of Hidden Dam on the Fresno River and Buchanan Dam on the Chowchilla River, which are included in the Eastside Division of the CVP.

The Friant-Kern Canal extends south from Friant Dam and Millerton Lake in Fresno County to Kern County near Bakersfield. Individual irrigation districts integrate CVP water supplies with water supplies from the Kings, Kaweah, Tule, and Kern rivers and through exchange agreements between Friant-Kern and Cross Valley canal contractors.

The annual water supply from the Friant Division is determined independently from other divisions of the CVP. On February 15 of each year, Reclamation provides contractors with an estimate of the water supply for the coming contract year based on hydrological conditions, water supply storage in upstream reservoirs, and assumptions based on statistical analysis of historic records.

Of the 0.5 million acre-feet per year capacity of Millerton Lake, up to 390,000 acre-feet per year is reserved for flood control storage (COE, 1975). Based upon the flood control diagram prepared by COE, part or all of the dedicated flood control storage may be used for conservation storage, depending on the time of year and the current flood hazard. Flood control operations of Millerton Lake are influenced by the storage available in upstream reservoirs.

Flood control releases from Millerton Lake may be used to satisfy portions of deliveries to the Mendota Pool Contractors and the San Joaquin River Exchange Contractors on the San Joaquin River below Mendota Pool. Millerton Lake operations are coordinated with operations of the Delta-Mendota Canal in the Delta Division to use all available Millerton Lake flood control releases before additional water is delivered to Mendota Pool. During wet hydrologic periods, overflow from the Kings River may enter the San Joaquin River Basin at the Mendota Pool through the Fresno Slough. This water is also used to meet demands at Mendota Pool. Flood control releases from Millerton Lake that exceed the requirements of the San Joaquin River Exchange Contractors are diverted into the Chowchilla Bypass, until flows in the Chowchilla Bypass reaches its capacity of 6,500 cfs. This diversion of flow helps avoid flooding of agricultural lands located in the floodplain along the San Joaquin River below Gravelly Ford.

CENTRAL VALLEY PROJECT WATER USERS

As indicated in the previous discussion, the CVP was constructed after many of the major water rights in the Central Valley had been established. In the development of the CVP, Reclamation entered into long-term contracts with some of these existing water rights to establish water delivery requirements. Therefore, CVP is operated to satisfy downstream water rights, meet the obligations of the water rights contracts, and deliver project water to CVP water service contractors.

A water right is a legal entitlement that authorizes the diversion of water from a particular source for beneficial use. All water rights are limited to amounts reasonably necessary for the intended use and do not extend to wasteful or unreasonable use or means of diversion. It is not an ownership of water, but the opportunity to share in the responsible development and beneficial use of a public resource. There are two major kinds of water rights: riparian rights that generally come with land bordering a water source, and appropriative rights that are granted by the SWRCB or its predecessors. Prior to the development of the CVP, existing water rights had been established on the Sacramento, American, San Joaquin, and Stanislaus rivers.

Many of the CVP water rights originated from applications filed by the state in 1927 and 1938 to advance the California Water Plan. After the federal government was authorized to build the CVP, those water rights were transferred to Reclamation; Reclamation made applications for the additional water rights needed for the CVP.

In granting water rights, the SWRCB sets certain conditions to protect prior water rights, fish and wildlife needs, and other prerequisites it deems in the public interest. Permits for CVP facilities include conditions requiring minimum flow below dams, and specify periods of the year when water may be directly diverted and periods when water may be stored at CVP facilities.

SACRAMENTO RIVER WATER RIGHTS CONTRACTORS

Sacramento River Water Rights Contractors are contractors who for the most part claim water rights on the Sacramento River. With the control of the Sacramento River by Shasta Dam, these water right claimants entered into contracts with Reclamation. Most of the agreements established a quantity of water the contractor is allowed to divert from April through October without charge and provided a supplemental CVP supply allocated by Reclamation.

SAN JOAQUIN RIVER EXCHANGE CONTRACTORS

San Joaquin River Exchange Contractors are CVP contractors who receive Project water from the Delta at Mendota Pool. Under the Exchange Contracts, the parties agreed to not exercise their San Joaquin River water rights in exchange for a substitute Project water supply from the Delta. These exchanges allow for water to be diverted from the San Joaquin River at Friant Dam under the water rights of the United States for storage at Millerton.

CVP WATER SERVICE CONTRACTS

Before construction of the CVP, many irrigators on the west side of the Sacramento Valley, on the east and west sides of the San Joaquin Valley, and in the Santa Clara Valley relied primarily on groundwater. With the completion of CVP facilities in these areas, the irrigators signed agreements with Reclamation for the delivery of CVP water as a supplemental supply. Several cities also have similar contracts.

CVP water service contracts are between the United States and individual water users or districts and provide for an allocated supply of CVP water to be applied for beneficial use. In addition to CVP water supply, a water service contract can include a supply of water that recognizes a previous water right. The purposes of a water service contract are to stipulate provisions under which a water supply is provided, to produce revenues sufficient to recover an appropriate share of capital investment, and to pay the annual operations and maintenance costs of the project.

Typical water service contracts include provisions that establish the following:

- the maximum quantity of water to be made available
- the types of water delivered, such a irrigation or M&I
- water shortage criteria
- acreage limitations
- water conservation requirements
- water and air pollution control regulatory requirements
- rate setting

Three types of water service contracts are used in the CVP as follows:

- Long-term contracts which have a term of more than 10 years. The Acts of July 2, 1956, and June 21, 1963, provide for renewal of these contracts at the request of the contractor.
- Short-term contracts which have a term of more than 5 but less than 10 years. Reclamation law does not provide for renewal of these contracts.

- Temporary contracts which have a term not to exceed 5 years. As with short-term contracts, these are no provisions within reclamation law for renewing temporary contracts.

Only long-term water service contracts are included in the PEIS analyses.

Some of the wildlife refuges in the Sacramento and San Joaquin valleys have long-term water service contracts for the delivery of water from the CVP. Annual deliveries under these contracts are subject to the same criteria used to determine deliveries to the CVP agricultural water service contractors.

Friant Division Contractors

The water supply that is developed by the Friant Division is made available in part through an exchange agreement with the Exchange Contractors who hold water rights on the San Joaquin River. Water from Millerton Lake is diverted north through the Madera Canal, and south through the Friant-Kern Canal. The Friant Division was designed to support the conjunctive use of surface water and groundwater that has long been a major component in the management of water supplies in the San Joaquin River and Tulare Lake basins. To support the management of conjunctive use, a two-class system of water service contracts is employed in the Friant Division.

Class I contracts are typically assigned to M&I users and agricultural districts with limited access to good quality groundwater. Class I water is available in most years and is considered to be a dependable supply.

Class II water is that supply available in addition to Class I water. Because of uncertainty in its annual availability and time of occurrence, it is not considered a dependable supply. Class II contracts are generally held by M&I and agricultural water users that have access to good quality groundwater that can be used during periods of surface water deficiency. Groundwater recharge and recharge/exchange agreements are frequently used in the management of Class II water supplies. Class II water is usually available in the full contract amount during wet years only. Class II water is taken on an as-available basis. On average only about 50 percent of the total contracted supply is available to contractors.

Cross Valley Canal Contractors

The Cross Valley Canal contractors are water users on the Friant-Kern Canal who receive water via an exchange made possible by DWR wheeling water through the SWP to the Cross Valley Canal. DWR diverts water for Reclamation from the Delta at the Banks Pumping Plant, through the California Aqueduct, and to the SWP’s portion of San Luis Reservoir. From San Luis reservoir, the water is conveyed via the San Luis Canal to the Cross Valley Canal turnout in Kern County, and delivered to Arvin Edison Water Service District. Arvin Edison Water Service District takes delivery of the Delta water, then “exchanges” water under contract with Reclamation from the Friant Division with other Reclamation contractors on the Friant-Kern Canal. The Cross Valley Canal contract is for an annual delivery of 128,000 acre-feet per year of water, depending on availability.

CRITERIA FOR WATER DELIVERIES TO CVP CONTRACTORS

The criteria for deliveries to CVP contractors consider available water supplies and superior obligations on the use of the available water. Decision-making criteria are similar within various units and divisions of the CVP. The criteria applicable to CVP contractors served by the North System (Trinity, Shasta, Sacramento River, and American River divisions) and the South System (Delta, West San Joaquin, and San Felipe divisions) are similar. The criteria applied to establish water delivery deficiencies in the Friant Division are somewhat different because this division is operated to provide water supplies for conjunctive use. In addition, the criteria for operations of New Melones Reservoir, and contract deliveries on the Stanislaus River, are affected by conditions unique to the Stanislaus River watershed.

Shasta Criteria

Shortage conditions for providing water to the Sacramento River Water Rights Contractors, the San Joaquin River Exchange Contractors, and the Mendota Pool Contractors are based on the "Shasta Criteria". The Shasta Criteria are used to establish when a water year is considered critical, based on inflow to Shasta Lake.

As defined by the Shasta Criteria, when inflows to Shasta Lake fall below specified thresholds, water year is critical, and water deliveries to the contractors may be reduced. A critical year is defined as one in which the full natural inflow to Shasta Lake for the current water year (October 1 of the preceding calendar year through September 30 of the current calendar year) is equal to or less than 3.2 million acre-feet per year. This is considered a single-year deficit. A critical year is also as one in which the accumulated difference (deficiency) between 4 million acre-feet per year and the full natural inflow to Shasta Lake for successive previous years, plus the forecasted deficiency for the current water year, exceeds 800,000 acre-feet per year.

Criteria for Deliveries to CVP Contractors in the North and South Systems

The criteria used to establish annual delivery amounts to CVP contractors served by the Sacramento River, American River, Delta, West San Joaquin, and San Felipe divisions is uniform. The following discussion does not apply to CVP contractors in the Friant and East Side Divisions. Criteria for annual water delivery quantities in these divisions are dependent on hydrologic and operational conditions unique to the individual divisions and are discussed in a subsequent section of this chapter.

Except in times of water shortages, the CVP makes available the amounts of water specified in the terms of its contracts in the CVP North and South systems. Water availability for delivery to the Sacramento River Water Rights Contractors is based on the Shasta Criteria which, as described above, reduces deliveries to 75 percent of the contract amount during critical years. Water availability for delivery to San Joaquin River Exchange Contractors and to Medota Pool Contractors is approximately based on the Shasta Criteria. Water availability for delivery to CVP water service contractors during periods of insufficient water supply is determined based on a combination of operational objectives, hydrologic conditions, and reservoir storage conditions. Reclamation is required to allocate shortages equally among water service contractors within the same service area, as individual contracts and CVP operational capabilities permit. In practice, agricultural contractors and some M&I contractors have received equal reductions in allocations during years of low water availability. Some M&I contracts prohibit the imposition of shortages until allocations to agricultural contractors are reduced by at least 25 percent.

The decision-making process for allocating the water supply available to CVP contractors involves comparing the forecasted conditions of reservoir storage and allocated water supply for the current year with the risks of potential impacts in the following water year or years. No formal rule or risk analysis exists upon which to make this decision. The process used during the recent years of drought conditions forms a basis for the current allocation decision process.

Soon after the beginning of the water year, the upcoming year's operations are forecasted on the basis of a range of assumed hydrologic and operations conditions. Generally, an initial array of operations forecasts is presented to Reclamation managers in December, updated by additional arrays prepared by January. These early forecasts may or may not include assumed water supply shortages, depending on reservoir storage existing at the time and the severity of the assumed hydrology of each forecast. The number of early forecasts developed may vary depending on the scope and complexity of the possible responses of the CVP to the range of operations conditions being examined. Because of widely varying weather conditions from year to year, no reliable forecasts of seasonal runoff are available before February.

Operations forecasts prepared before February are based on current storage conditions and an array of scenarios covering the reasonably expected range of runoff for the remainder of the season. These early operations forecasts provide direction for forecasting and a method of assessing current and future conditions and preliminary implications of alternative decisions. The operations forecasts provide monthly information on water allocations, reservoir storage, releases, electrical generation and capacity, Delta exports and inflows, and Delta outflow requirements. By developing an array of possible conditions, CVP operators and managers can evaluate potential problems in advance of the first official water allocations announcement, which is made by Reclamation on February 15.

The February 15 forecasts of runoff and CVP operations are used to develop the initial water allocations announcement for the current year. Agricultural contractors need to know what their minimal water supply will be as early as possible to support timely decisions regarding crop types, delivery schedules, water transfer possibilities, and other related issues. Water rights and exchange contracts require notification of shortages not later than February 15; no additional shortages may be imposed after that date. Other water service contractors generally have no such provisions in their contracts. Because of the uncertainty regarding the total available water supply, the February forecast of runoff and CVP operations must be based on a conservative prediction of spring and summer runoff. This approach minimizes the likelihood that the projected allocation to water service contractors would need to be further reduced in adverse hydrologic conditions. In some years, the allocations to CVP water service contractors have increased after the February announcement when improved hydrologic conditions increased the projections of runoff and reservoir carryover storage conditions. Similarly, in years initially categorized as critical under the Shasta Criteria, allocations to water rights and exchange contractors have been restored when the forecasted natural inflow to Lake Shasta increases to a non-critical level.

The February 15 water allocation decision reflects assessments of both total CVP reservoir storage upstream of the Delta and individual CVP reservoir storage. Because the integrated CVP operations focus on requirements in the Delta, the total storage available to meet these requirements is one measurement of water supply. Further, because the Delta requirements include limitations on CVP export operations, the forecasting process can be iterative to achieve the balance between storage and water delivery levels. Storage levels in individual reservoirs are subject not only to Delta water requirements but also to the geographical distribution of precipitation and runoff during the year, local demands, and minimum streamflow needs below each reservoir. Updated monthly operations forecasts, after the initial February 15 forecast, are used to identify both total and individual reservoir storage needs and impacts.

Criteria for Deliveries to CVP Contractors in the Friant Division

The determination of annual water supply from the Friant Division is done independently from other divisions of the CVP. On February 15 of each year, Reclamation provides Friant Service Area contractors with an estimate of the water supply for the coming contract year based on hydrological conditions, water supply storage in upstream reservoirs, and assumptions based on statistical analysis of historic records. This estimate is revised monthly throughout the contract year.

Criteria for Deliveries to CVP Contractors in the Eastside Division

Historically, Reclamation has had difficulty meeting all of the operational obligations on New Melones Reservoir. This difficulty became apparent during the period of 1987-1992 when New Melones Reservoir was drawn down to approximately 80,000 acre-feet per year in 1992. Numerous unanticipated operational factors influenced the drawdown of New Melones during this period. These include the severity of drought conditions from 1989 through 1992, the effect of water quality of return flows into the San Joaquin River on the ability to attain the water quality objectives, and low instream flows on the Merced and Tuolumne rivers. During the drought period, Stanislaus River stakeholder meetings were convened to coordinate operational objectives to manage the limited water supplies available.

STATE WATER PROJECT WATER USERS AND OPERATIONS

The SWP includes facilities to capture and store water north of the Delta, on the Feather River, and to deliver water to service areas in the Feather River Basin, the San Francisco Bay area, the San Joaquin Valley, the Tulare Basin, and Southern California. The major facilities of the SWP, as well as the extent of the SWP service area, are shown in Figure II-17.

The SWP operates four reservoirs in the Feather River Basin. Three relatively small reservoirs in the upper Feather River Basin in Plumas County include Lake Davis, Frenchman Lake, and Antelope Lake. These reservoirs are operated for recreational, fish and wildlife, and local water

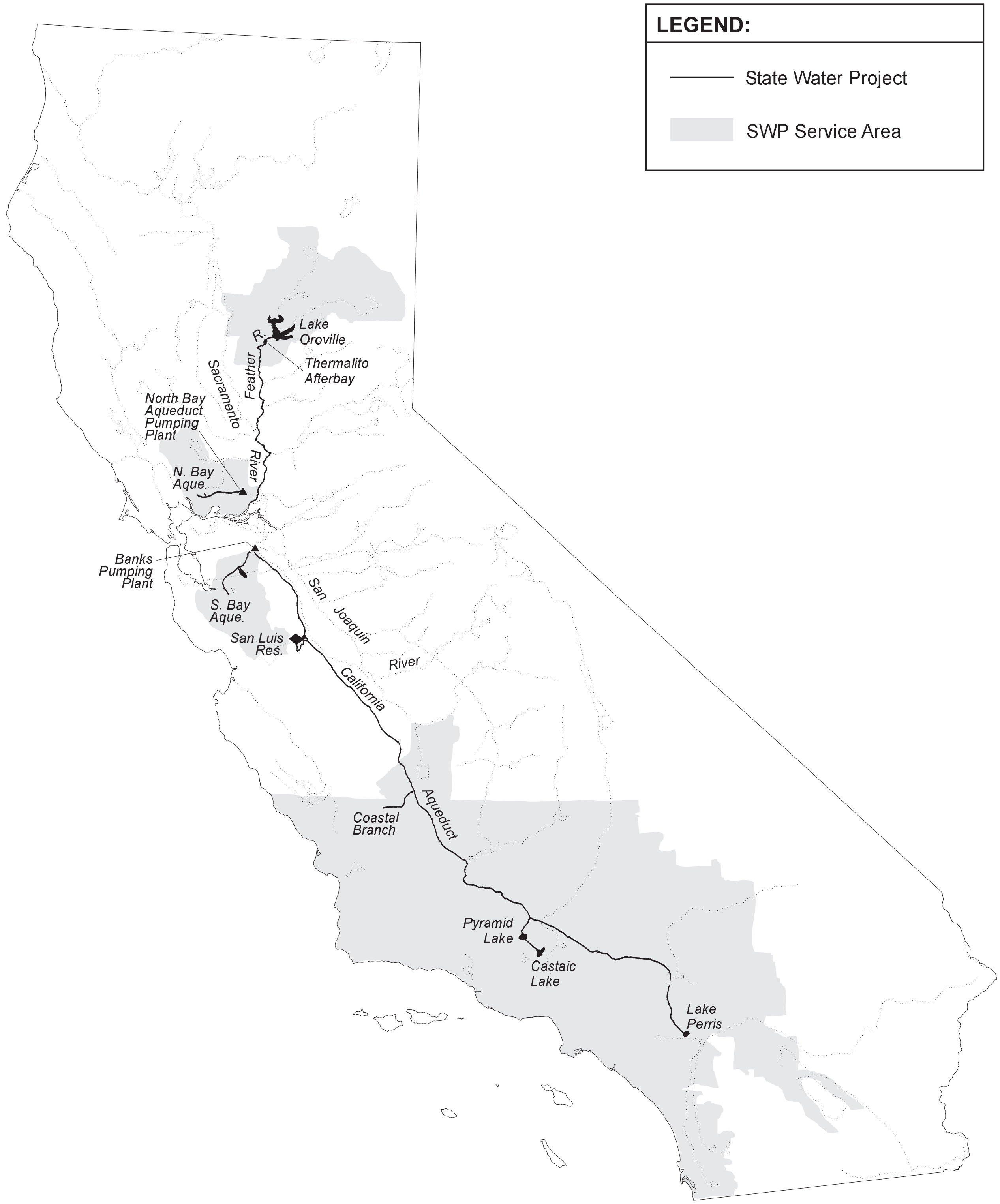


FIGURE II-17

STATE WATER PROJECT AND SERVICE AREAS

supply purposes. Farther downstream in the foothills of the Sierra Nevada is the multi-purpose Lake Oroville, the second largest reservoir in California, with a storage capacity of approximately 3.5 million acre-feet per year. Lake Oroville is used to conserve and regulate the flows of the Feather River for subsequent release to the Delta, where they can be diverted by various facilities of the SWP for delivery to contractors, or to provide salinity control against the intrusion of saline water from the ocean. Hydroelectric power production at Oroville represents a major source of revenue for the SWP. Oroville Dam and Lake Oroville also provide flood control for the protection of downstream communities and developed lands. Releases from Oroville Dam are re-regulated by the Thermalito Diversion Dam and Reservoir, completed in 1967, with a storage capacity of 13,000 acre-feet per year. This facility diverts the water released from Lake Oroville from the Feather River into Thermalito Forebay for use in power generation at the Thermalito Powerplant. Releases from the powerplant flow into the Thermalito Afterbay, for regulation of releases to the Feather River.

The North Bay Aqueduct diverts water from the north Delta near Cache Slough, which began operation of initial facilities in 1968. Construction of final facilities was completed in the mid-1980s. The North Bay Aqueduct which extends from Barker Slough to the Napa Turnout Reservoir in southern Napa County, conveys water for SWP entitlements and provides conveyance capacity for the City of Vallejo. The aqueduct serves agricultural and municipal areas in Napa and Solano counties, including Solano Irrigation District and the cities of Fairfield and Vallejo.

In the southern portion of the Delta, the Banks Delta Pumping Plant lifts water into the California Aqueduct from the Clifton Court Forebay. Clifton Court Forebay serves as a regulating reservoir for the pumping plant, allowing much of the pumping to occur at night when energy costs are lower. It also allows diversion from the Delta to be varied to minimize salinity intrusion. The John E. Skinner Delta Fish Protective Facility removes migrating fish drawn from the Delta with the pumping plant inflow.

The California Aqueduct is the state's largest and longest water conveyance system, beginning at the Banks Pumping Plant in the southwestern portion of the Delta and extending to Lake Perris south of Riverside, in Southern California. Bethany Reservoir, at the head of the California Aqueduct, provides an afterbay for discharges from the Banks Delta pumps and serves as a regulating reservoir for the California and South Bay aqueducts. The South Bay Aqueduct delivers water to urban and agricultural areas in the Santa Clara and Livermore-Amador valleys. Water in the California Aqueduct flows to O’Neill Forebay, which marks the beginning of the federal-state joint-use facilities. At the O'Neill Forebay, part of the flow is lifted through the William R. Giannelli Pumping-Generating Plant to the joint CVP/SWP San Luis Reservoir for offstream storage. From O’Neill Forebay, the joint-use portion of the aqueduct extends south to the Kettleman City area. From the Dos Amigos Pumping Plant near Kettleman City, the water flows to the southern end of the San Joaquin Valley, where it is pumped over the Tehachapi Mountains to the South Coast Region by the Edmonston Pumping Plant.

The initial facilities in the Coastal Branch of the California Aqueduct consist of a 15-mile-long canal and two pumping plants, constructed as part of the SWP. These initial facilities extend from the California Aqueduct in southwestern Kings County to western Kern County near Devils Den.

Construction of facilities to complete the Coastal Aqueduct is now underway. The Coastal Aqueduct is being extended to the Santa Barbara area with the addition of an 87-mile pipeline. Several terminal storage reservoirs have been constructed in the South Coast Region, including Silverwood Lake, Lake Perris, Pyramid Lake, and Castaic Lake. These lakes are operated, independent of operations within the Central Valley, for the purposes of deliveries, flow regulation, and emergency storage. Power is generated at Castaic Lake.

STATE WATER PROJECT WATER USERS

Currently, the SWP has contracted a total of 4.23 million acre-feet per year of water for delivery in the San Joaquin River Region, the Central Coast Region, and the San Francisco and South Coast regions. Of this amount, about 2.5 million acre-feet per year is designated for the Southern California Transfer Area, nearly 1.36 million acre-feet per year to the San Joaquin Valley, and the remaining 0.37 million acre-feet per year to the San Francisco Bay Region, the Central Coast Region, and the Feather River area. Generally, deliveries to the San Joaquin River Region from the SWP have been near full contract amounts since about 1980, except during very wet years when the total contract amount was not required, and during deficient supply years. Deliveries to the South Coast Region have been at approximately 60 percent of the contract entitlement (DWR, 1994).

SWP Contract Entitlements

Contracts executed in the early 1960s established the maximum annual water amount (entitlement) that each long-term contractor may request from the SWP. The annual quantities, specified on Table A in DWR Bulletin 132 (Operation of the State Water Project annual reports) reflect each contractor's projected annual water needs at the time the contracts were signed. Every September, each contractor must submit a request to the DWR for water delivery for the next 5 years. (This request cannot exceed the contractor's Table A allocation.) These 5-year projections form the basis for SWP planning and operation studies in the upcoming year.

The SWP delivers water to agricultural and M&I water contractors based on criteria established in the Monterey Agreement, which provides for the application of equal deficiency levels to all contractors.

Allocation of water supplies for a given year is based on four variables:

- forecast water supplies based on the Sacramento River Index (the Sacramento River Index is the sum of measured runoff at four locations: Sacramento River near Red Bluff, Feather River inflow to Lake Oroville, Yuba River at Smartville, and American River inflow to Folsom Lake);
- amount of carryover storage in Oroville and San Luis reservoirs;
- projected requirement for end-of-year carryover storage; and
- SWP system delivery capability.

These criteria ensure that sufficient water is carried over in storage to protect Delta water quality the next year, to meet fishery requirements, and to provide an emergency reserve. Beginning in December each year, initial allocations of entitlement deliveries are determined based on the four criteria. Allocations are updated monthly until May, and more often if significant storms result in an increase in the Sacramento River Index.

Following is a chronology of the SWP water delivery allocation process.

- December. Initial allocations are made, based on operation studies using the four criteria and an assumed historical 90 percent accedence water supply. Accedence refers to the probability that a particular value will exceed a specified magnitude; for example, 90 percent accedence means the water supply will be exceeded 90 percent of the time.

- January and February. Allocations will not be reduced, even if water supply forecasts and operation studies indicate the initial allocation may be too high. Allocations may be increased if the water supply forecast (99 percent accedence) and operation studies show delivery capability to be greater than forecast the month before.

- March. Allocations will be reduced if the supply is less than forecast in December. Allocations can be increased based on forecasted 99 percent accedence water supplies.
- April and May. Allocations will not be reduced further unless operational storage and forecast runoff (99 percent accedence) indicate carryover conservation storage will fall below targeted minimums. Increases in water delivery allocations can be made based on improved 99 percent accedence forecasts and supportive operational studies. Final allocations are based on the May water supply forecast.

Feather River Settlement Contractors

The Feather River Settlement Contractors are water users who held riparian and senior appropriative rights on the Feather River. As the SWP was built, the state entered into contractual agreements with these existing water rights holders (e.g., water rights settlements). Most of these agreements established the quantity of water the contractor is permitted to divert under independent senior water rights on a monthly basis and outlined supplemental SWP supply allocated by the state. Contract shortages are applied based on hydrologic conditions and storage in Lake Oroville.

STATE WATER PROJECT OPERATIONS

The operation of the SWP is affected by D-1485, instream flow requirements on the Feather River, and pumping limitations at the Banks Pumping Plant. A discussion of D-1485 is provided in the description of operating criteria that affect the CVP and is not repeated in this section. A discussion of the remaining operational requirements of the SWP follows.

Feather River Minimum Instream Flows

Feather River minimum fish flow requirements are maintained per the August 26, 1983, agreement between DWR and DFG. In normal years these minimum flows are 1,700 cfs from October through March and 1,000 cfs from April through September, with lower minimum flows allowed in dry and critical dry years. Additionally, the maximum flow restriction of 2,500 cfs for October and November is maintained per the agreement criteria.

Banks Pumping Plants Limits

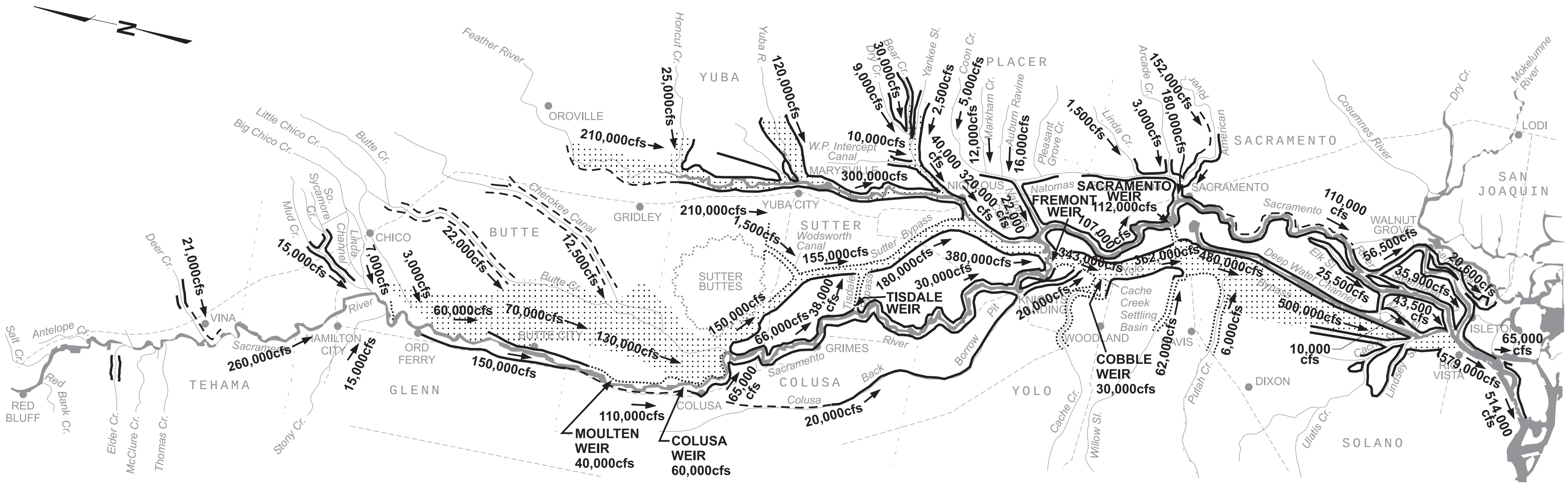
The Banks Pumping Plant is operated to meet demands south of the Delta. In October, November, April, August, and September, pumping capacity at the Banks Pumping Plant is 6,680 cfs. Between December 15 and March 15, pumping may be augmented above 6,680 cfs, depending upon flow in San Joaquin River at Vernalis per the COE's October 13, 1981, Public Notice criteria. In December and March, the augmented flows are 7,590 cfs, and in January and February the augmented flows are 8,500 cfs. A maximum of 8,500 cfs is assumed based on hydraulic constraints surrounding the pumps. Improvements south of the Delta that would allow the full 11-pump capacity of 10,300 cfs to be realized are assumed not to be in place. In May and June, D-1485 criteria for stripped bass survival reduces pumping capacity to 3,000 cfs. Additionally SWP pumping is limited to 2,000 cfs in any May or June in which storage withdrawals from Oroville Reservoir were required (per the January 5, 1987, Interim Agreement between DWR and DFG). In July, D-1485 criteria for striped bass survival reduces pumping capacity to 4,600 cfs.

FLOOD CONTROL IN THE CENTRAL VALLEY

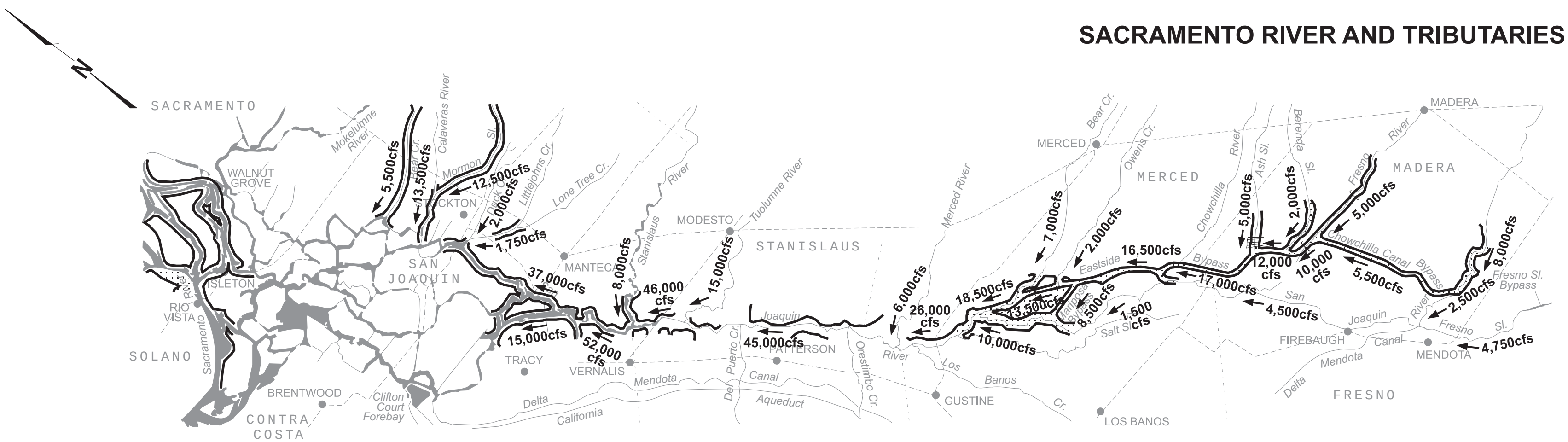
The COE is responsible for flood control in the State of California. In this capacity, the COE has developed operations and storage criteria for several reservoirs permitted for flood protection. Most of the water supply reservoirs potentially affected by CVPIA actions are permitted for flood protection, and are operated in accordance with flood control rules. Flood control operational criteria for CVP reservoirs is discussed in a previous section of this chapter.

In addition to reservoir storage criteria, the COE has determined flow capacities for various locations along major rivers and drainage areas in the Central Valley. Figure II-18 shows the flood channel design flow capacities for various locations along rivers in the Sacramento and San Joaquin valleys. Controlled releases of stored water from upstream facilities are limited to quantities that would not cause these design capacities to be exceeded. Historically, flood channel capacities have been exceeded at several of the shown locations, as a result of uncontrolled releases from upstream facilities and local runoff.

In addition to reservoirs, other flood control facilities in the Central Valley include the Sutter and Yolo bypasses, on the Sacramento River system and the Chowchilla and Eastside bypasses on the San Joaquin River system. These facilities provide bypass routing of excessive flows, and provide flood protection to downstream locations. Flows into these flood control facilities are regulated by weirs and gates, which are operated either by COE or local reclamation or levee districts.



SACRAMENTO RIVER AND TRIBUTARIES



SAN JOAQUIN RIVER AND TRIBUTARIES

- - - - Project Levees Maintained By Department of Water Resources, Sec. 12878 to Sec. 12878.45 of the Water Code.

.... Project Levees Maintained By Department of Water Resources, Sec. 8361 of the Water Code.

—— Project Levees Maintained By Reclamation, Levee, and Drainage Districts and Municipalities.

20,000cfs → Flood Channel Design Flows.

Source: CWR, 1985.

FIGURE II-18

FLOOD CHANNEL DESIGN FLOWS

CHAPTER III

ENVIRONMENTAL CONSEQUENCES

Chapter III

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter summarizes potential changes to the operation of CVP facilities, river flow regimes, and CVP water supply deliveries that would result from the implementation of the alternatives considered in the Draft PEIS. The Draft PEIS alternatives include a range of component CVPIA actions that would affect facility and river operations, as well as the availability of water supplies to CVP water users. These component CVPIA actions include the dedication of CVP water supplies toward meeting the target flows, the delivery of firm Level 2 refuge water supplies, and releases from Lewiston Dam to provide increased instream Trinity River flows. Additional actions include the retirement of land pursuant to the San Joaquin Valley Drainage Plan, and the acquisition of water from willing sellers for delivery to wildlife refuges, increased instream flows, and increased Delta outflow.

The chapter begins with a brief discussion of the impact assessment methodology used for analysis of the Draft PEIS alternatives, followed by a description of the assumptions and operational criteria used in the No-Action Alternative, which serves as the base condition for the Draft PEIS impact analysis. For each alternative, the objectives and CVPIA actions included in the alternative are presented along with model simulation results showing the re-operation of CVP facilities, SWP facilities, and local water supply project facilities towards accomplishing the goals of the alternative.

The analysis focuses primarily on the operation of surface water supply facilities, and describes changes in reservoir storage conditions, reservoir releases, resulting downstream river flows, deliveries of surface water pursuant to CVP and SWP contracts, and water acquisition quantities.

IMPACT ASSESSMENT METHODOLOGY

The impact assessment methodology used to support the analysis presented in this chapter is based on the use of surface water, groundwater, and agricultural economics computer model analyses. Model simulations were conducted at a planning level, in accordance with the programmatic nature of the overall Draft PEIS analysis. The Project Simulation Model (PROSIM) and the San Joaquin Area Simulation Model (SANJASM) were used to evaluate the potential to re-operate system reservoirs towards meeting CVPIA objectives, and assess the resulting impacts to CVP water supply deliveries.

The model simulations for the Draft PEIS analyses were conducted using the historical hydrology for the period 1922 through 1990, adjusted to be representative of a projected 2020 level of development. The projected land-use conditions were based on information developed for DWR Bulletin 160-93 (DWR, 1993) and are assumed to be constant over the simulation period. The historical hydrology for the 1922 through 1990 period is considered to be representative of the range of hydrologic conditions that may be expected under future CVP operations.

The models use a monthly time step and general operations criteria representative of CVP operations. The simulations do not take into account daily or weekly changes in operations, river travel time, or fluctuations in natural hydrology. A discussion of the specific approach, model modifications, and data development required to apply these analytical tools to the analysis of the alternatives in the Draft PEIS is provided in the PROSIM and SANJASM Methodology/Modeling Technical Appendices.

Subsequent to the completion of the surface water modeling conducted for the Draft PEIS, Reclamation and the Service have discovered an inconsistency in the PROSIM input hydrology that may cause the model to over estimate the potential flexibility of CVP operations. As a result, current PROSIM simulations may under estimate the use of CVP storage and conversely over estimate water deliveries in some critical dry years. This inconsistency affects all of the Draft PEIS simulations, including the No-Action Alternative, and has a minimal impact on the relative differences between the simulations. Therefore, there is little affect on the comparison of surface water issues in the Draft PEIS, due to the general programmatic nature of the Draft PEIS analyses and the comparative use of the PROSIM simulation results. However, this reduction in operational flexibility in the No-Action Alternative may make incremental reductions in water availability in the other alternatives more difficult to accommodate operationally.

NO-ACTION ALTERNATIVE

The No-Action Alternative provides a base condition for comparison of Draft PEIS alternatives analyses, and represents assumed future conditions at a projected 2022 level of development without implementation of CVPIA. As described in Chapter II of the Draft PEIS, the No-Action Alternative assumes that CVP facilities would be operated in accordance with operating rules and criteria that were in effect or being developed as of October 1992 when the CVPIA was adopted.

The No-Action Alternative assumes the continued implementation of the Bay-Delta Plan Accord and WR-95-01 because the process to develop the new Delta water quality standards was being implemented at the time CVPIA was enacted. Similarly, the No-Action Alternative includes the 1993 Winter-Run Chinook Salmon Biological Opinion as amended in 1995 by NMFS, because Reclamation had begun to operate to preliminary provisions of the 1993 biological opinion in October 1992. As described in the Affected Environment, requirements of the 1995 Delta Smelt Biological Opinion are fulfilled through meeting the operations requirements of the Bay-Delta Plan Accord, WR-95-01, and 1995 amendments to the Winter-Run Chinook Salmon Biological Opinion. On the Stanislaus River, it is assumed that the interim drought management actions implemented during the drought period from 1987 through 1992 do not constitute a long-term operational approach, and therefore could not be anticipated to represent operational conditions in the year 2022. Descriptions of the Bay-Delta Water Quality Control Plan, the Winter Run Biological Opinion, and the operations of New Melones Reservoir are provided in the description of the No-Action Alternative in Chapter II of the Draft PEIS.

For the purposes of the Draft PEIS No-Action Alternative, it is assumed that the COA, as described in Chapter II, would remain in place in the year 2022. The COA is the mechanism by which the CVP and SWP coordinate operations to meet Delta standards as defined by SWRCB Water Quality Control Plans. The current COA was developed based on the SWRCB D-1485 standards. Additional assumptions were required to adapt the COA to criteria included in the May 1995 Draft Water Quality Control Plan. In the analysis of Draft PEIS alternatives, it is assumed that total CVP and SWP exports would be reduced on an equal basis to meet monthly export/inflow ratios, and export limitations from April 15 through May 15. These assumptions do not necessarily reflect revisions to the COA that may occur at a future time. A detailed description of the assumptions regarding the COA and May 1995 Draft Water Quality Control Plan in the Draft PEIS analyses is presented in the PROSIM Methodology/Modeling Technical Appendix.

ALTERNATIVE 1

DESCRIPTION OF ALTERNATIVE

Water management provisions in Alternative 1 were developed to utilize two of the tools provided by CVPIA, 3406(b)(1)(B) Re-operation and 3406(b)(2) Water Management, toward meeting the target flows for chinook salmon and steelhead trout in the CVP-controlled streams. In the Draft PEIS, the term "(b)(2) Water Management" is used to indicate the integrated use of 3406(b)(1)(B) Re-operation and 3406(b)(2) Water Management. As described in Chapter II of the Draft PEIS, Alternative 1 also includes the use of CVP water to provide firm Level 2 water supplies to refuges, and the preliminary Trinity River instream fishery flow pattern developed by the Service for the Draft PEIS.

Under Alternative 1, the CVP would be operated in an attempt to increase September end-of-month storage in Shasta and Folsom lakes in order to provide increased reservoir releases in the fall into the Sacramento and American rivers as compared to the No-Action Alternative. Increased reservoir releases would also be made from Whiskeytown Lake to increase Clear Creek minimum flows year round, and from New Melones Reservoir to provide higher flows on the Stanislaus River to attempt to meet flow targets. Increased releases from Clair Engle Lake, to meet Trinity River instream fishery flows, would release the spring and summer diversions to the Sacramento River.

The combined implementation of (b)(2) Water Management, the increase to firm Level 2 refuge water supply deliveries, and the modified Trinity River pattern would affect CVP operations and would result in changes in deliveries to water service contractors. A brief description of each component of Alternative 1 is provided below.

PEIS (b)(2) Water Management

The goal of the PEIS (b)(2) Water Management analysis was to develop a simplified strategy for use in the Draft PEIS alternatives. The Draft PEIS analysis was purposely limited to a planning level evaluation, due to the many uncertainties associated with the prioritization, allocation, and accounting of (b)(2) water. The approach consisted of development of preliminary prescriptions designed to attempt to meet the target flows developed by the Service and presented in Attachment G-4 of the Draft PEIS. This simplified analysis was developed for the purposes of the Draft PEIS only. The formal Water Management Plan (WMP) process, involving Reclamation and the Service, will provide detailed evaluation of the use of (b)(2) water for incorporation into CVP operating prescriptions for Reclamation's Operations and Criteria Plan. A description of the development of the PEIS (b)(2) Water Management and associated assumptions is presented in Attachment G-2 of the Draft PEIS.

Firm Level 2 Refuge Water Supplies

Alternative 1 includes delivery of firm CVP water supply to 19 wildlife refuges. Diversion quantities would include additional water to provide for conveyance losses, which previously had often been provided by users that conveyed water to the refuges. The annual firm Level 2 refuge water supply amounts are presented in Table III-1.

Firm Level 2 annual refuge water supplies provide an additional 245,000 acre-feet per year above the Level 2 refuge water supplies delivered in the No-Action Alternative simulation. These increased refuge water supplies are subject to shortage criteria based on the Shasta Index, which imposes a maximum shortage of 25 percent. In wet, above normal, and some below normal water year types, there is often enough water to deliver the increased refuge water supplies without affecting deliveries to CVP Water Service Contractors. In dry and critical dry year types, increased deliveries to refuges may result in reduced deliveries to CVP Water Service Contractors.

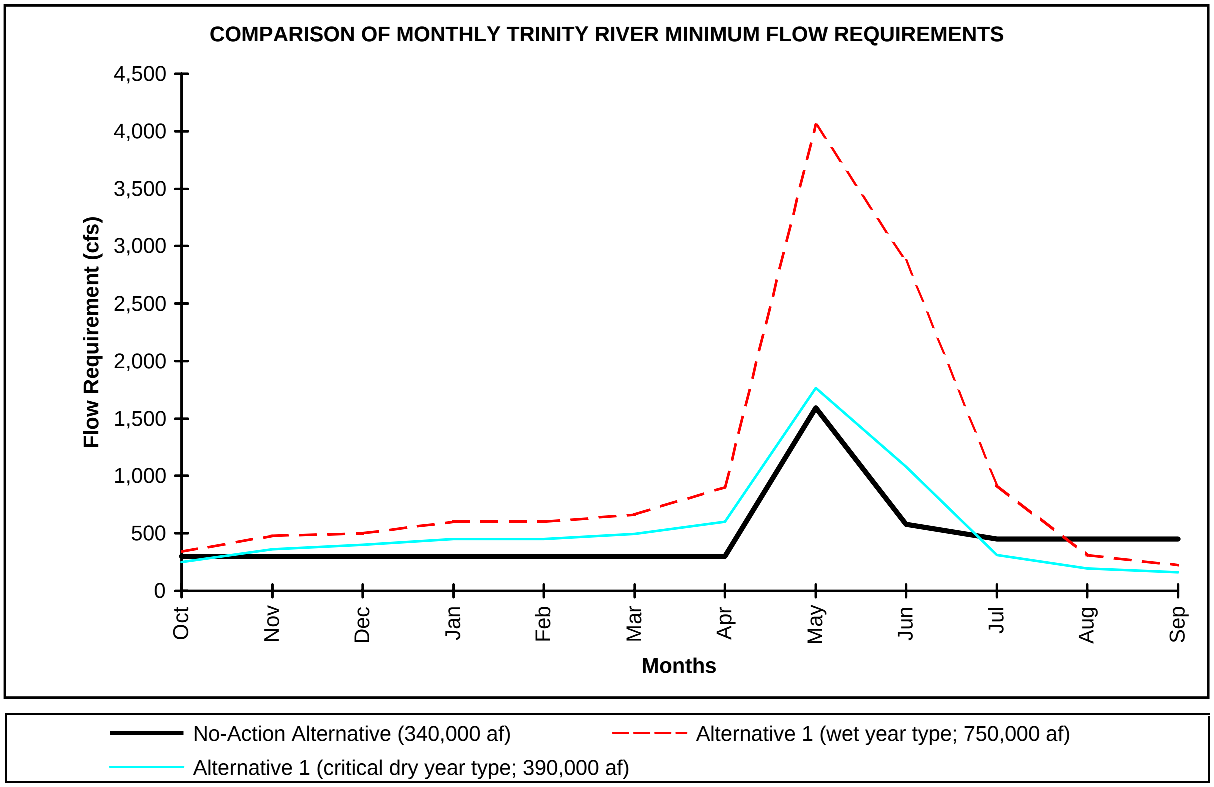
Trinity River Instream Fishery Flow Release Pattern

Alternative 1 assumes implementation of the restoration program. A revised preliminary Trinity River instream fishery flow pattern was developed by the Service for use in the Draft PEIS alternatives. The annual instream fishery flow releases range from 390,000 acre-feet per year in critical dry years to 750,000 acre-feet per year in wet years. The water year type index for these flow requirements is based on the annual inflow to Clair Engle Lake.

In the No-Action Alternative simulation, the Trinity River minimum instream flow volume is 340,000 acre-feet per year in all year types. The preliminary Alternative 1 instream fishery flow release pattern increases the annual release volume by 50,000 acre-feet per year in dry years and by 410,000 acre-feet per year in wet years. A monthly comparison of the No-Action Alternative and the Alternative 1 flow requirements for wet and critically dry year types is presented in Figure III-1.

TABLE III-1
ALTERNATIVE 1 FIRM LEVEL 2 REFUGE WATER SUPPLIES

Refuge	Firm Level 2 Water Supplies (1,000 acre-feet) At Boundary	Conveyance Loss	To Be Diverted	Notes
SACRAMENTO VALLEY REFUGES				
Sacramento NWR	46.4	15.5	61.9	Source: CVP. Conveyance loss on CVP water is 25 percent.
Delvan NWR	20.9	7.0	27.9	Source: CVP. Conveyance loss on CVP water is 25 percent.
Colusa NWR	25.0	8.3	33.3	Source: CVP. Conveyance loss on CVP water is 25 percent.
Sutter NWR	23.5	2.6	26.1	Source: CVP provides Level 2 through exchanges. Conveyance loss on CVP water is 10 percent.
Grey Lodge NWR	35.4	5.2	40.6	Source: Briggs-West Gridley Irrigation District provides Level 1. CVP through exchanges provides remaining Level 2. Conveyance loss on CVP water is 17 percent.
TOTAL FOR SACRAMENTO VALLEY REFUGES	**151.2**	**38.6**	**189.8**	
San Luis NWR	19.0	6.3	25.3	Source: CVP. Conveyance loss on CVP water is 15 percent.
Kesterson NWR	10.0	1.1	11.1	Source: CVP. Conveyance loss on 6,500 acre-feet of CVP water is 15 percent. No loss for 3,500 acre-feet due to delivery through Volta Wasteway.
Volta WMA	13.0	0.0	13.0	Source: CVP. No loss due to delivery through Volta Wasteway.
Los Banos WMA	16.6	2.8	19.4	Source: CVP. Conveyance loss on 10,500 acre-feet of CVP water is 21 percent. No loss for 6,200 acre-feet.
San Joaquin Basin Action Lands				
Freitas	5.3	1.8	7.1	Source: CVP. Conveyance loss on CVP water is 25 percent.
West Gallo	10.8	3.6	14.4	Source: CVP. Conveyance loss on CVP water is 25 percent.
Salt Slough	6.7	1.2	7.9	Source: CVP. Level 2 amount at boundary based on 67 percent of Level 4 amounts at boundary. Conveyance loss on CVP water is 15 percent.
China Island	7.0	1.2	8.2	Source: CVP. Level 2 amount at boundary based on 67 percent of Level 4 amounts at boundary. Conveyance loss on CVP water is 15 percent.
Grasslands Resource Conservation District	125.0	22.1	147.1	Source: CVP. Conveyance loss on CVP water is 15 percent.
Mendota WMA	27.6	0.0	27.6	Source: CVP contract. No losses due to delivery at Mendota Pool.
Merced NWR	15.0	5.0	20.0	Source: Merced Irrigation District in accordance with a FERC agreement. Conveyance loss on water is 25 percent.
East Gallo	8.9	2.9	11.8	Source: Merced River users. Conveyance loss on water is 25 percent.
Kern NWR	9.9	1.5	11.4	Source: CVP. Conveyance loss on CVP water is 13 percent.
Pixley NWR	1.3	0.0	1.3	Source: Well.
TOTAL FOR SAN JOAQUIN VALLEY REFUGES	**276.1**	**49.5**	**325.6**	
TOTAL FOR ALL REFUGES	**427.3**	**88.1**	**515.4**	



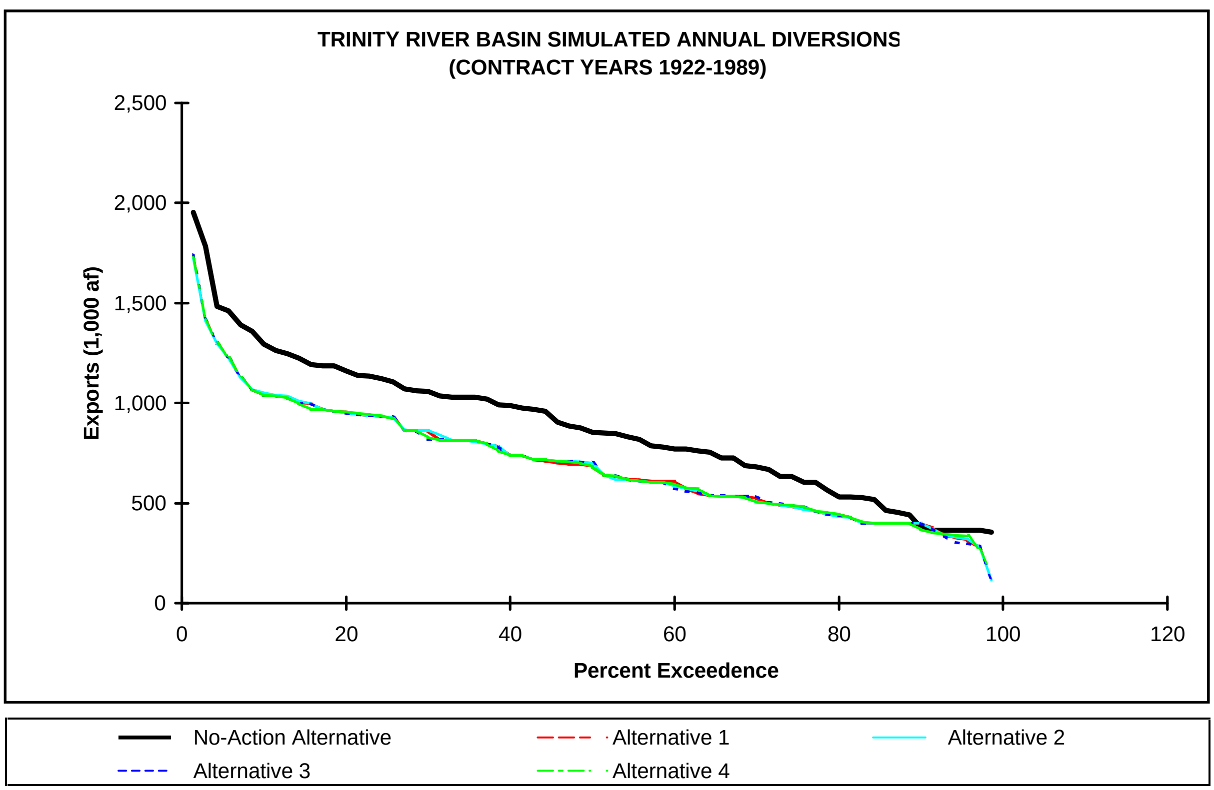


FIGURE III-1
TRINITY RIVER MINIMUM FLOW REQUIREMENTS AND SIMULATED ANNUAL EXPORTS

ALTERNATIVE 1 IMPACTS ON CVP OPERATIONS AND DELIVERIES

This section describes potential changes to the operation of CVP facilities, river flow regimes, and CVP water deliveries that would result from implementation of the CVPIA actions included in Alternative 1. All of the Draft PEIS computer model simulations and analyses were conducted at a programmatic level and are valid on a comparative basis only. A summary comparison of deliveries to CVP contractors in the Alternative 1 simulation, as compared to the No-Action Alternative simulation, is provided in Table III-2. A discussion of the impacts to SWP operations and SWP deliveries south of the Delta is provided in the next section.

TABLE III-2
COMPARISON OF CVP DELIVERIES IN THE ALTERNATIVE 1 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual CVP Deliveries (1,000 acre-feet)		Average Annual Change in CVP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 1	
1922 - 1990	Simulation Period	5,770	5,300	-470
1928 - 1934	Dry Period	4,560	4,050	-510
1967 - 1971	Wet Period	6,310	6,020	-290

Notes:
(1) CVP deliveries include deliveries to agricultural and M&I water service contractors, Sacramento River water rights contractors, other water rights contractors, San Joaquin Exchange Contractors. CVP deliveries do not include refuge water supplies.

CVP Operations

Trinity River Division. The major change specific to Trinity River Division operations in Alternative 1 is the incorporation of the instream fishery flow release pattern developed by the Service for the Draft PEIS. In Alternative 1, annual instream fishery flow releases range from 390,000 acre-feet per year in critical dry years to 750,000 acre-feet per year in wet years. Average flows down the Trinity River in Alternative 1 increase by about 190,000 acre-feet per year as compared to the No-Action Alternative. A comparison of the frequency distributions of simulated Clair Engle Lake end-of-water year storage for Alternative 1 and the No-Action Alternative is shown in Figure III-2. The increase in Trinity River flow releases in Alternative 1 reduces Clair Engle Lake average end-of-water year storage by about 200,000 acre-feet per year as compared to the No-Action Alternative. CVP Trinity River diversions to Whiskeytown Lake would be reduced by about 180,000 acre-feet per year on an average annual basis to attempt to balance the net demands on Clair Engle Lake. Frequency distributions of the simulated annual diversions from the Trinity River Basin in the No-Action Alternative and Alternative 1 are presented in Figure III-1. The overall reduction in Clair Engle Lake storage results from the increase in fishery flow releases in wetter years, and the low refill potential of the lake.

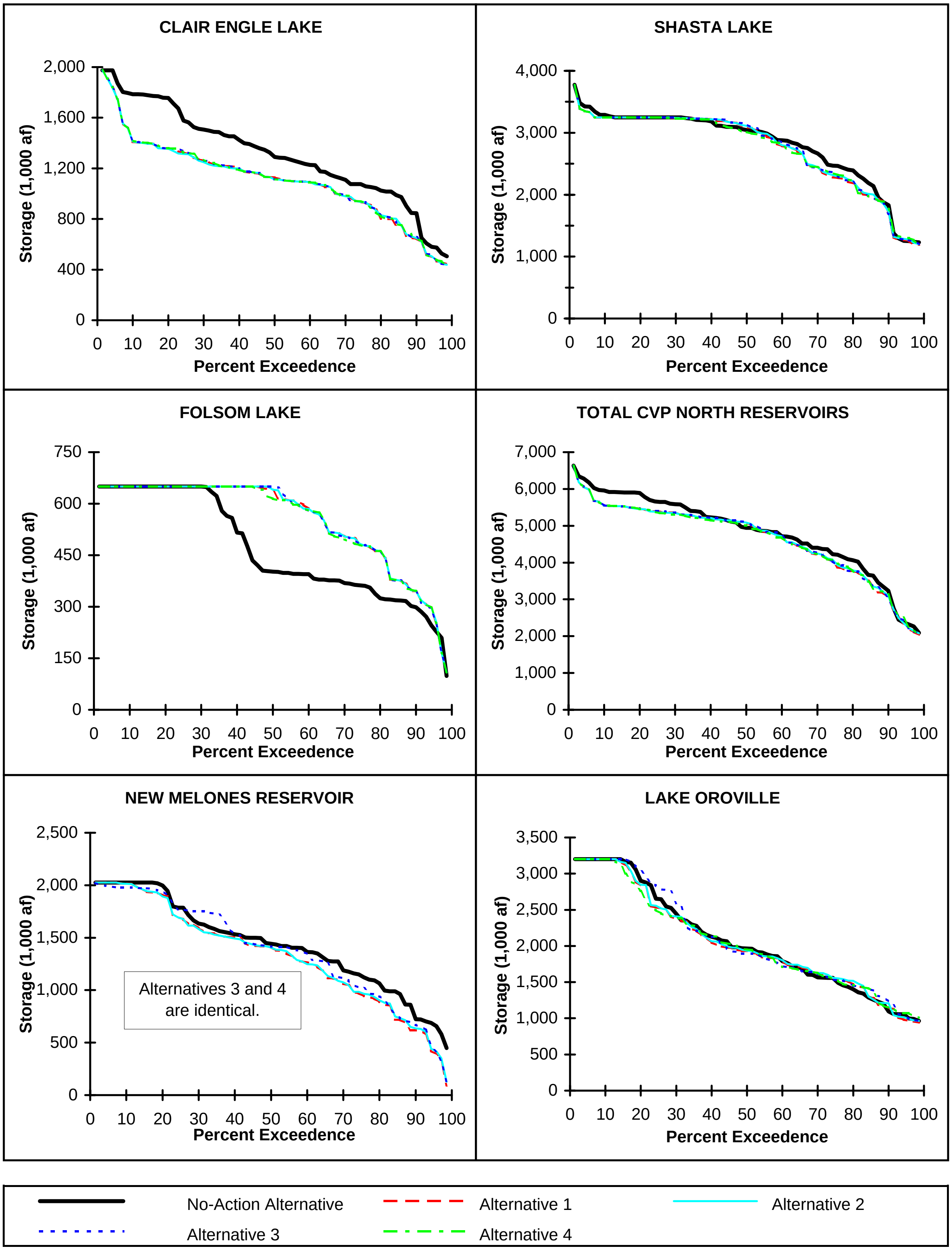


FIGURE III-2

SIMULATED FREQUENCY OF END-OF-WATER YEAR STORAGE 1922-1990

Alternative 1 includes use of (b)(2) water on Clear Creek to attempt to meet target flows. These target flows are achieved in all but critically dry years, when natural inflows to Whiskeytown Lake and diversions from the Trinity River Basin are not sufficient to maintain both the target flows and minimum storage levels in Clair Engle and Whiskeytown lakes. Figure III-3 shows the increase in simulated average monthly Clear Creek flows in Alternative 1 as compared to the No-Action Alternative. The average monthly flows are compared for the 69-year simulation period, as well as for critical dry and wet periods to show the range of Clear Creek flow variation. Figure III-4 shows the increase in simulated monthly Clear Creek flows for the critical dry period 1929 through 1934 and the wet period 1967 through 1971. The increase in flow would result in generally lower water temperatures as compared to the No-Action Alternative.

Shasta and Sacramento River Divisions. The Alternative 1 operations of the Shasta and Sacramento River divisions are affected by the multiple changes to CVP operations associated with (b)(2) Water Management, the delivery of firm Level 2 refuge supplies, and the increase in Trinity River instream fishery flow releases. The increase in Trinity River flow releases decreases the average annual diversions from the Trinity River Basin by about 180,000 acre-feet per year. This reduction of inflow to the Sacramento River requires increased releases from Shasta Lake during spring and summer months for Winter-Run Biological Opinion temperature requirements, downstream water rights, minimum navigational flow requirements, water service contractors, and Delta water quality requirements. During fall and winter months, Shasta releases must be increased to meet (b)(2) target flow and to supply water for export to San Luis Reservoir. The resulting decrease in Shasta Lake end-of-water year storage is shown in the comparison of frequency distributions for Alternative 1 and the No-Action Alternative in Figure III-2. The average annual reduction in Shasta Lake end-of-water year storage is about 60,000 acre-feet per year or 2 percent.

The reduced diversions from the Trinity River Basin under Alternative 1 require increased releases from Shasta Lake to meet the target flows and reduce the operational flexibility to meet winter-run temperature control requirements. This occurs because, although there are no target flows from May 1 through September 30, Shasta Lake releases are still required during this period to maintain water temperatures in the Sacramento River for winter-run chinook salmon. To the extent possible, releases from Shasta Dam during spring and summer months are shifted to the fall and winter months to meet target flows while maintaining summer water temperature levels. The October-through-April Keswick target flows are based on October 1 storage in Shasta Lake and are therefore achieved in all months. A comparison of flows in the Sacramento River below Keswick Dam, Figure III-5, shows that summer flows in Alternative 1 are lower than flows in the No-Action Alternative, and that fall and winter flows are generally similar. Simulated monthly flows in the Sacramento River below Keswick Dam for the dry period 1929 through 1934 and the wet period 1967 through 1971 are shown in Figure III-6. The October-through-April Keswick target flows are based on October 1 storage in Shasta Lake and are therefore achieved in 100 percent of the months.

The flexibility to meet winter run temperature control requirements in Alternative 1 is limited by the reduction in diversions from the Trinity River Basin. Reclamation's PROSIM and temperature models were run iteratively in an attempt to determine spring and summer Shasta

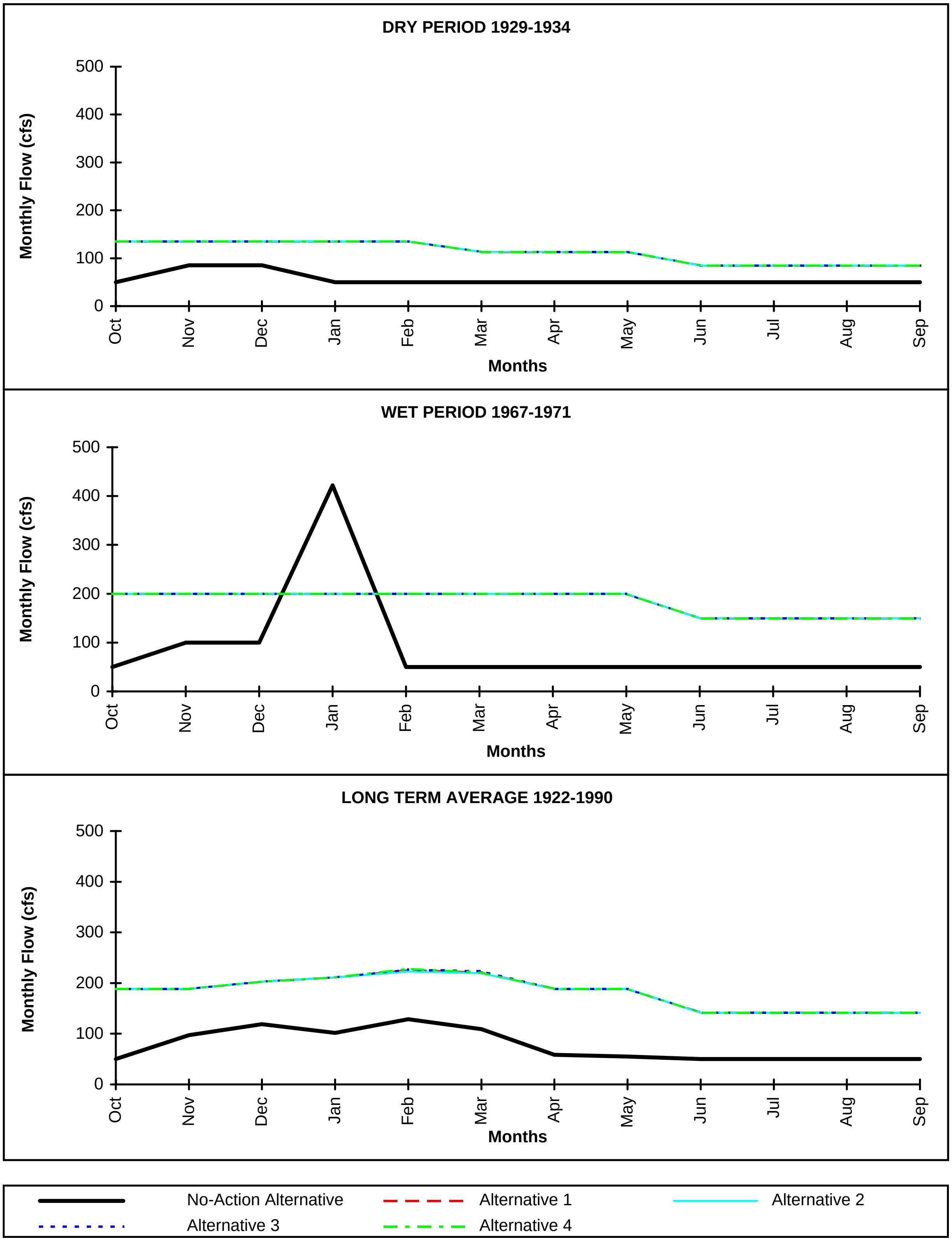


FIGURE III-3
CLEAR CREEK BELOW WHISKEYTOWN
SIMULATED AVERAGE MONTHLY FLOWS

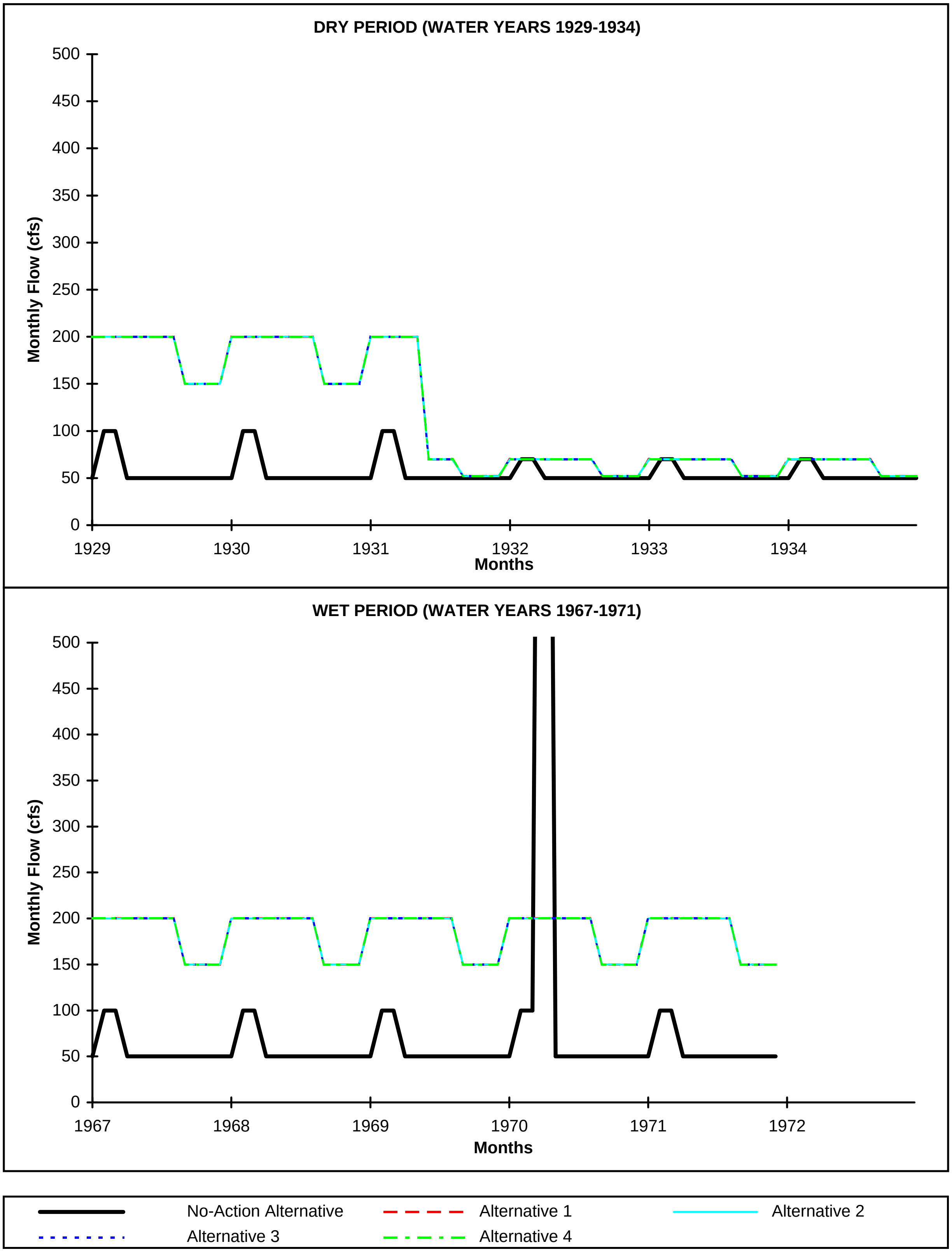


FIGURE III-4

CLEAR CREEK BELOW WHISKEYTOWN SIMULATED MONTHLY FLOWS

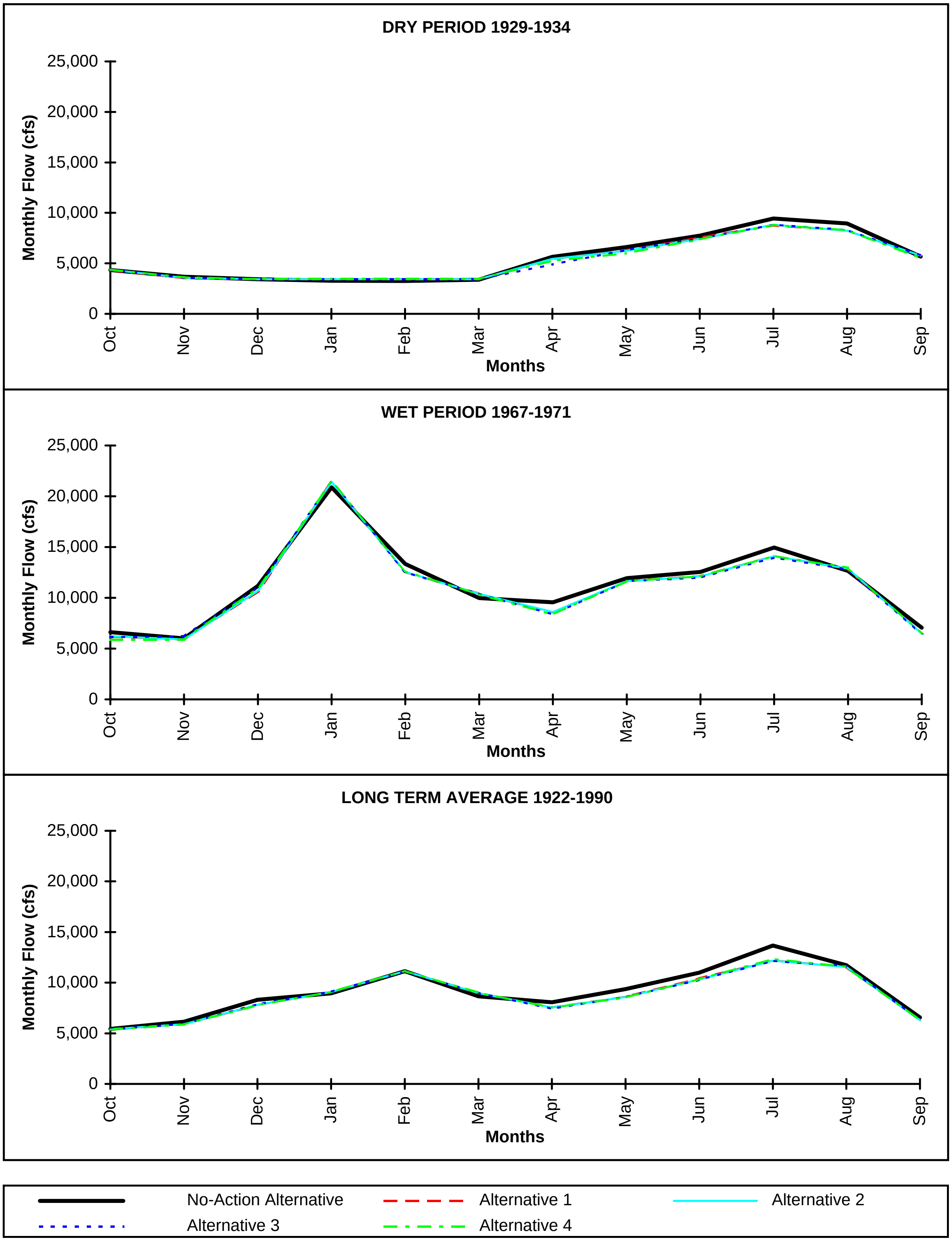


FIGURE III-5
SACRAMENTO RIVER BELOW KESWICK
SIMULATED AVERAGE MONTHLY FLOWS

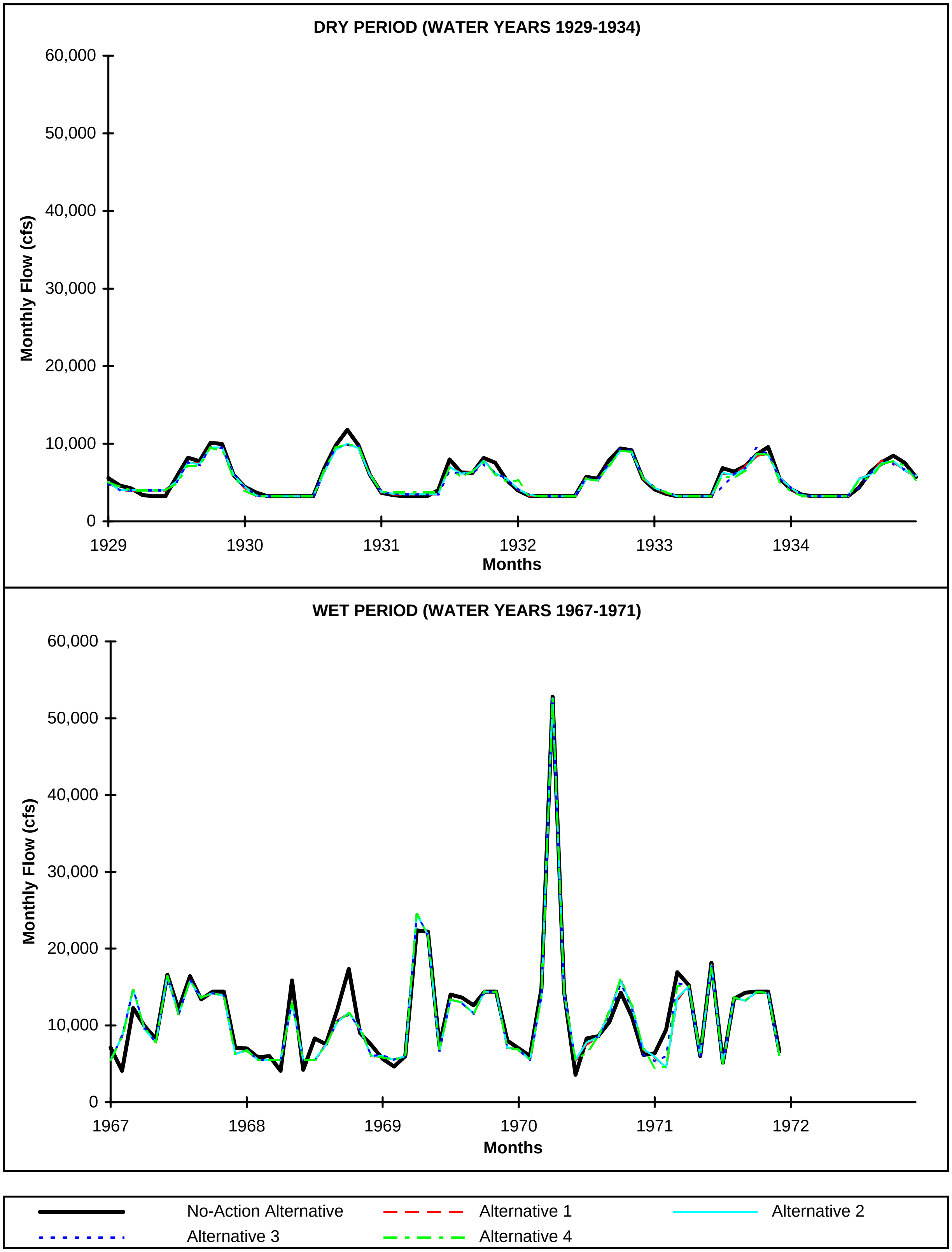


FIGURE III-6

SACRAMENTO RIVER BELOW KESWICK SIMULATED MONTHLY FLOWS

Lake releases that compensate for the reduction in Trinity diversions, while continuing to maintain downstream water temperatures for winter-run salmon at the No-Action level. As shown in Table III-3, average monthly temperature model results for Alternative 1 are generally similar to results for the No-Action Alternative during the critical summer months. Results indicate that temperature would exceed target levels more frequently during spring and fall.

TABLE III-3
RECLAMATION TEMPERATURE MODEL RESULTS FOR SACRAMENTO RIVER BELOW KESWICK DAM, 1922-1990

Alternative	Percent of Months with Simulated Average Monthly Temperatures within 0.5 °F of 1993 Winter Run Biological Opinion Target (1)						
	April	May	June	July	August	September	October
No-Action Alternative	100	90	91	94	93	78	96
Alternative 1	99	88	91	93	87	74	94
Alternative 2	99	86	91	94	91	74	94
Alternative 3	97	86	91	93	90	74	96
Alternative 4	99	84	91	94	90	74	94

NOTE:
(1) Temperature Control not in effect January through March and November through December. Target location for Bend Bridge and Jelly's Ferry based on Sacramento River Index.

These differences are attributable to conditions during critical dry years, where re-consultation with NMFS would be necessary under the biological opinion. Table III-4 compares average temperature simulation results in non-critical years.

Changes to Folsom Lake operations for (b)(2) water purposes also affect the need for Shasta Lake releases, and resulting Sacramento River flows below Keswick Dam. In Alternative 1, increased fall and winter Folsom Lake releases, to attempt to meet American River target flows. These increased flows meet a greater portion of the downstream Delta export and water quality requirements, reducing the need for Shasta Lake releases, which may be in excess of the Keswick target flows. Conversely, in some years lower Folsom Lake summer releases may require higher summer Shasta Lake releases for Delta water rights and water quality requirements. The integrated operations of Shasta and Folsom lakes were balanced to try to meet as many of the (b)(2) water objectives as possible, while still fulfilling existing CVP obligations and operational criteria as defined under the No-Action Alternative.

TABLE III-4
RECLAMATION TEMPERATURE MODEL RESULTS FOR SACRAMENTO RIVER BELOW KESWICK DAM FOR NON-CRITICAL YEARS 1922 - 1990

Alternative	Percent of Months with Simulated Average Monthly Temperatures within 0.5 °F of 1993 Winter-Run Biological Opinion Target (1)						
	April	May	June	July	August	September	October
No-Action Alternative	100	91	97	100	99	87	100
Alternative 1	99	90	96	100	96	83	100
Alternative 2	99	87	96	100	100	83	100
Alternative 3	99	87	96	99	99	84	100
Alternative 4	99	87	96	100	99	83	100

NOTES:
(1) Temperature Control not in effect January through March and November through December. Target location for Bend Bridge and Jelly's Ferry based on Sacramento River Index.

Results for the critical years 1924, 1929, 1931, 1932, 1933, 1934, and 1977 are not included. Per the 1993 Winter-Run Biological Opinion, reconsultation would be expected to occur in these years because simulated end-of-water year storage in Shasta Lake is less than 1.9 million acre-feet per year.

As system demands increase and operational criteria become more complex, the ability of the CVP to respond to short-term increases in the need for water is reduced. In most dry and critical dry years, Shasta Lake releases are governed by water rights and fisheries objectives including the target flows, the Winter-Run Biological Opinion, and Delta water quality requirements. CVP Delta exports are generally limited to incidental Delta inflows resulting from upstream releases for fisheries purposes and return flows from water rights diversions.

Simulated average monthly flows in the Sacramento River below Knights Landing for the No-Action Alternative and Alternative 1 simulations are presented in Figure III-7. These flows reflect operational changes upstream of Knights Landing including releases from Shasta and Whiskeytown lakes for target flows and from reductions in diversions from the Trinity River Basin. The average monthly flows decrease slightly in June through August; however, the flow changes are small in proportion to total flows at Knights Landing. Simulated monthly flows in the Sacramento River below Knights Landing for the dry period 1929 through 1934 and the wet period 1967 through 1971 are shown in Figure III-8.

American River Division. Alternative 1 Folsom Lake and American River operations are directly affected by attempts to meet flow targets on the American River, as well as the changes to Trinity, Shasta, and Sacramento River division operations described above. The primary fishery goals on the American River are to increase Folsom Lake September end-of-water year storage and to provide higher, more stable fall and winter river flows. The CVP's operational ability to meet the flow targets is limited by the highly variable American river flows, relatively small Folsom Lake storage capacity, and the high M&I and water rights demands.

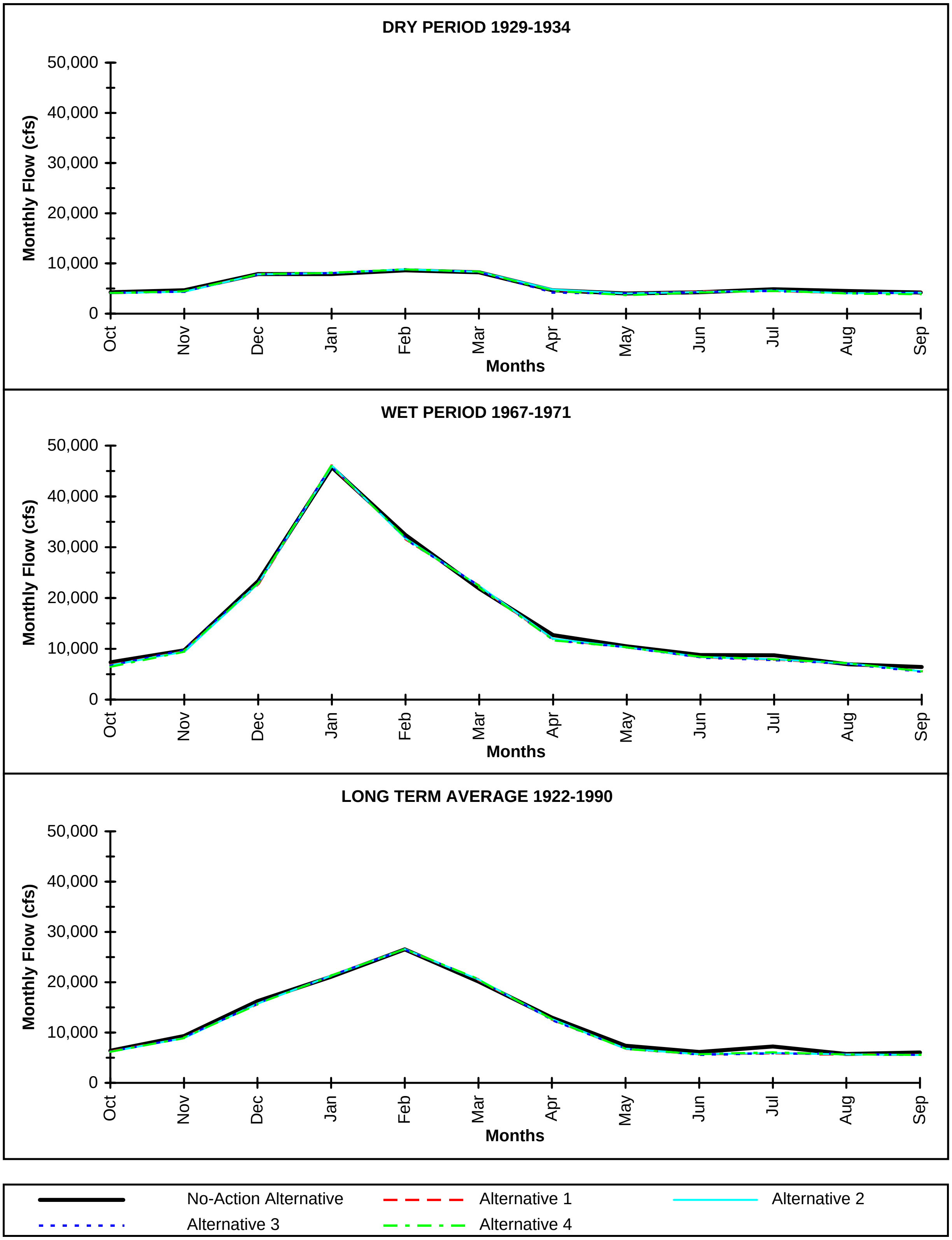


FIGURE III-7
SACRAMENTO RIVER AT KNIGHTS LANDING
SIMULATED AVERAGE MONTHLY FLOWS

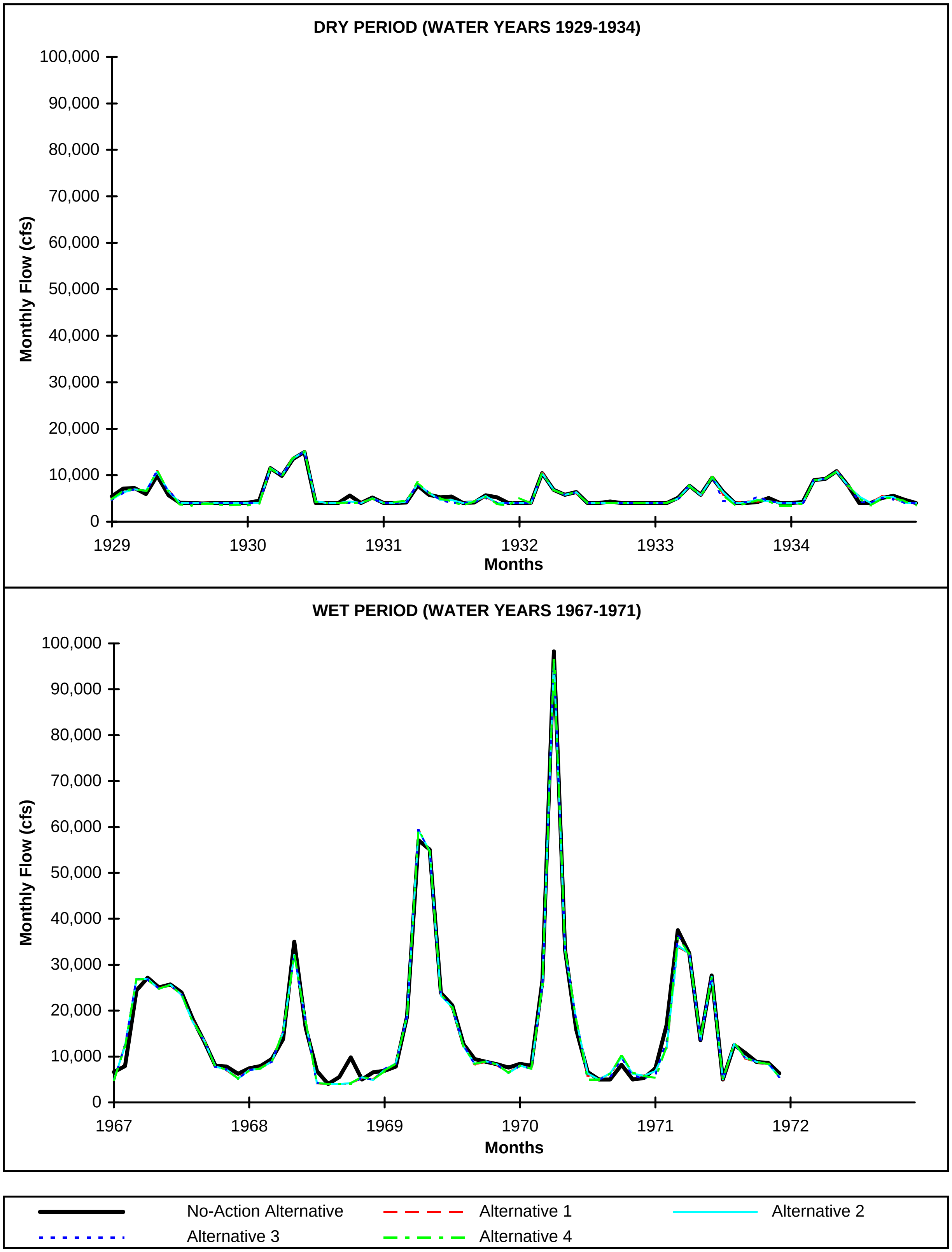


FIGURE III-8

SACRAMENTO RIVER AT KNIGHTS LANDING SIMULATED MONTHLY FLOWS

The frequency distribution in Figure III-2 shows the increase in Alternative 1 Folsom Lake end-of-water-year storage as compared to the No-Action Alternative. Average end-of-water-year lake storage increases by about 80,000 acre-feet per year in comparison to the No-Action Alternative. The AFRP September storage target of 610,000 acre-feet per year is met in about 50 percent of the 69 years in the Draft PEIS simulation period. The re-operation of Folsom Lake average monthly storage in the dry, wet, and 69-year average simulation periods is shown in Figure III-9.

Folsom Lake releases are shifted from the spring and summer months to the fall and winter months in an attempt to meet target flows on the American River below Nimbus Dam. These target flows are based on the storage/inflow relationship developed as part of the PEIS (b)(2) Water Management analysis discussed previously. The target flows in the October-through-February period are achieved in 100 percent of the months in wet, above normal, and below normal water years. For the same period, target flows are met in 80 percent of the dry years and 40 percent of the critical dry years. Simulated average monthly flows in the American River below Nimbus Dam in the No-Action Alternative and Alternative 1 are compared in Figure III-10. The re-operation of Folsom Lake releases is most evident in the comparison of average monthly flows for the dry period 1929 through 1934. Simulated monthly flows in the American River below Nimbus Dam for the dry period 1929 through 1934 and the wet period 1967 through 1971 are shown in Figure III-11.

The integrated operations of Shasta and Folsom lakes were balanced in an attempt to meet as many of the (b)(2) water objectives as possible, while still fulfilling existing CVP obligations and operational criteria as defined under the No-Action Alternative. This was particularly difficult during summer periods when the objective was to decrease releases on both the Sacramento and American rivers to provide additional September storage to help meet fall and winter flow targets. The ability to decrease summer releases is constrained by CVP obligations to provide water for existing minimum flow requirements, CVP M&I and agricultural contract obligations, water rights holders, and Delta water quality requirements. The reduction in Trinity River Basin diversions to the Sacramento River also impacts the ability to re-operate Folsom Lake releases.

Eastside Division. In Alternative 1, New Melones Reservoir would be operated in an attempt to completely meet target flows in the Stanislaus River in the months of July through March, and partially meet Stanislaus River target flows during April through June in non-critical years. Because of the limited available water supply to the CVP in the Stanislaus River watershed, no change in instream flow objectives is made during critically dry years, as compared to the No-Action Alternative.

The frequency distribution in Figure III-2 shows the end-of-water year storage levels in New Melones Reservoir in the No-Action Alternative and Alternative 1 simulations. In general, reservoir storage levels are lower in Alternative 1 than in the No-Action Alternative because of larger releases from New Melones Reservoir for higher instream flows in non-critical years.

The resulting operation would meet July-through-March target flows in all years, and would meet or partially meet target flows during the April-through-June period in some but not all years.

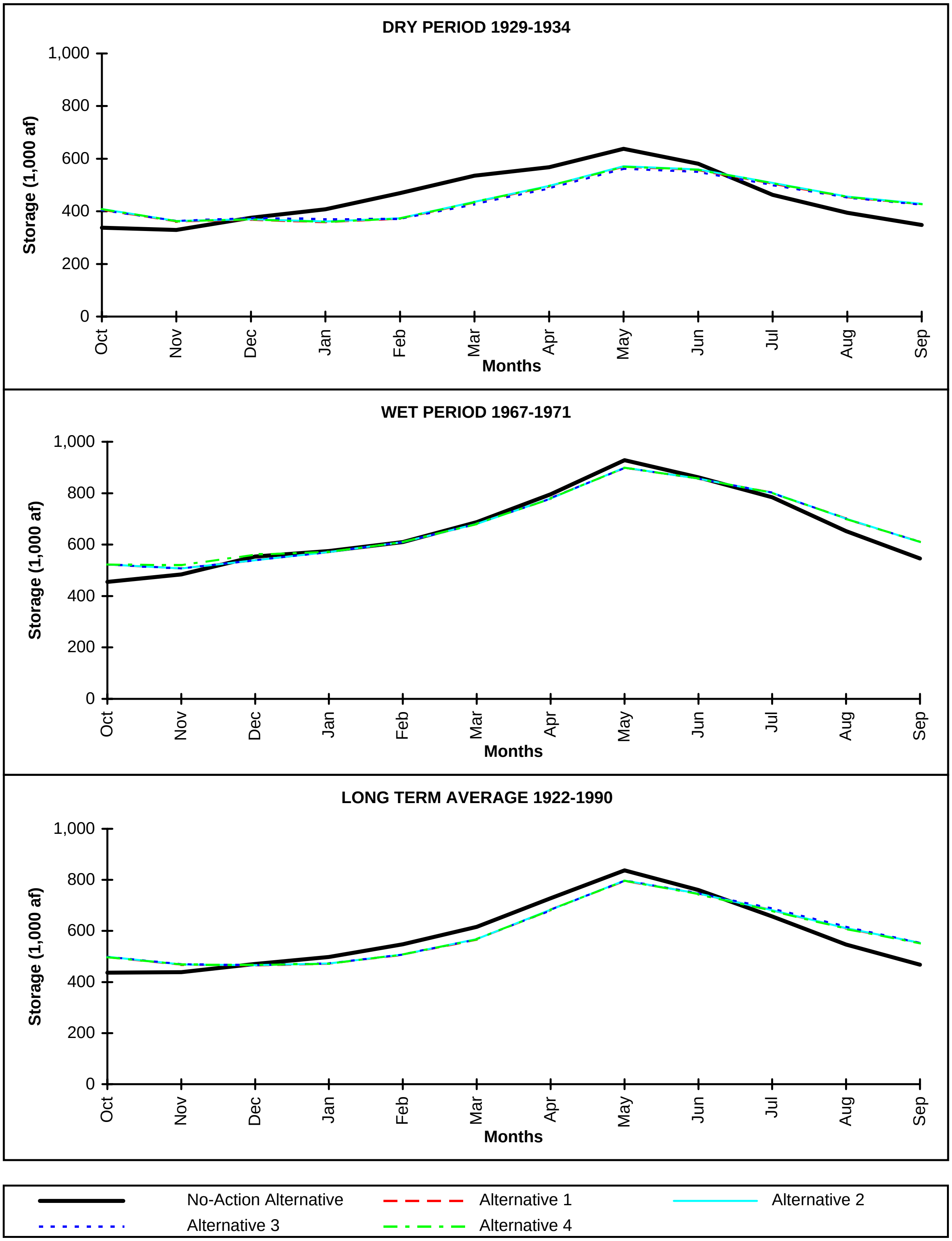


FIGURE III-9

SIMULATED FOLSOM LAKE AVERAGE END-OF-MONTH STORAGE

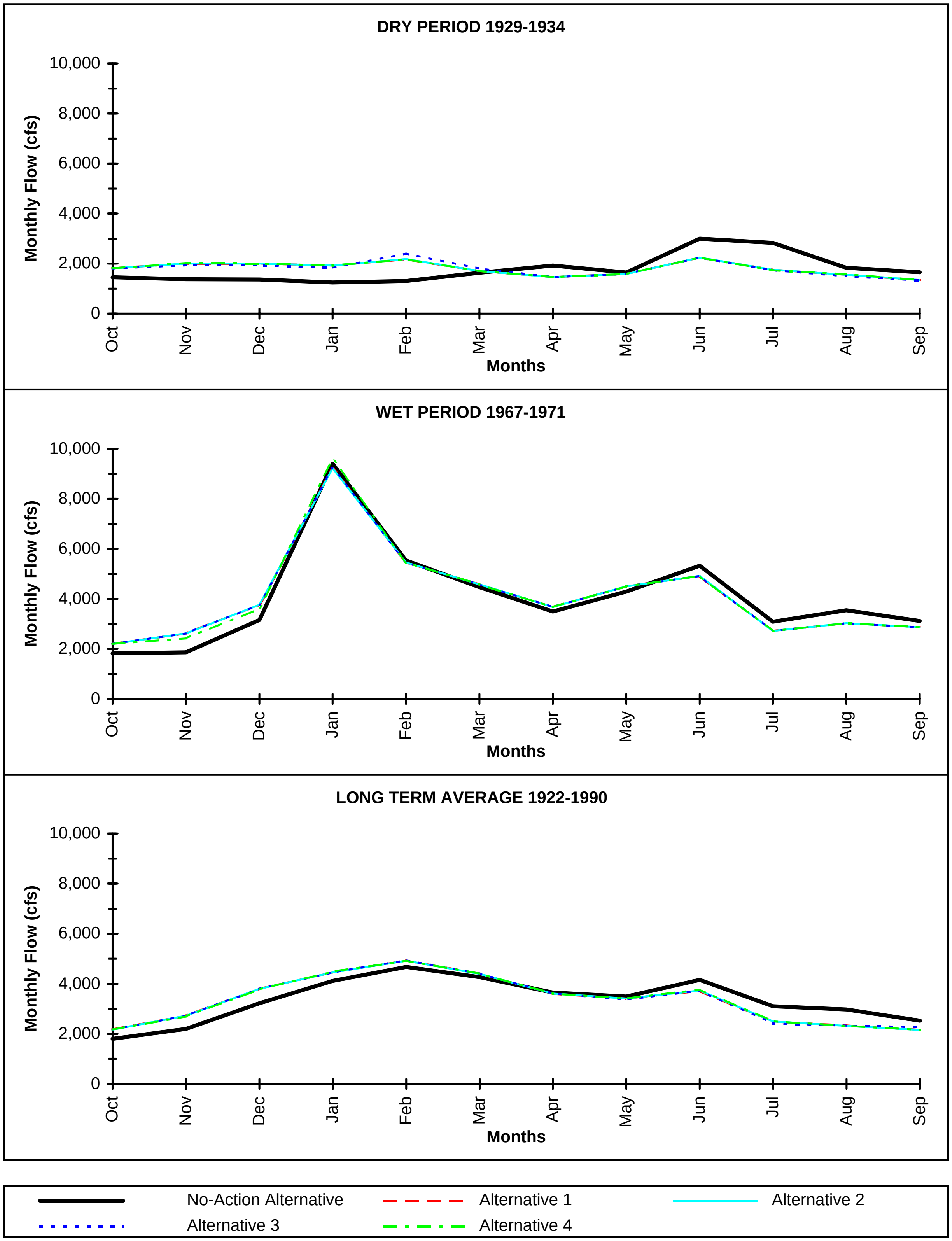


FIGURE III-10

AMERICAN RIVER BELOW NIMBUS SIMULATED AVERAGE MONTHLY FLOWS

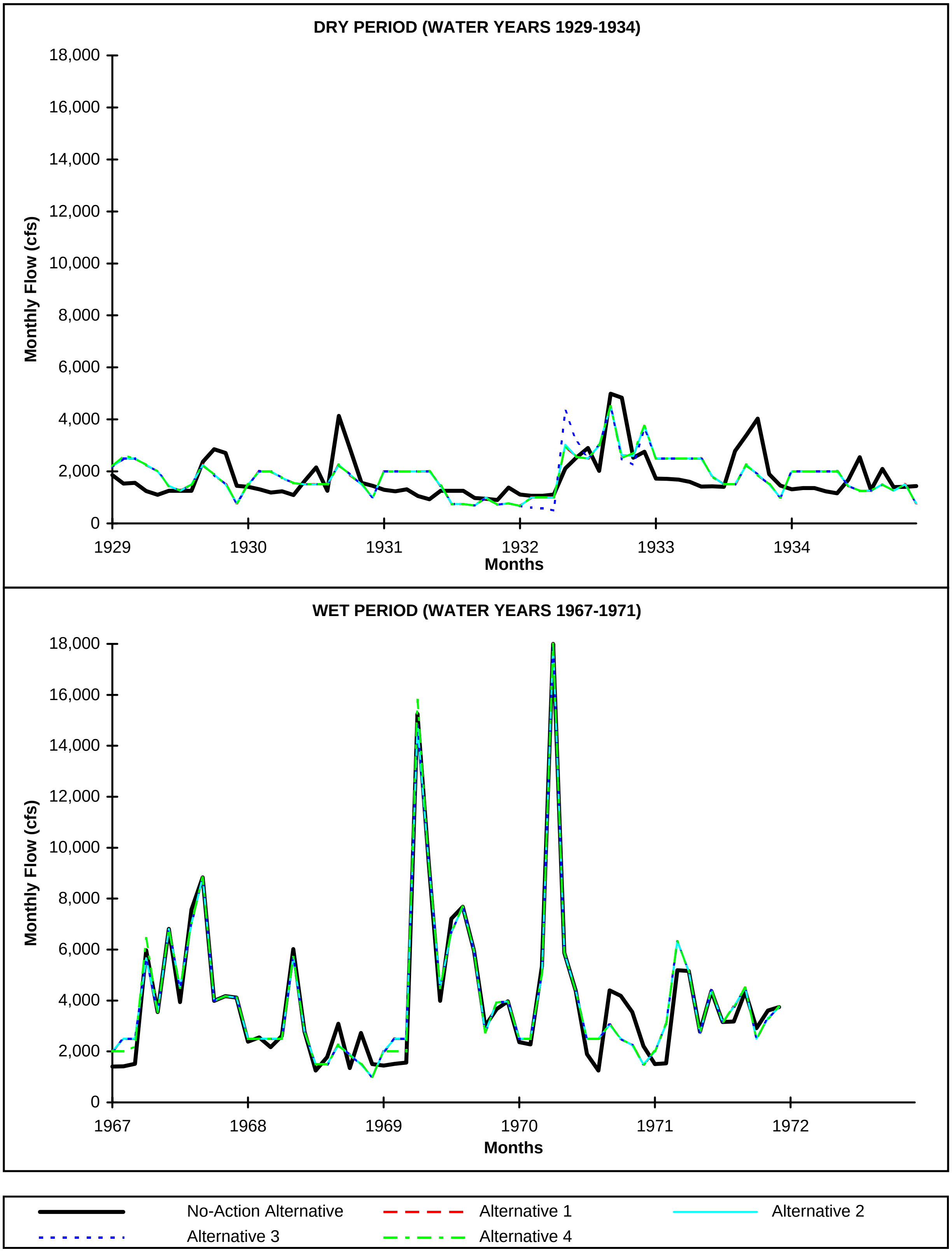


FIGURE III-11

AMERICAN RIVER BELOW NIMBUS SIMULATED MONTHLY FLOWS

Simulated average monthly flows in the Stanislaus River below Goodwin Dam in the No-Action Alternative and Alternative 1 simulations are shown in Figure III-12. As a result of the reduced storage conditions in New Melones Reservoir, the threshold for maximum water quality releases during water deficient years is invoked in one additional year during the dry simulation period of 1929-1934, and results in lower average monthly flows during June, July, and August in that period. Simulated monthly flows in the Stanislaus River below Goodwin Dam for the dry period 1929 through 1934 and the wet period 1967 through 1971 are shown in Figure III-13.

Simulated average monthly flows in the San Joaquin River at Vernalis in the No-Action Alternative and Alternative 1 are shown in Figure III-14. Simulated monthly flows in the dry period 1929 through 1934 and the wet period 1967 through 1971 are shown in Figure III-15. Although the changes in flows resulting from modified Stanislaus River operations affect the flow at Vernalis, the changes are relatively small compared to the total flow at Vernalis. The frequency distribution of simulated monthly water quality on the San Joaquin River at Vernalis during irrigation season (April - August) and non-irrigation season (September - March) for the No-Action Alternative and Alternative 1 is shown in Figures III-16. The figures show that for both the irrigation and non-irrigation seasons, the frequency with which water quality exceeds the standard increases in Alternative 1 over the No-Action Alternative. The increase in the salinity concentration during the irrigation season occurs during the driest 10 percent of the simulated years, and corresponds to periods when releases from New Melones Reservoir for water quality would be limited by available supplies. Salinity concentration increases during the non-irrigation season would primarily result from the increase in deliveries and subsequent return flows from the refuges in the San Joaquin Valley.

Delta Division. Impacts to operations of the Delta Division in Alternative 1 are a result of reductions in diversions from the Trinity River Basin, and of the combined changes to CVP upstream operations for Whiskeytown, Shasta, Folsom, and New Melones lakes in the attempt to meet target flows. In comparison to the No-Action Alternative simulation, average annual Delta inflows in Alternative 1 are reduced by approximately 240,000 acre-feet per year. Compared to the No-Action Alternative average annual Delta inflow of about 23 million acre-feet per year, this is a reduction of about 1 percent.

Figure III-17 shows the change in simulated average monthly Tracy exports for the dry, wet, and long-term average periods. The figure shows an increase in October-through-January average monthly Tracy exports, for the dry and long-term average conditions, because of the increased upstream CVP releases to meet target flows. In many years, these combined upstream reservoir releases exceed the maximum pumping capacity of Tracy Pumping Plant. In contrast, the Alternative 1 average monthly March-through-September Tracy exports are lower because of decreased spring and summer Trinity River Basin diversions to the Sacramento River, and reduced summer upstream CVP reservoir releases. The net impact is a reduction of about 250,000 acre-feet per year, or 10 percent, in average annual CVP exports through Tracy Pumping Plant. The frequency distribution in Figure III-18 shows the Alternative 1 decrease in annual Tracy Pumping Plant exports as compared to the No-Action Alternative.

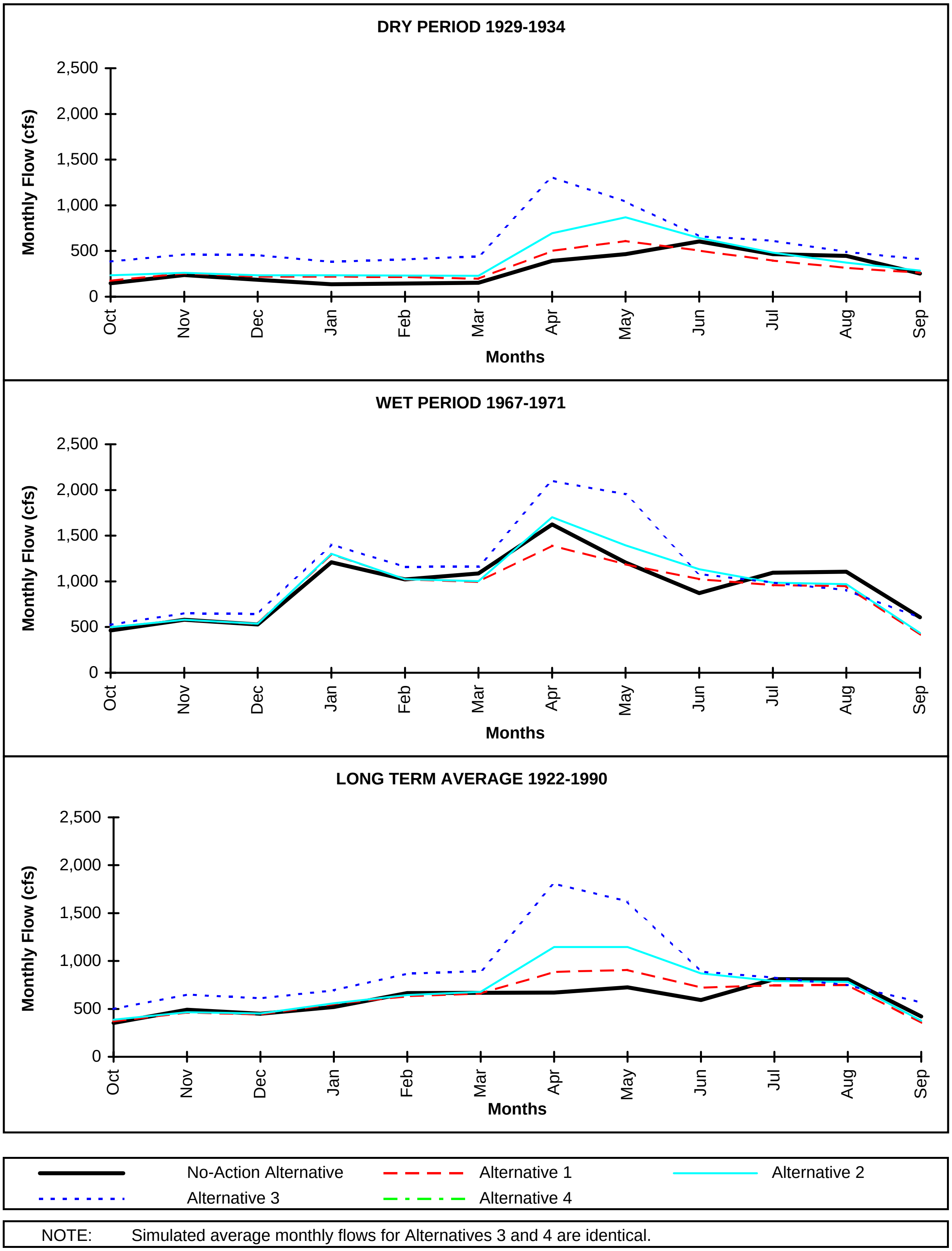


FIGURE III-12
STANISLAUS RIVER BELOW GOODWIN
SIMULATED AVERAGE MONTHLY FLOWS

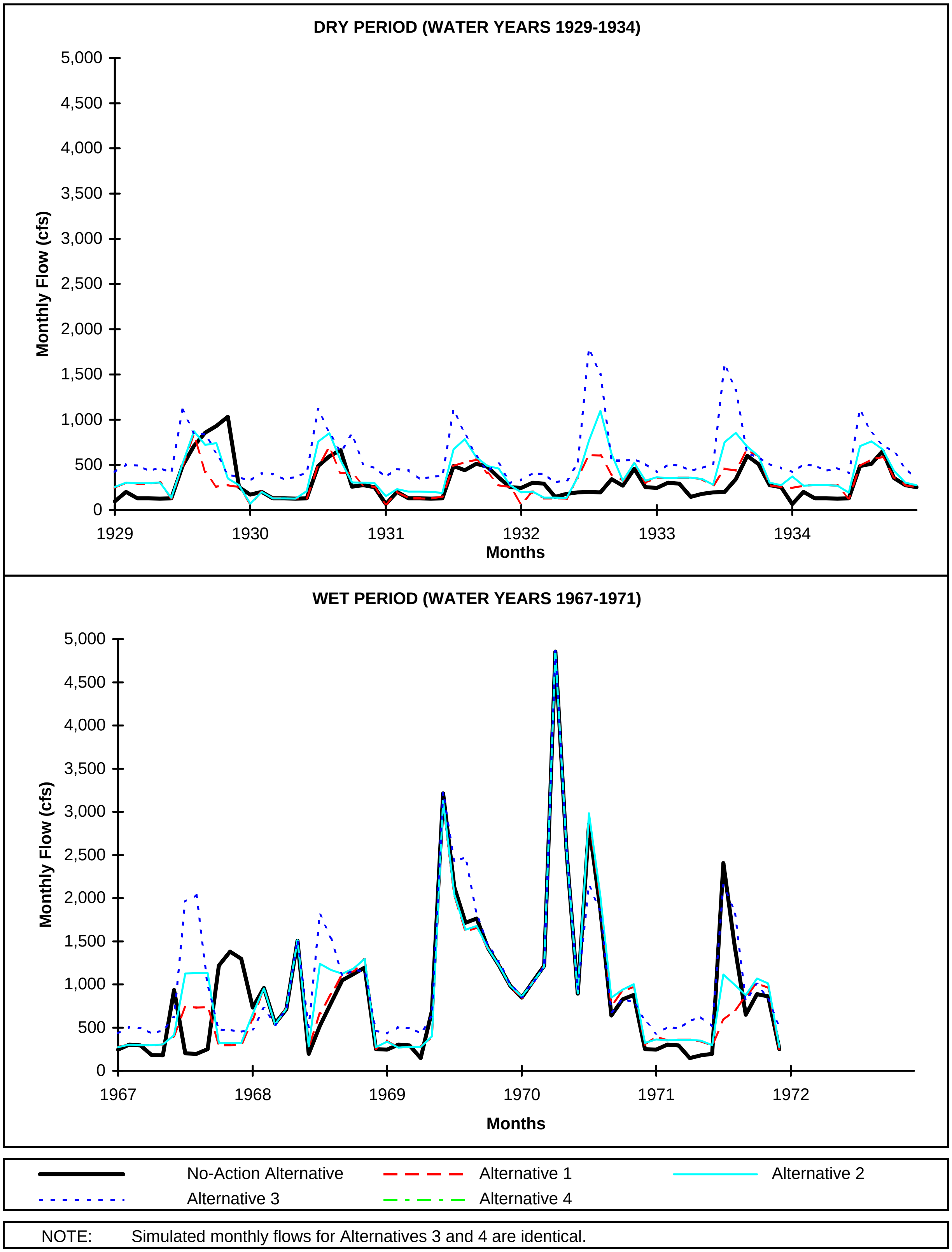
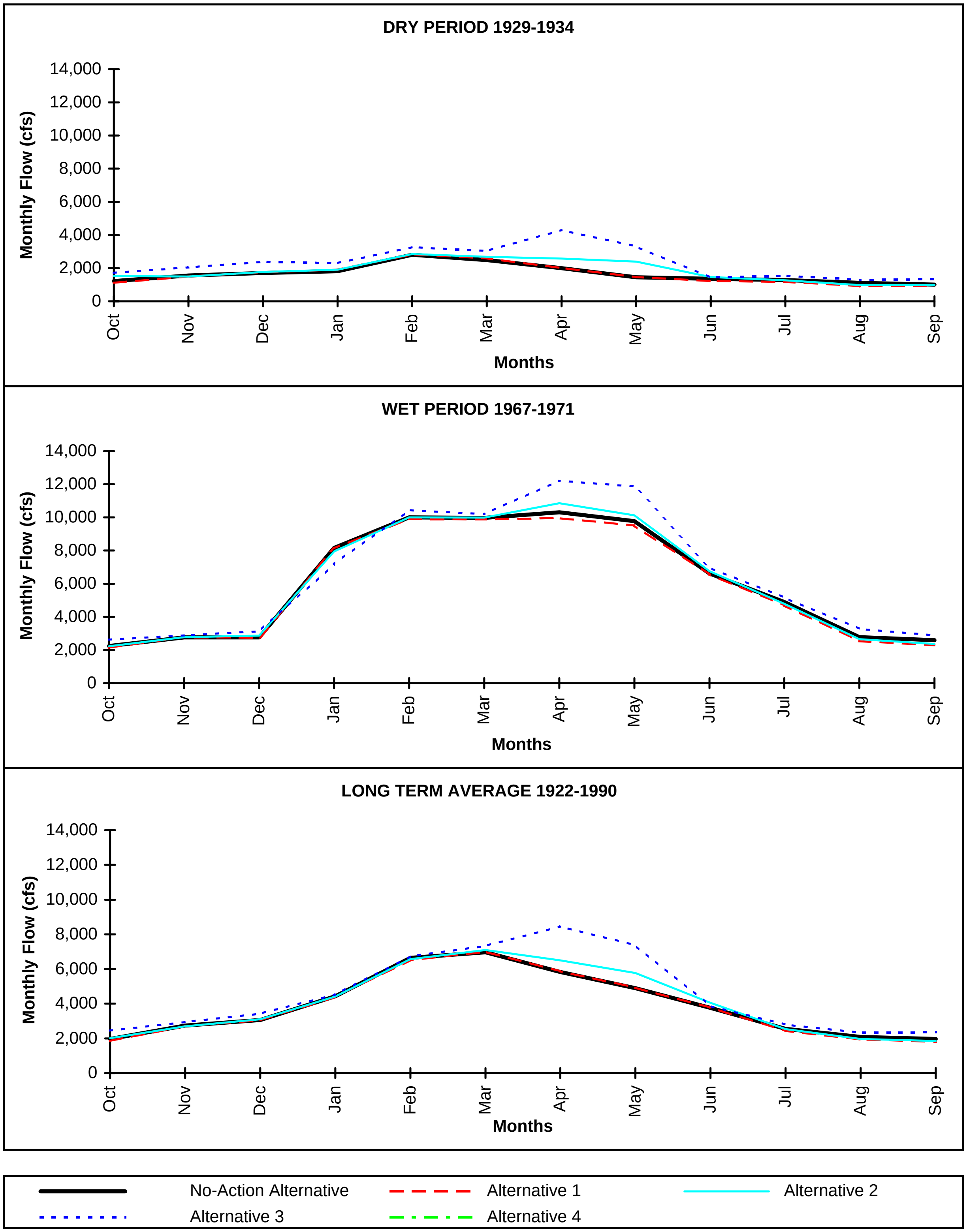


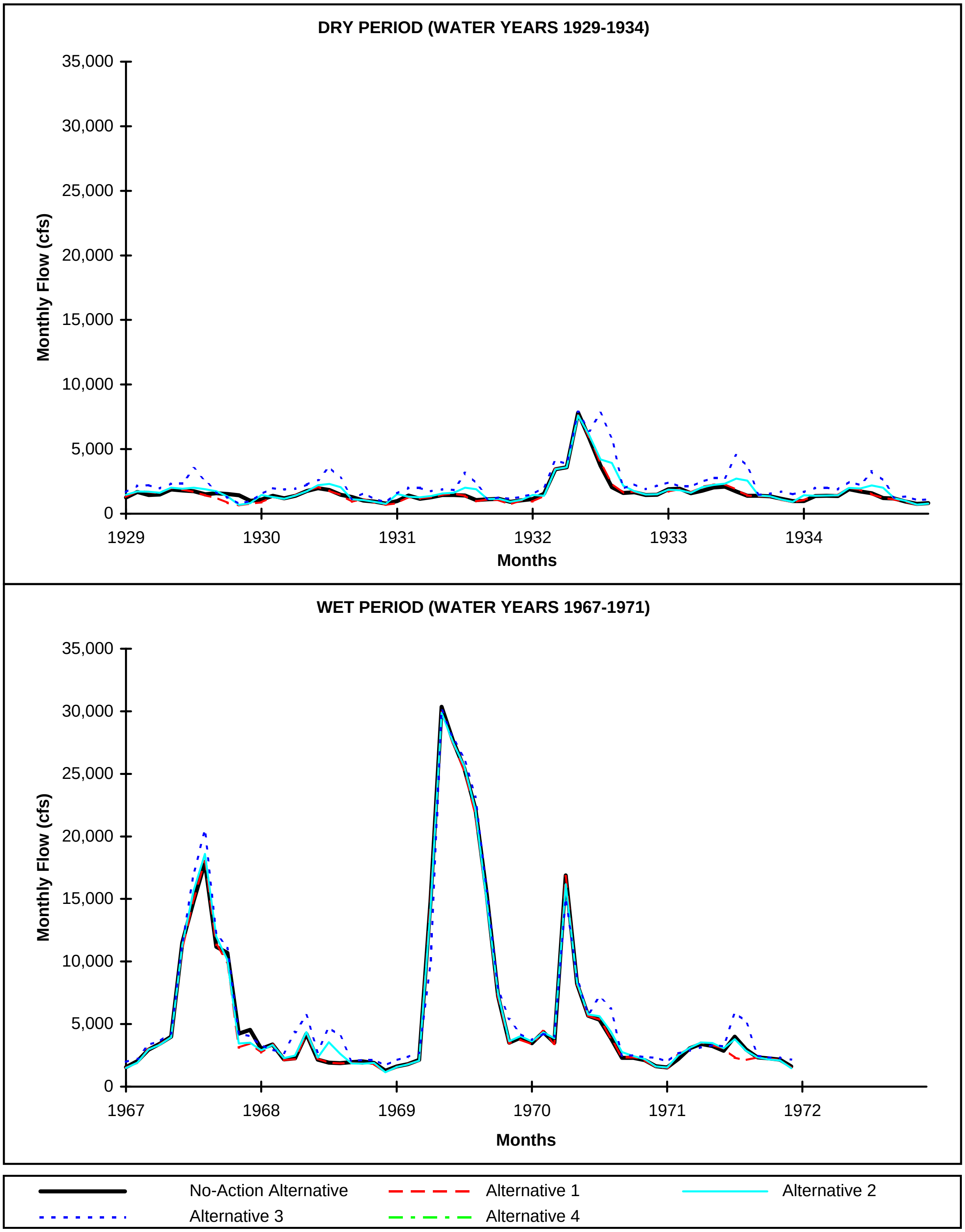
FIGURE III-13

STANISLAUS RIVER BELOW GOODWIN SIMULATED MONTHLY FLOWS



NOTE: Simulated average monthly flows for Alternatives 3 and 4 are identical.

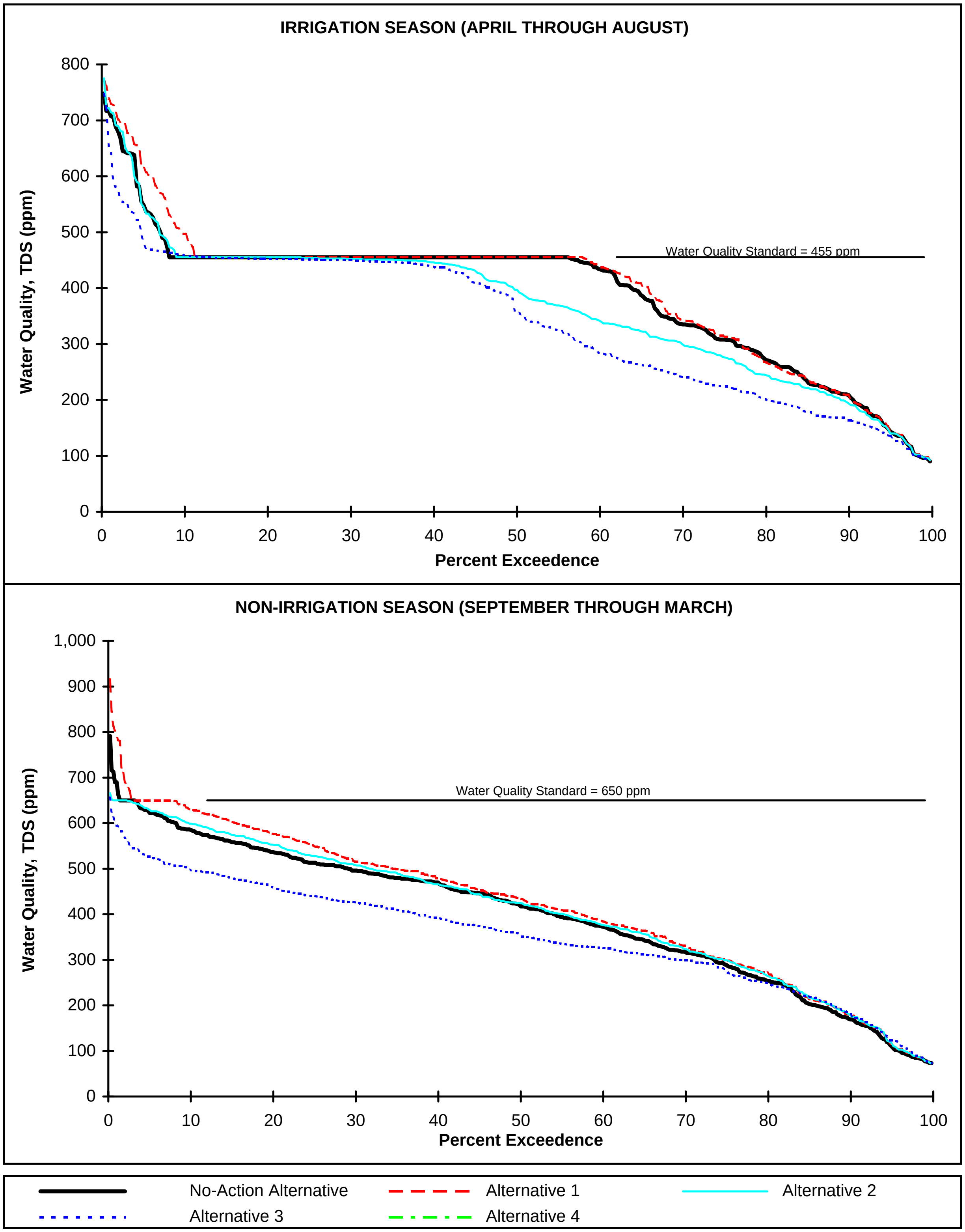
FIGURE III-14
SAN JOAQUIN RIVER AT VERNALIS
SIMULATED AVERAGE MONTHLY FLOWS



NOTE: Simulated monthly flows for Alternatives 3 and 4 are identical.

FIGURE III-15

SAN JOAQUIN RIVER AT VERNALIS SIMULATED MONTHLY FLOWS



NOTE: Water quality conditions under Alternatives 3 and 4 are identical.

FIGURE III-16

SIMULATED MONTHLY WATER QUALITY AT VERNALIS

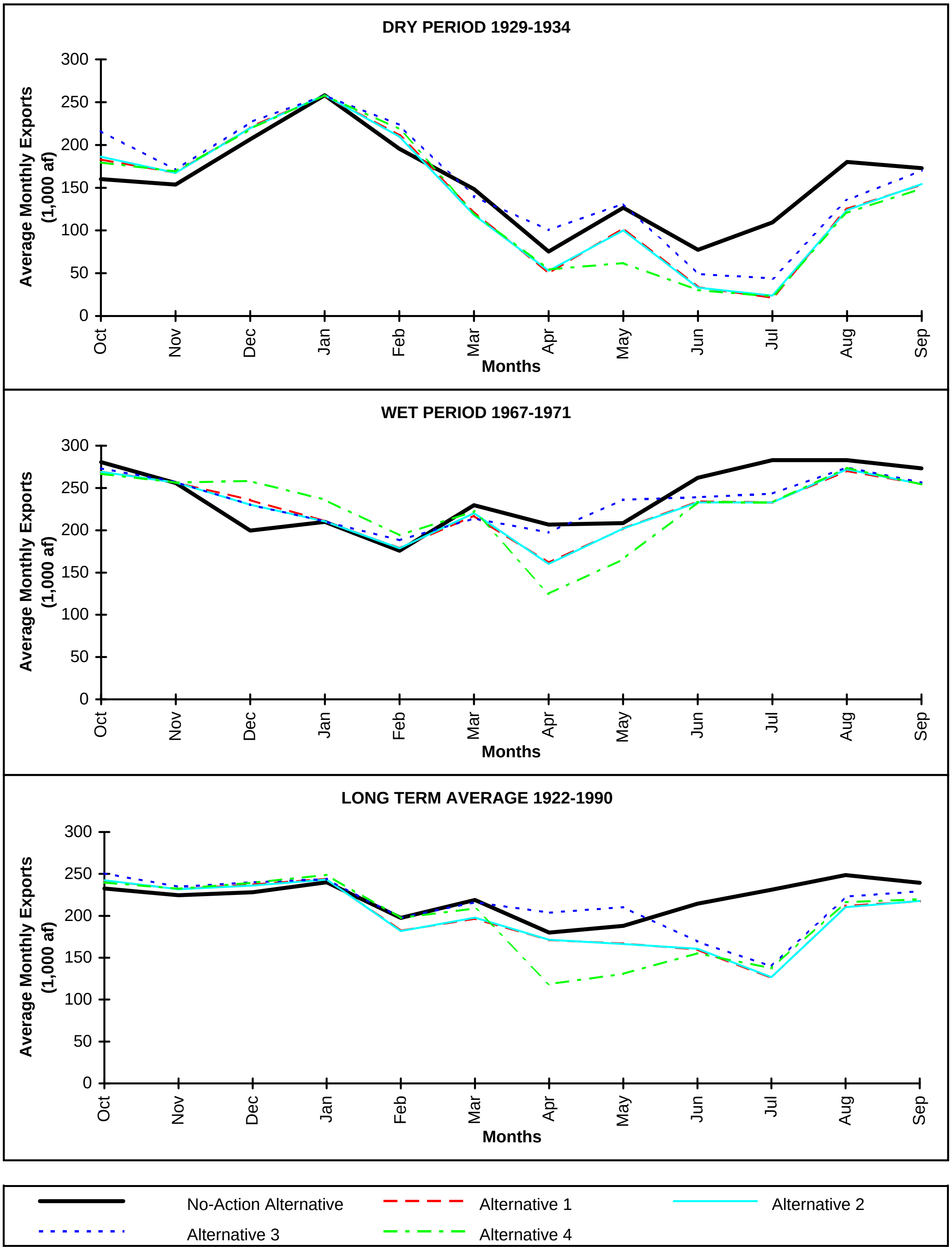


FIGURE III-17

TRACY PUMPING PLANT SIMULATED AVERAGE MONTHLY EXPORTS

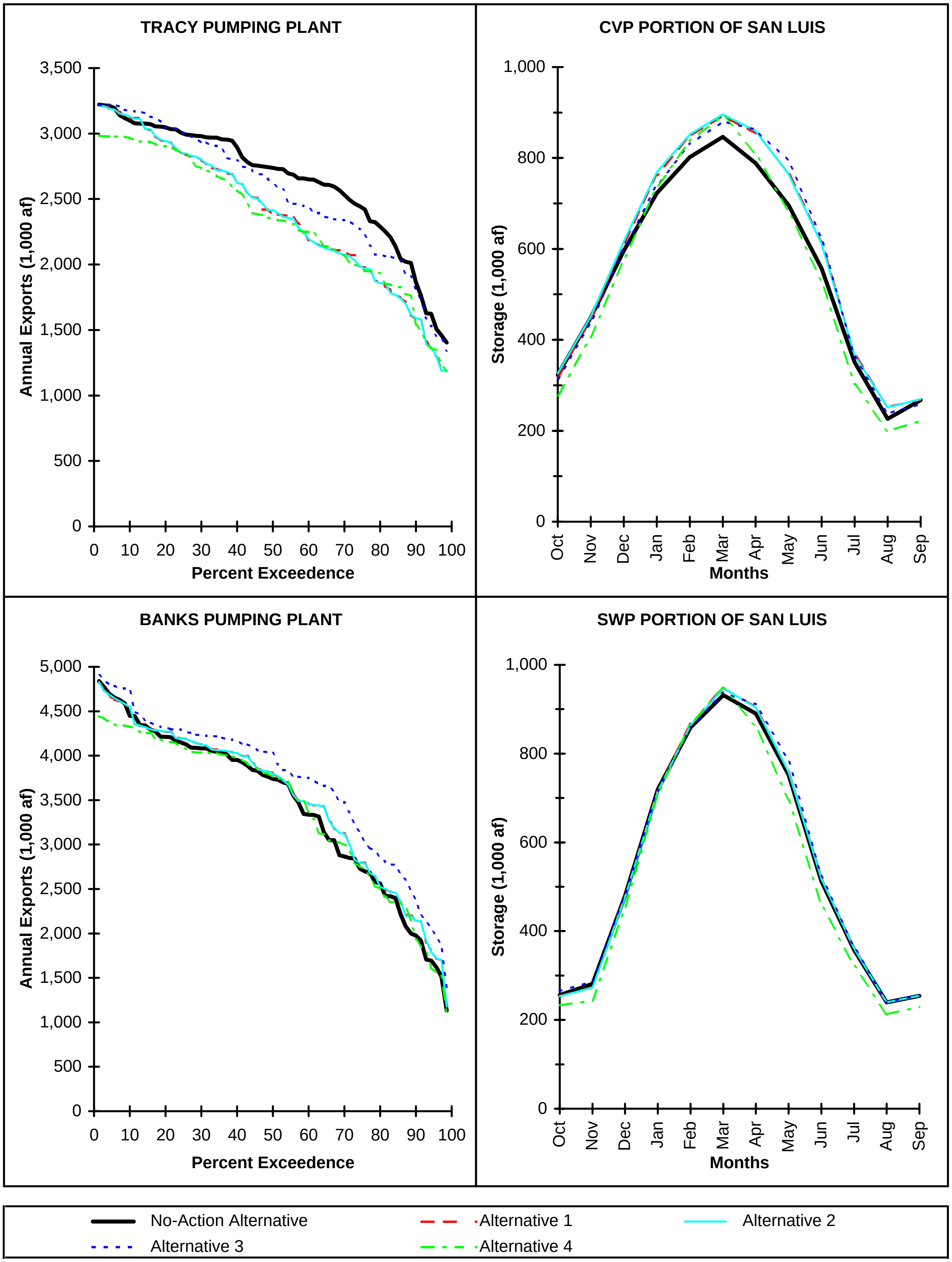


FIGURE III-18
SIMULATED ANNUAL EXPORTS AND SAN LUIS RESERVOIR AVERAGE END-OF-MONTH STORAGE 1922-1990

In comparison to the No-Action Alternative simulation, average annual Delta outflows in Alternative 1 are reduced by approximately 60,000 acre-feet per year or 0.5 percent. However, the reduction in outflow is small in proportion to the total Delta outflow and cannot be discerned in the average monthly outflow plots shown in Figure III-19 or the monthly time series plots for dry and wet periods shown in Figure III-20. The reduction in average monthly Delta outflow occurs primarily during spring and summer months because of the decrease in Trinity River Basin diversions to the Sacramento River and reduced summer upstream CVP reservoir releases.

West San Joaquin Division. The Alternative 1 impacts to CVP storage in San Luis Reservoir are a direct result of changes in Tracy Pumping Plant monthly exports. As shown in Figure III-18, Alternative 1 average monthly CVP San Luis Reservoir storage levels are higher than in the No-Action Alternative, because of increased October-through-January Tracy Pumping Plant exports. As described above, these increased exports are a result of higher Delta inflows, due to greater upstream CVP reservoir releases to attempt to meet flow targets. Minimum end-of-water year September average monthly storage levels are similar to the No-Action Alternative.

CVP Water Contract Deliveries

This section describes potential changes to CVP water contract deliveries in Alternative 1, as compared to the No-Action Alternative, because of use of (b)(2) water toward meeting the target flows, firm Level 2 refuge deliveries, and increased instream Trinity River fishery flows. The discussion includes CVP deliveries to Sacramento River Water Rights Contractors, San Joaquin River Exchange Contractors, refuges, and Agricultural and M&I Water Service Contractors north and south of the Delta. This section is divided into deliveries north of the Delta, deliveries south of the Delta, and refuge deliveries.

CVP Water Deliveries North of the Delta. CVP deliveries north of the Delta include deliveries to Sacramento River Water Rights Contractors and to Agricultural and M&I Water Service Contractors. CVP deliveries to Sacramento River Water Rights Contractors do not change in Alternative 1 because their delivery deficiencies are based on the Shasta Criteria. The Shasta Criteria is a function of Shasta Lake inflow, which does not change among the Draft PEIS alternatives. Deliveries to Agricultural and M&I Water Service Contractors north of the Delta are a function of CVP available water supply. As available water supply is reduced by the use of (b)(2) water, increased firm Level 2 refuge water supplies, and decreased diversions from the Trinity River Basin, there is a resulting decrease in water service contract deliveries.

Figure III-21 shows the decrease in simulated annual total deliveries to agricultural contractors north of the Delta, including water rights and water service contractors. The frequency distribution for the percent of full delivery to CVP Agricultural Water Service Contractors north of the Delta is presented in Figure III-22. The figure generally shows a 5 to 10 percent reduction in the frequency of deliveries across all delivery levels, with the minimum delivery dropping from about 15 to 0 percent of full contract amount.

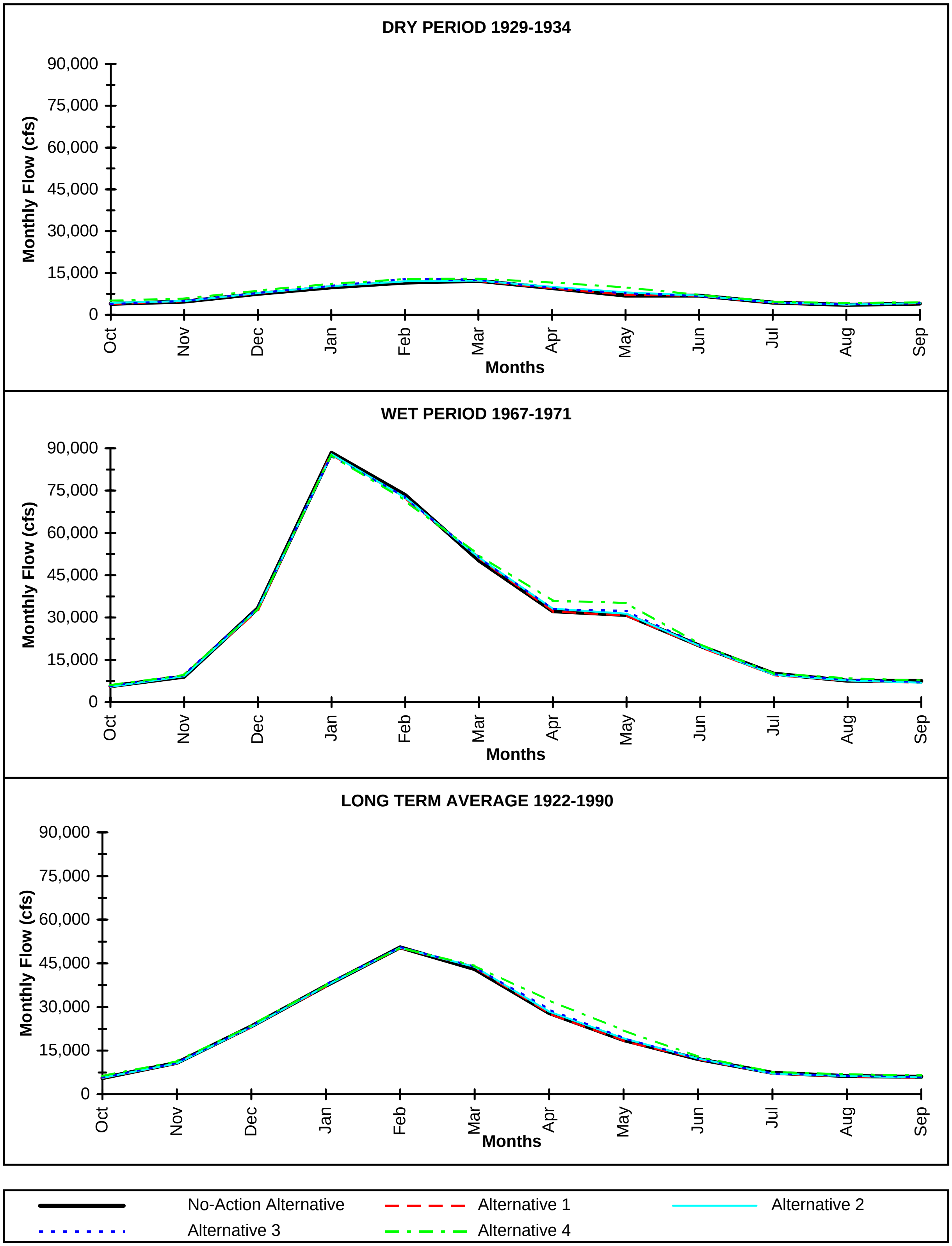


FIGURE III-19

DELTA OUTFLOW SIMULATED AVERAGE MONTHLY FLOWS

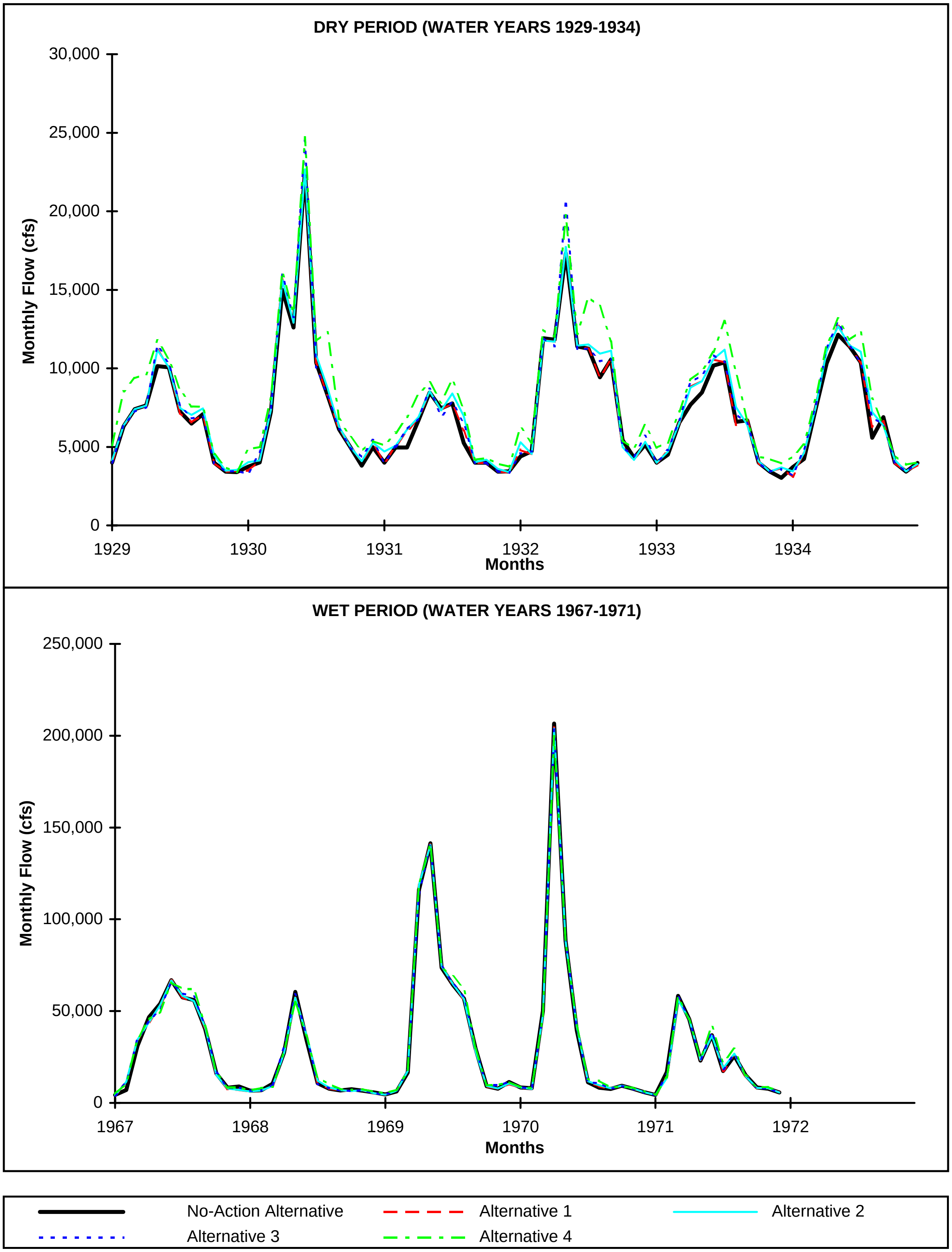
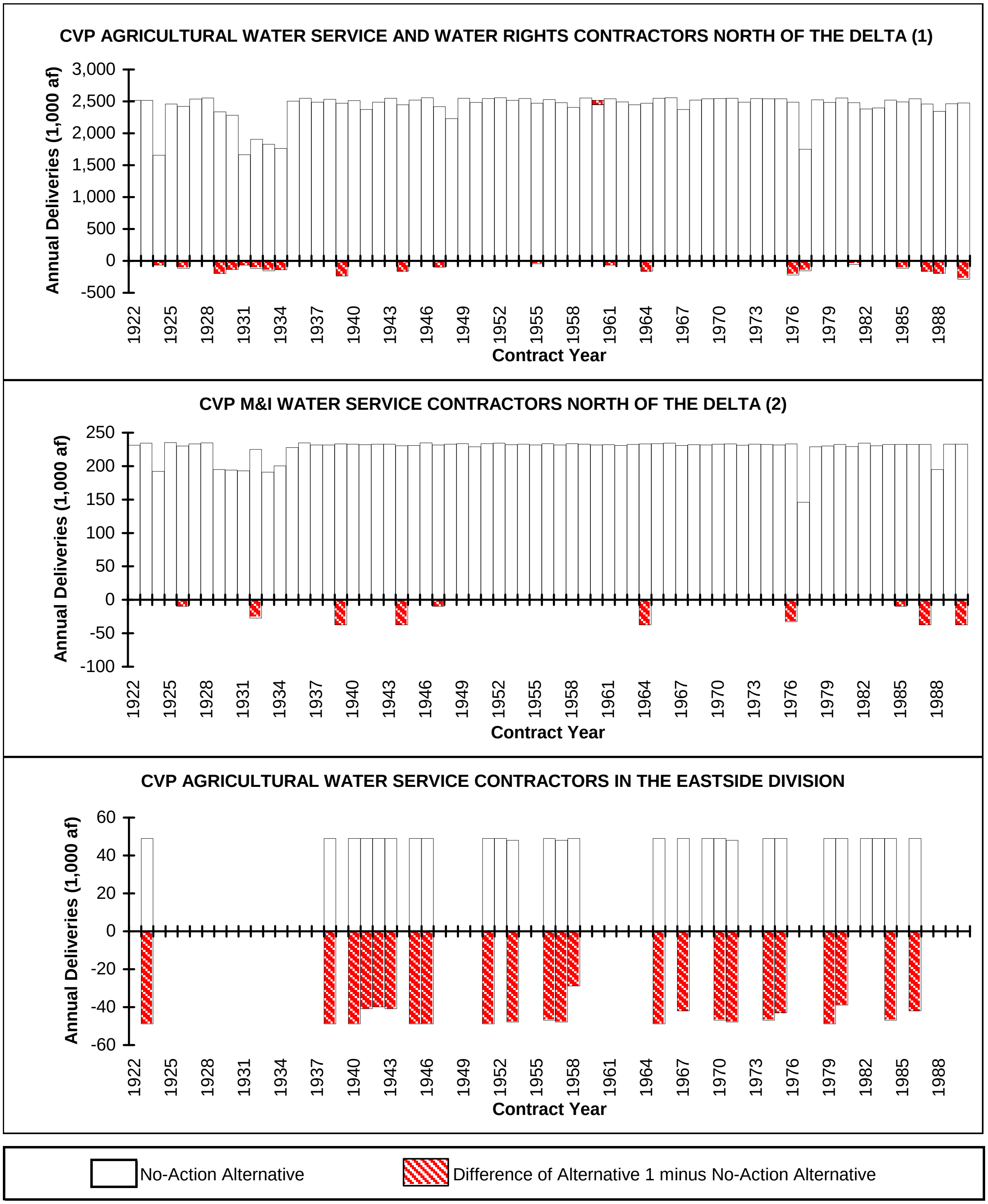


FIGURE III-20

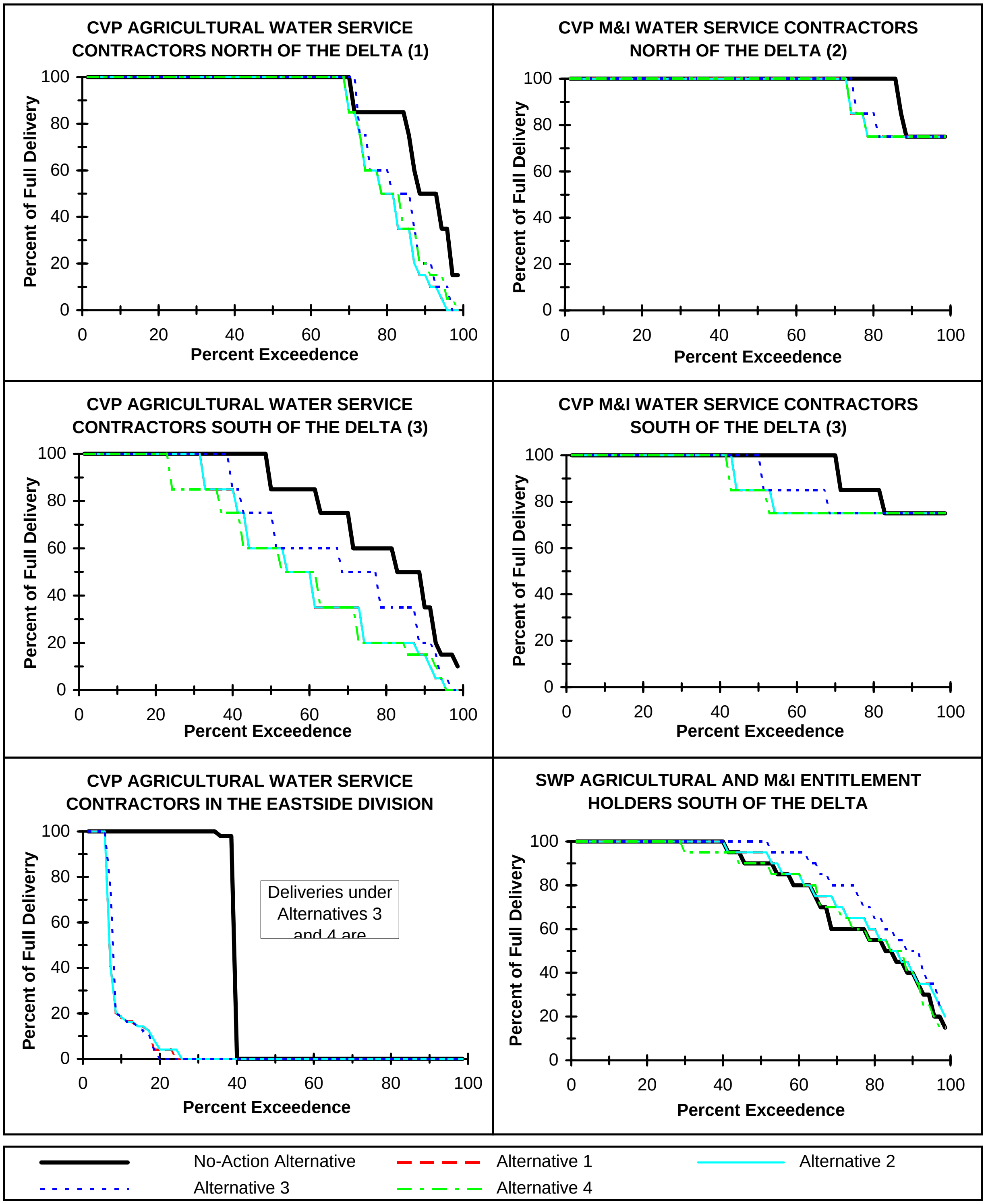
DELTA OUTFLOW SIMULATED MONTHLY FLOWS



NOTES: (1) Includes Sacramento River and American River Divisions.

(2) Includes Sacramento River and American River Divisions plus Contra Costa exports.

FIGURE III-21
SIMULATED ALTERNATIVE 1 DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990



NOTES: (1) Includes Sacramento River and American River Divisions.
(2) Includes Sacramento River and American River Divisions plus Contra Costa exports.
(3) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE III-22
SIMULATED FREQUENCY OF PERCENT OF FULL ANNUAL DELIVERIES 1922-1990

The reduction in Alternative 1 annual deliveries to M&I Water Service Contractors north of the Delta is shown in Figure III-21. The minimum delivery to M&I Water Service Contractors is limited to 75 percent of the contract amount, as shown in the frequency distribution in Figure II-22. The minimum delivery is made in 15 percent of the years in the No-Action Alternative and 45 percent of the years in Alternative 1. The only exception occurs on the American River in 1977, when all M&I contract and water rights deliveries from the river are reduced below 75 percent in the No-Action Alternative and Alternative 1. The figure shows that full M&I deliveries are reduced from 85 to 70 percent of the years in the 69-year simulation period.

CVP Deliveries in the Eastside Division. As described in Chapter II of the Draft PEIS, two types of long-term CVP Agricultural Water Service Contracts exist for water from the Stanislaus River. These long-term contracts are based on either firm or interim water supplies. In the simulation of Stanislaus River operations for the Draft PEIS, the portion of long-term CVP agricultural water service contracts based on a firm water supply is a direct demand on New Melones Reservoir, and is subject to deficiency criteria based on reservoir storage and projected inflow. The portion of the total long-term CVP agricultural water service contract amount based on an interim water supply would be delivered on an “as available” basis in the Draft PEIS analysis, and is assessed based on the availability and occurrence of flood control releases from New Melones Reservoir.

Simulated annual deliveries to Agricultural Water Service Contractors from the Stanislaus River for the No-Action Alternative and Alternative 1 are compared in Figure III-21. As shown in this figure, water service contract deliveries based on a firm water supply would be reduced or eliminated in many years of the simulation period as a result of (b)(2) Water Management in Alternative 1. A frequency distribution of these deliveries, shown in Figure III-22, reveals that partial or full deliveries would be made in approximately 10 to 20 percent of the years in Alternative 1, as compared to approximately 40 percent of the years under the No-Action Alternative. Similarly, the opportunity for delivery pursuant to contracts based on an interim water supply would be reduced in Alternative 1 as compared to the No-Action Alternative. In the No-Action Alternative, partial or full deliveries of contract amounts based on an interim water supply could be provided in 10 percent of the simulated years, and partial delivery could occur in up to 40 percent of the years.

As a result of (b)(2) Water Management in Alternative 1, end of September storage levels in New Melones Reservoir would be lowered, as shown in Figure III-2. This would reduce the frequency of flood control releases, and would therefore affect the opportunity for deliveries to CVP contracts based on an interim water supply. Under Alternative 1, the opportunity for full or partial delivery to CVP contracts based on an interim water supply would be reduced to approximately 10 percent of the simulated years.

CVP Water Deliveries South of the Delta. CVP deliveries south of the Delta include deliveries to San Joaquin River Exchange Contractors, and Agricultural and M&I Water Service Contractors. CVP deliveries to San Joaquin River Exchange Contractors do not change in Alternative 1 because their delivery deficiencies are based on the Shasta Criteria. The Shasta Criteria is a function of Shasta Lake inflow, which does not change between the Draft PEIS alternatives and the No-Action Alternative. Deliveries to Agricultural and M&I Water Service Contractors south of the Delta are a function of available CVP water supply and the amount of water that can be exported through Tracy Pumping Plant.

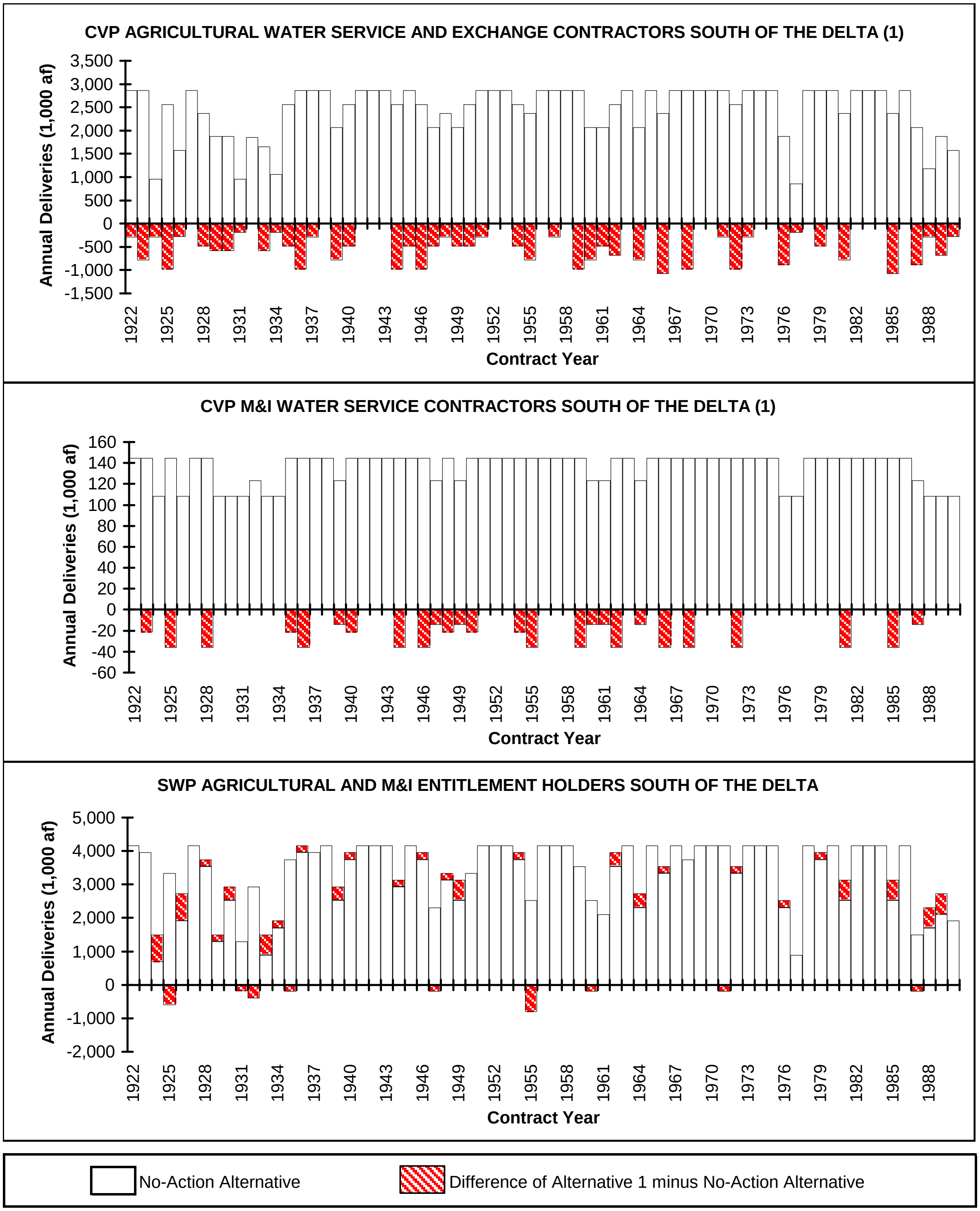
Figure III-23 shows the decrease in simulated annual total deliveries to agricultural contractors south of the Delta, including exchange and water service contractors. The frequency distribution for the percent of full delivery to CVP Agricultural Water Service Contractors south of the Delta is presented in Figure III-22. The figure generally shows a 20 to 30 percent reduction in the frequency of deliveries across all delivery levels, with the minimum delivery dropping from about 10 to 0 percent of full contract amount.

The reduction in Alternative 1 annual deliveries to M&I Water Service Contractors south of the Delta is shown in Figure III-23. The minimum delivery to M&I Water Service Contractors is limited to 75 percent of the contract amount, as shown in the frequency distribution in Figure III-22. The minimum delivery is made in 20 percent of the years in the No-Action Alternative and about 50 percent of the years in Alternative 1. The figure shows that full M&I deliveries are reduced from 70 to 40 percent of the years in the 69-year simulation period.

CVP Water Deliveries To Refuges. Alternative 1 includes delivery of firm Level 2 water supplies to refuges. Figure III-24 shows the increase of about 180,000 acre-feet per year in Alternative 1 annual refuge deliveries as compared to the No-Action Alternative. The 25 percent deficiency to refuge deliveries in critical dry years is based on the Shasta Criteria, as it is in the No-Action Alternative.

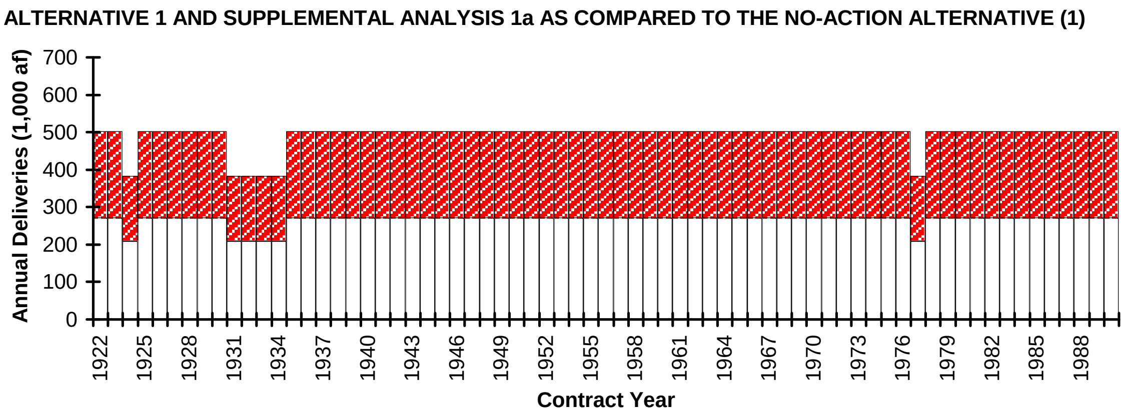
ALTERNATIVE 1 IMPACTS ON SWP OPERATIONS AND DELIVERIES

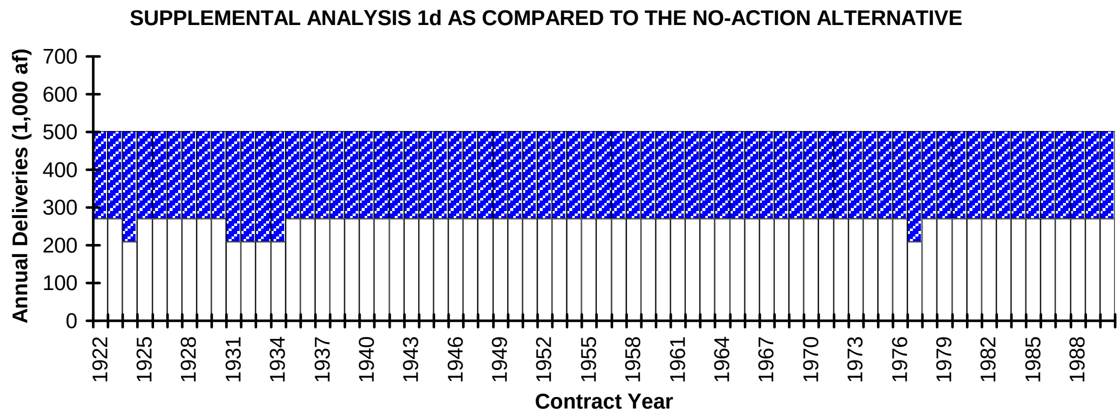
This section provides a comparison of Alternative 1 and No-Action Alternative SWP reservoir operations, resulting river flows, and water deliveries to SWP contractors. Deliveries to SWP contractors in the Alternative 1 simulation, as compared to deliveries in the No-Action Alternative simulation, are shown in Table III-5.

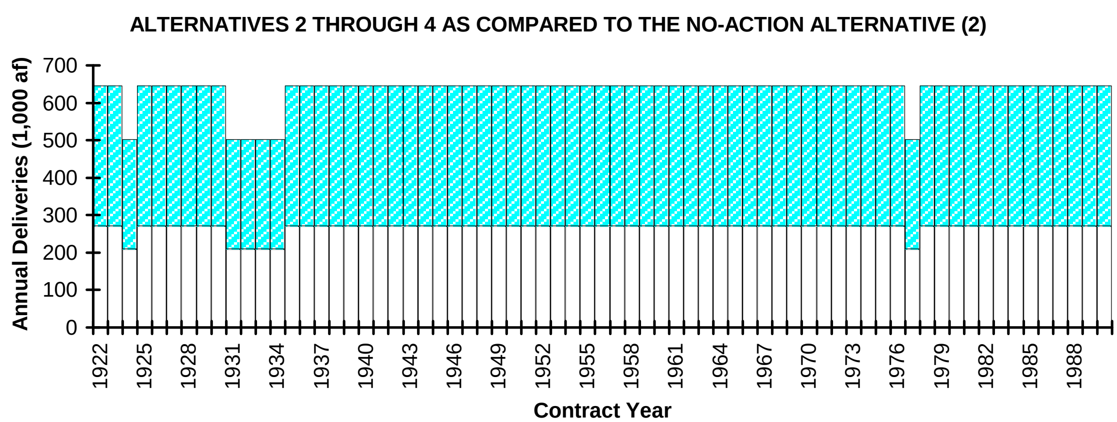


NOTE: (1) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE III-23
SIMULATED ALTERNATIVE 1 DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990







No-Action Alternative

Additional CVP deliveries to refuges for specified alternatives.

NOTES: (1) Refuge deliveries under Supplemental Analysis 1a are identical to Alternative 1.
(2) Refuge deliveries under Alternatives 3 and 4 are identical to Alternative 2.

FIGURE III-24

SIMULATED CVP ANNUAL REFUGE DELIVERIES 1922-1990

TABLE III-5
COMPARISON OF SWP DELIVERIES IN THE
ALTERNATIVE 1 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual SWP Deliveries (1,000 acre-feet)		Average Annual Change in SWP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 1	
1922 - 1990	Simulation Period	3,330	3,430	+100
1928 - 1934	Dry Period	2,050	2,200	+150
1967 - 1971	Wet Period	4,140	4,100	-40

NOTES:
(1) SWP deliveries include deliveries south of the Delta to entitlement holders. SWP deliveries do not include refuge water supplies.

SWP Operations

SWP operations are affected by the changes in seasonal releases from upstream CVP reservoirs for target flows. These changes to CVP operations shift the timing of flow entering the Delta, and affect the SWP responsibility to help meet in-basin water rights and Delta water quality requirements under the COA.

Lake Oroville and Feather River Operations. Small differences in SWP Lake Oroville operations are the result of changes in response to the availability of excess water in the Delta, as a function of (b)(2) Water Management and reduced diversions from the Trinity River Basin. These changes in water availability require different Lake Oroville releases to meet COA obligations and/or Delta water quality requirements. Figure III-2 shows a comparison of the frequency distributions for Lake Oroville end-of-water year storage for Alternative 1 and the No-Action Alternative.

Simulated average monthly flows in the Feather River below Nicolaus in the No-Action Alternative and Alternative 1 are presented in Figure III-25 for dry, wet, and 69-year simulation periods. The small differences in the flows reflect decreased fall and increased summer upstream Lake Oroville releases in response to Delta needs. However, the changes in flow are small in proportion to total flows at Nicolaus. Figure III-26 shows a comparison of simulated monthly flows for the dry period 1929 through 1934 and the wet period 1967 though 1972.

Delta Operations. In Alternative 1 Delta inflows are increased during fall and winter months because of greater upstream CVP reservoir releases for target flows. In many years, the additional fall and winter Delta inflow exceeds the pumping capacity of the CVP Tracy Pumping Plant. When this occurs, the SWP has the potential to increase Banks Pumping Plant exports to take advantage of the excess water, or pump at capacity while reducing upstream releases from

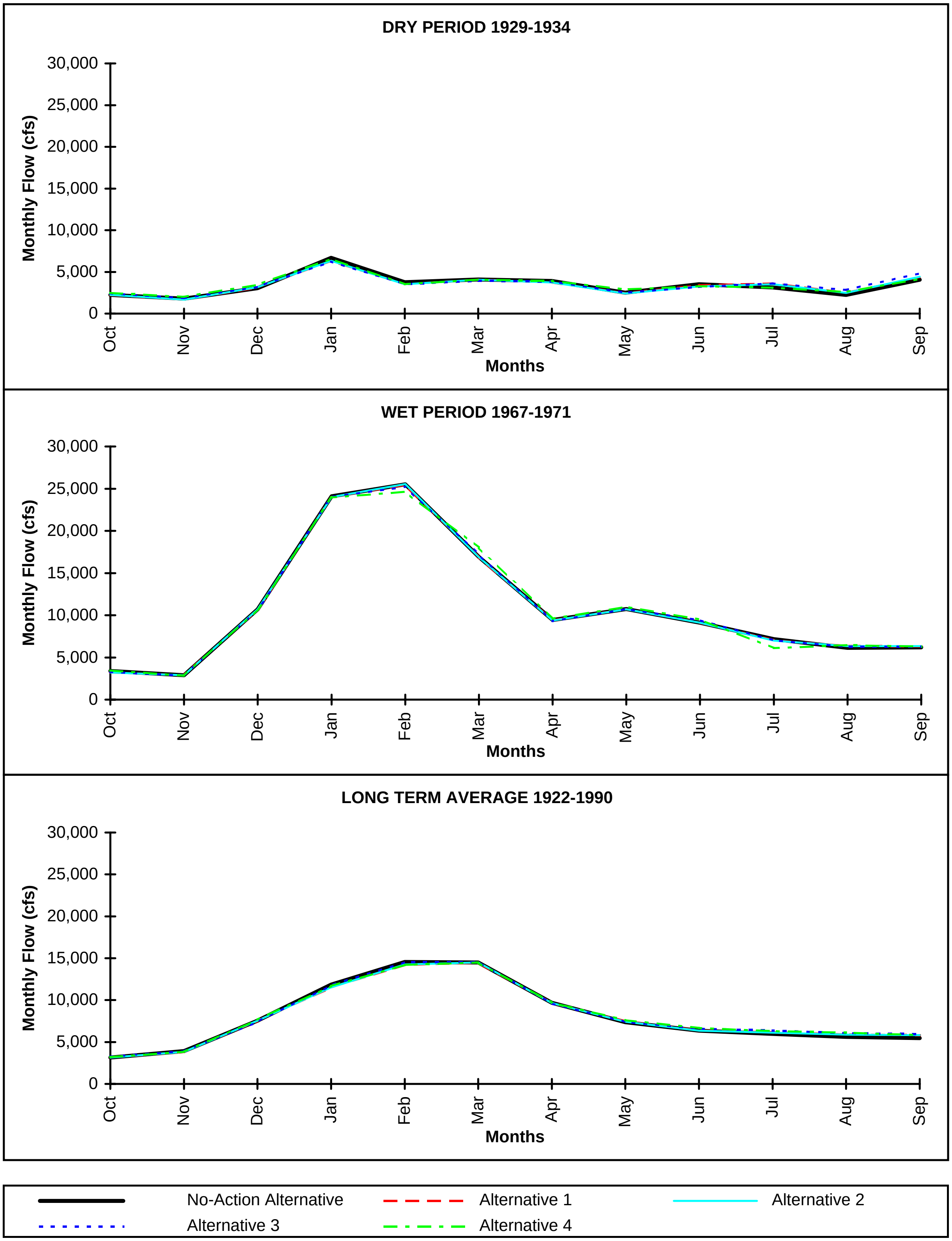


FIGURE III-25

FEATHER RIVER AT NICOLAUS SIMULATED AVERAGE MONTHLY FLOWS

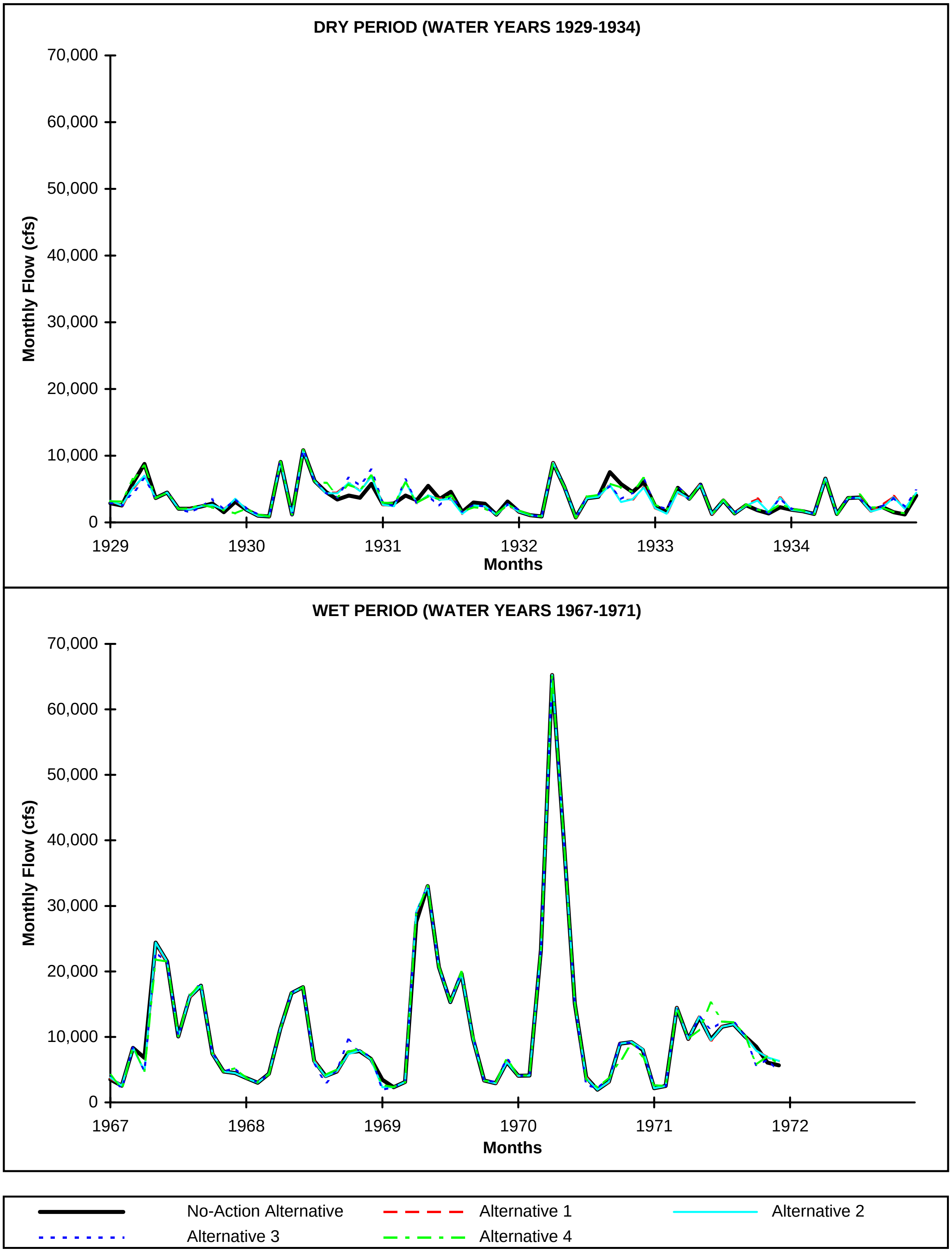


FIGURE III-26

FEATHER RIVER AT NICOLAUS SIMULATED MONTHLY FLOWS

Lake Oroville. Lake Oroville releases can then be increased in the summer for delivery purposes. Frequency distributions of simulated annual exports through Banks Pumping Plant in the No-Action Alternative and Alternative 1 simulations are compared in Figure III-18. In comparison to the No-Action Alternative, the average annual increase in SWP exports is about 70,000 acre-feet per year. Figure III-27 shows a comparison of average monthly Banks exports for the dry, wet, and 69-year simulation period.

It is possible that a portion of the water pumped at the Banks Pumping Plant would be wheeled by the SWP for delivery to CVP Cross Valley Canal contractors.

San Luis Reservoir Operations. The Alternative 1 impacts to SWP storage in San Luis Reservoir are a direct result of changes in Banks Pumping Plant monthly exports. As shown in Figure III-18, Alternative 1 average monthly SWP San Luis Reservoir storage levels are slightly higher than in the No-Action Alternative, a result of increased October-through-January Banks Pumping Plant exports. Minimum end-of-water year September average monthly storage levels are similar to the No-Action Alternative.

SWP Entitlement Water Deliveries

In Alternative 1 SWP deliveries to agricultural and M&I entitlement holders south of the Delta increase about 100,000 acre-feet per year on an average annual basis. A comparison of frequency distributions for the simulated percent of full contract delivery in the No-Action Alternative and Alternative 1 is presented in Figure III-22. The difference in simulated annual deliveries is presented in Figure III-23. The increase in SWP deliveries in Alternative 1 because of the SWP's ability to adjust operations to take advantage of excess Delta inflows resulting from increased upstream CVP reservoir releases for target flows. If the SWP contracted with CVP water users to wheel this excess CVP water through Banks Pumping Plant, these increased SWP deliveries might not occur.

SUPPLEMENTAL ANALYSIS 1a

DESCRIPTION OF SUPPLEMENTAL ANALYSIS

As described in the previous section, Alternative 1 includes the use of (b)(2) water to help meet fishery target flow goals on CVP-controlled streams, provides delivery of firm Level 2 water supplies to refuge, and implements the revised instream fishery flow pattern on the Trinity River. In addition, Supplemental Analysis 1a includes the use of (b)(2) water to attempt to meet fishery objectives in the Delta, as well as on CVP-controlled streams. As is the case with Alternative 1, a simplified version of the (b)(2) Water Management in the Delta was developed for the Draft PEIS analysis. The Delta (b)(2) actions evaluated in Supplemental Analysis 1a are based on preliminary actions proposed by the Service in February of 1996. The assumptions and process to develop a (b)(2) Water Management strategy for Supplemental Analysis 1a are discussed in Attachment G-2 of the Draft PEIS.

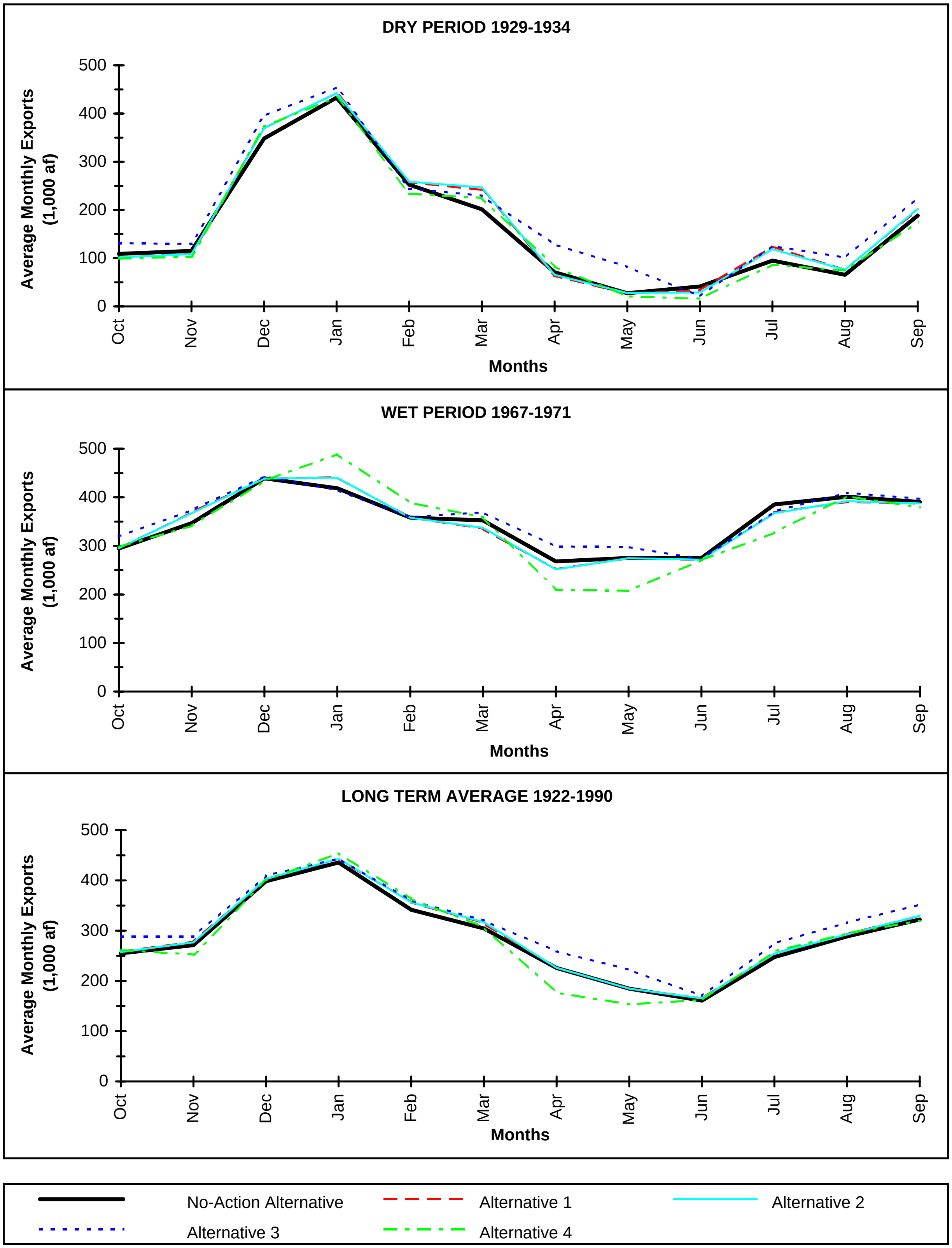


FIGURE III-27

BANKS PUMPING PLANT SIMULATED AVERAGE MONTHLY EXPORTS

The Delta (b)(2) actions incorporated into Supplemental Analysis 1a, in addition to the upstream (b)(2) Water Management described in Alternative 1, are listed below.

- Maintain a 1,500-cfs maximum for total CVP/SWP exports during the 30-day pulse flow period from April 15 through May 15. The 1,500-cfs maximum pumping limit approximates the Service's desired San Joaquin River pulse flow export/inflow ratio under each of the different water year types.

- Increase level of protection targeted by the May and June X2 requirement to a 1962 level of development. This represents an increase in the number of days when X2 (the 2 parts per thousand isohaline) would be required at Chipps Island as specified in Table A of the SWRCB May 1995 Water Quality Control Plan.

- Reduce CVP Tracy Pumping Plant exports in November and December to decrease the fall Delta export/inflow ratio. This action is intended to reduce the direct and indirect entrainment effects of export pumping on migrating juvenile chinook salmon.

SUPPLEMENTAL ANALYSIS 1a IMPACTS ON CVP OPERATIONS AND DELIVERIES

Supplemental Analysis 1a includes all the CVPIA actions in Alternative 1, plus the use of (b)(2) water in the Delta as described above. The Delta (b)(2) actions specified above would reduce the flexibility of the CVP to fill San Luis Reservoir during November and December and would further limit the amount of water that could be exported during the pulse flow period of April 15 to May 15. The simulated delivery impacts of Supplemental Analysis 1a as compared to the No-Action Alternative are shown in Table III-6. A discussion of operational and delivery impacts as compared to the No-Action Alternative is provided below.

CVP Operations

The addition of Delta (b)(2) water use in Supplemental Analysis 1a would have a minor effect on upstream CVP reservoir operations of the Trinity River, Shasta River, Sacramento River, and American River divisions. The (b)(2) Delta actions primarily affect the CVP's ability to export water south of the Delta through Tracy Pumping Plant. Some additional water would also need to be released from upstream reservoirs to meet the increased number of X2 days specified at Chipps Island. A summary of the impacts to each of the CVP divisions is provided below.

TABLE III-6
COMPARISON OF CVP DELIVERIES IN SUPPLEMENTAL ANALYSIS 1a, ALTERNATIVE 1, AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual CVP Deliveries (1,000 acre-feet)			Alternative 1a and No-Action Alternative:
		No-Action Alternative	Alternative 1	Supplemental Analysis 1a	Average Annual Change in CVP Deliveries (1,000 acre-feet)
1922 - 1990	Simulation Period	5,770	5,300	5,200	-570
1928 - 1934	Dry Period	4,560	4,050	3,980	-580
1967 - 1971	Wet Period	6,310	6,020	5,970	-340

NOTES:
(1) CVP deliveries include deliveries to agricultural and M&I water service contractors, Sacramento River water rights contractors, other water rights contractors, San Joaquin Exchange Contractors. CVP deliveries do not include refuge water supplies.

Trinity River Division. As shown in Figures III-28 and III-29, the simulated operations of Clair Engle Lake and the releases into Clear Creek from Whiskeytown Lake to meet target flows are similar to those in Alternative 1.

Shasta and Sacramento River Divisions. As in the Trinity River Division, the simulated Shasta Lake operations and the resulting average monthly flows on the Sacramento River at Keswick and Sacramento River at Knights Landing are the same as in Alternative 1. Figures III-28, III-30, and III-31 show there is virtually no discernable change to simulated CVP operations.

American River Division. The frequency distribution for simulated Folsom Lake end-of water-year storage in Figure III-28 and the monthly flows shown in Figure III-32 for the American River below Nimbus are similar to Alternative 1.

Eastside Division. Supplemental Analysis 1a includes no actions that would change operations of New Melones Reservoir or flows in the Stanislaus River below Goodwin Dam as compared to Alternative 1, as shown in Figures III-28 and III-33. Similarly, flows and water quality conditions on the San Joaquin River at Vernalis would be similar to conditions under Alternative 1, as shown in Figures III-34 and III-35.

Delta Division. The Delta (b)(2) actions in Supplemental Analysis 1a would have a direct impact on CVP Tracy Pumping Plant exports. The frequency distribution in Figure III-36 shows the reduction in simulated annual exports, as compared to Alternative 1 and the No-Action Alternative, over the 69-year simulation period. Figure III-37 shows the shift in average monthly Tracy Pumping Plant exports for the dry, wet, and simulation periods. The figure shows the

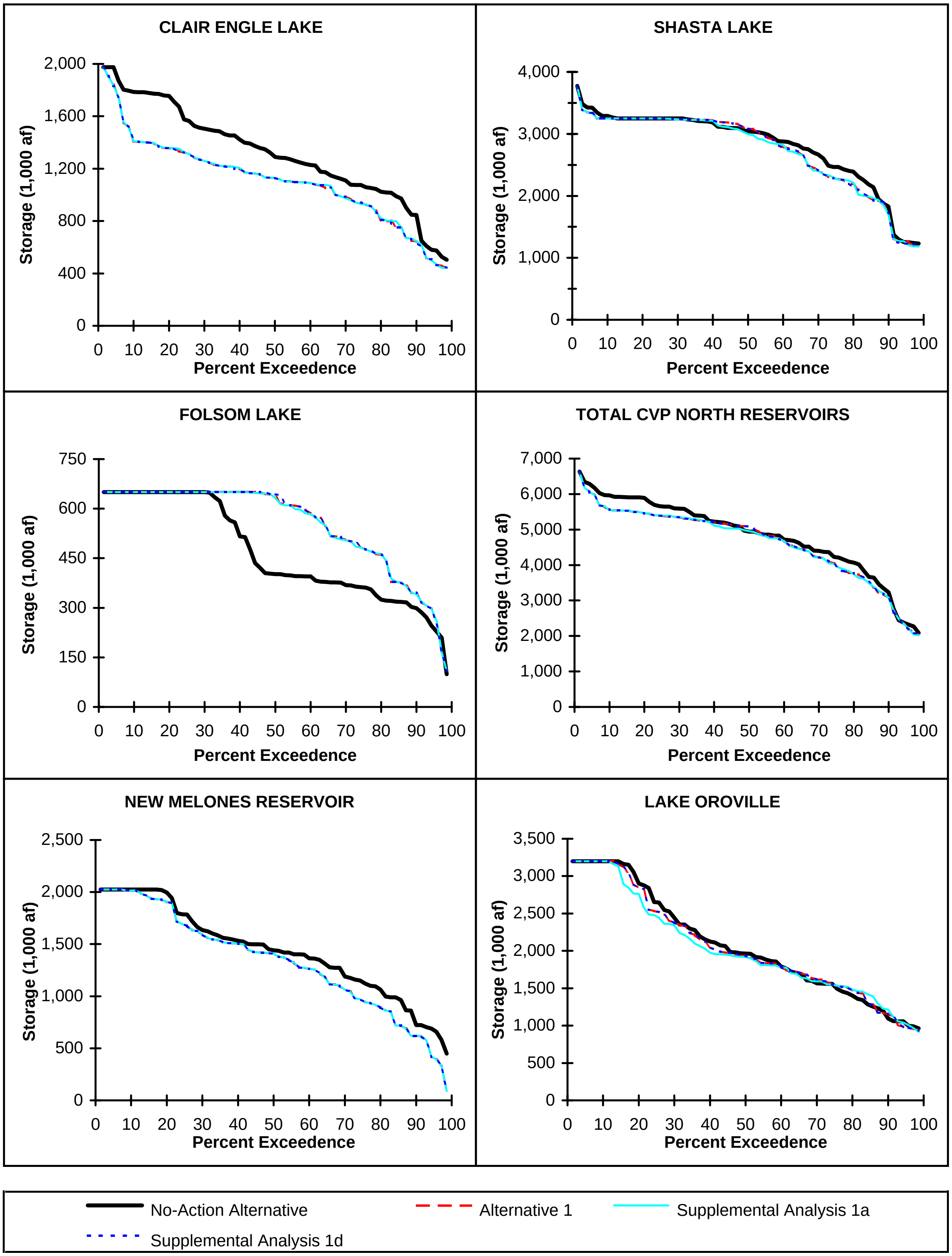


FIGURE III-28

SIMULATED FREQUENCY OF END-OF-WATER YEAR STORAGE 1922-1990

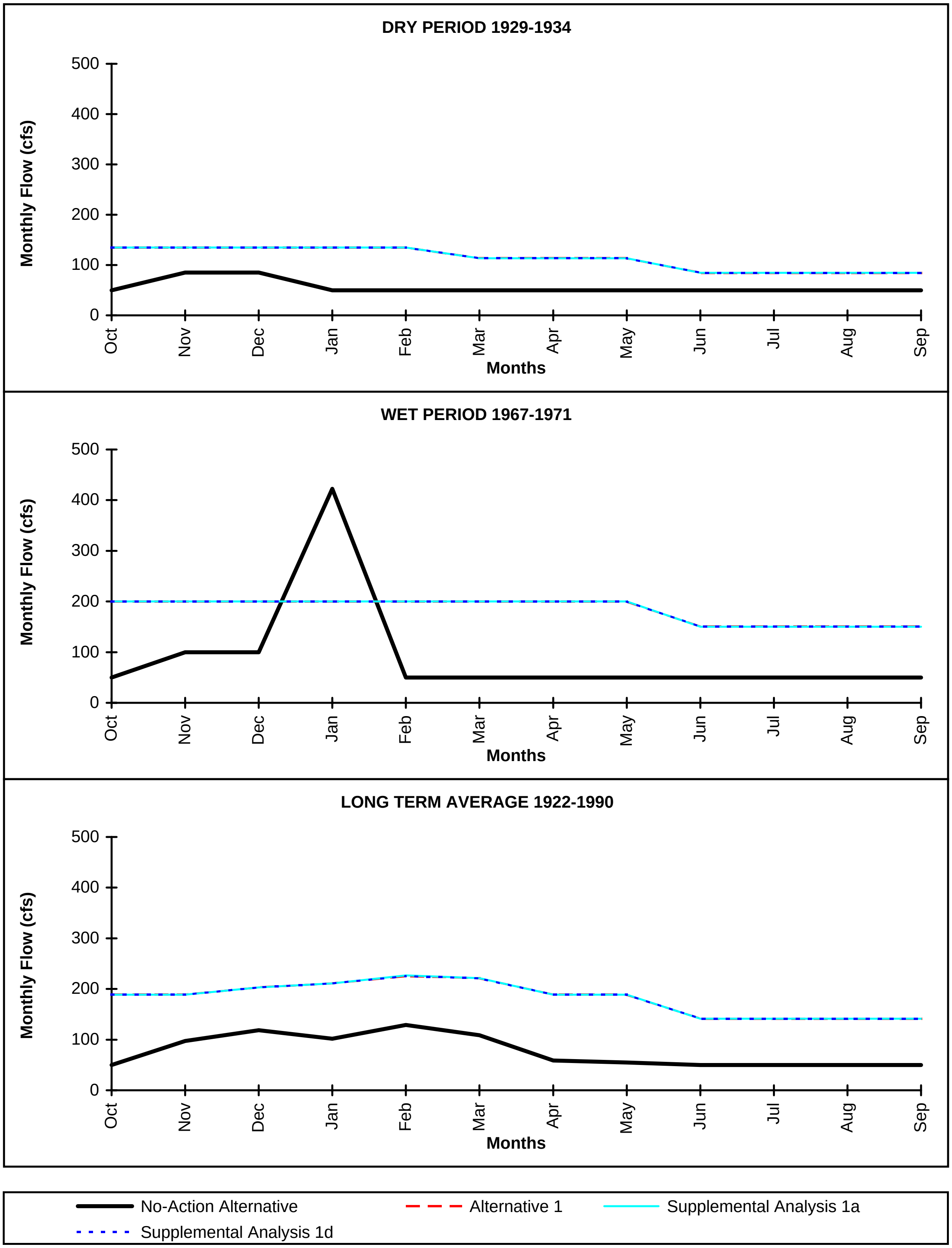


FIGURE III-29
CLEAR CREEK BELOW WHISKEYTOWN
SIMULATED AVERAGE MONTHLY FLOWS

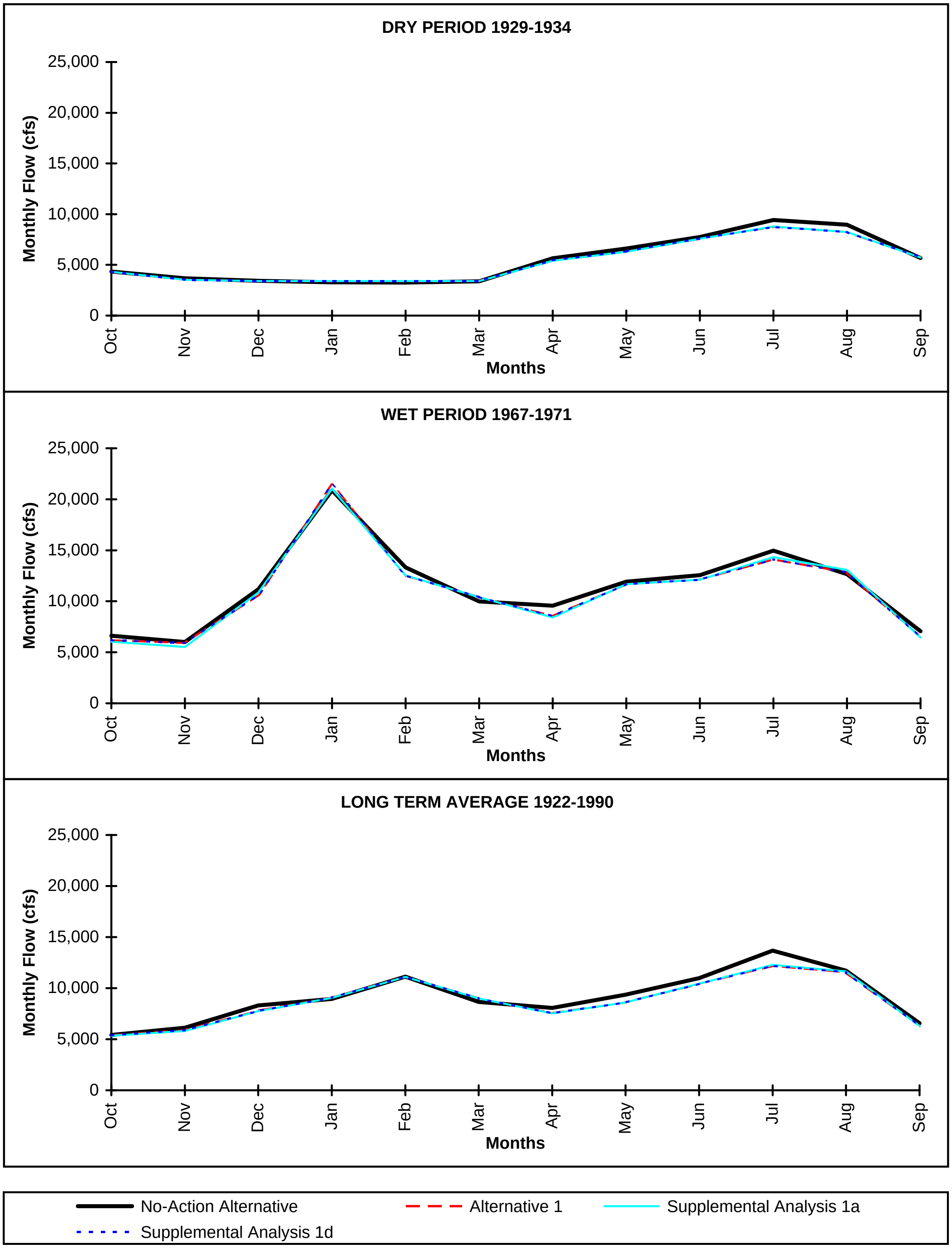


FIGURE III-30
SACRAMENTO RIVER AT KESWICK
SIMULATED AVERAGE MONTHLY FLOWS

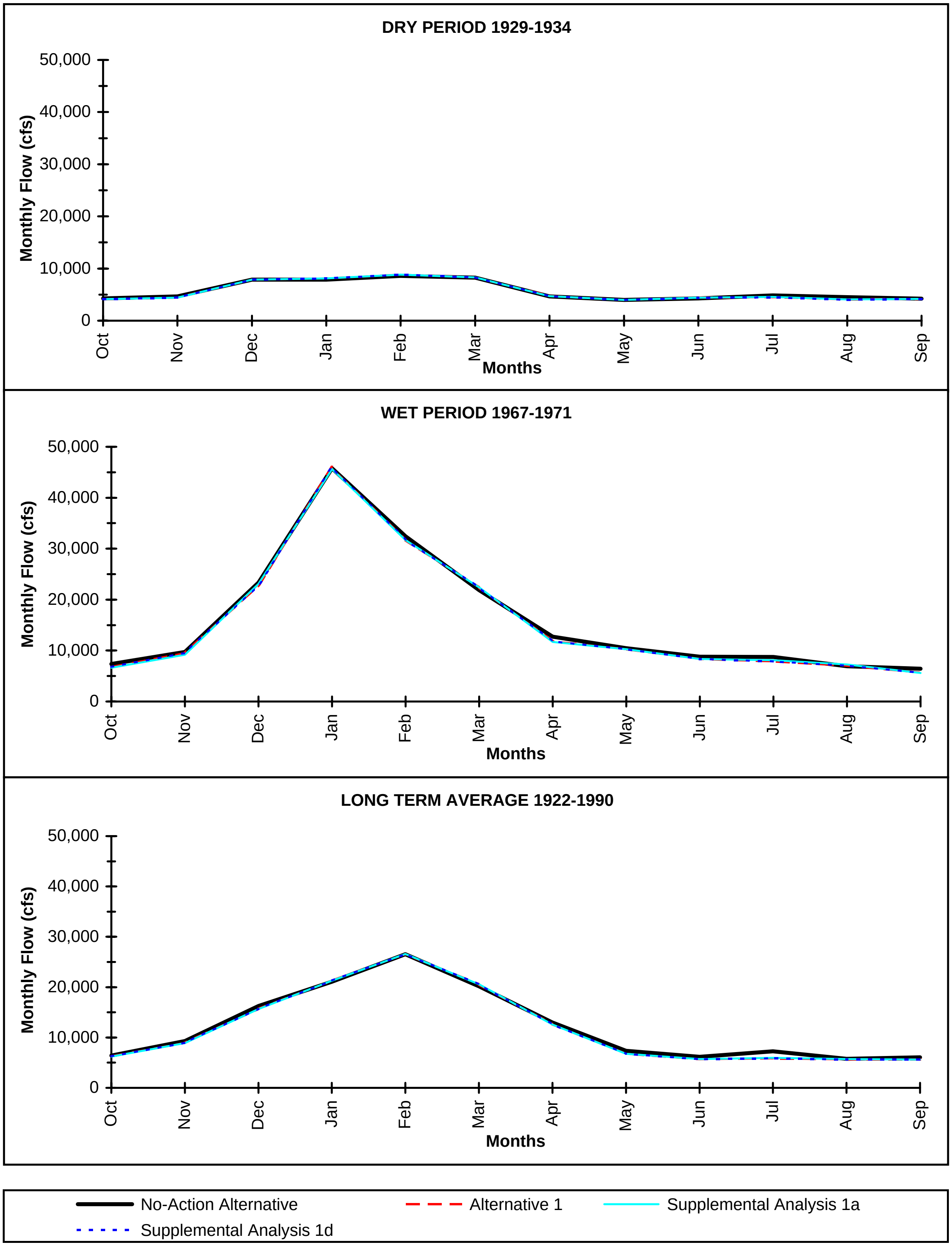


FIGURE III-31
SACRAMENTO RIVER AT KNIGHTS LANDING
SIMULATED AVERAGE MONTHLY FLOWS

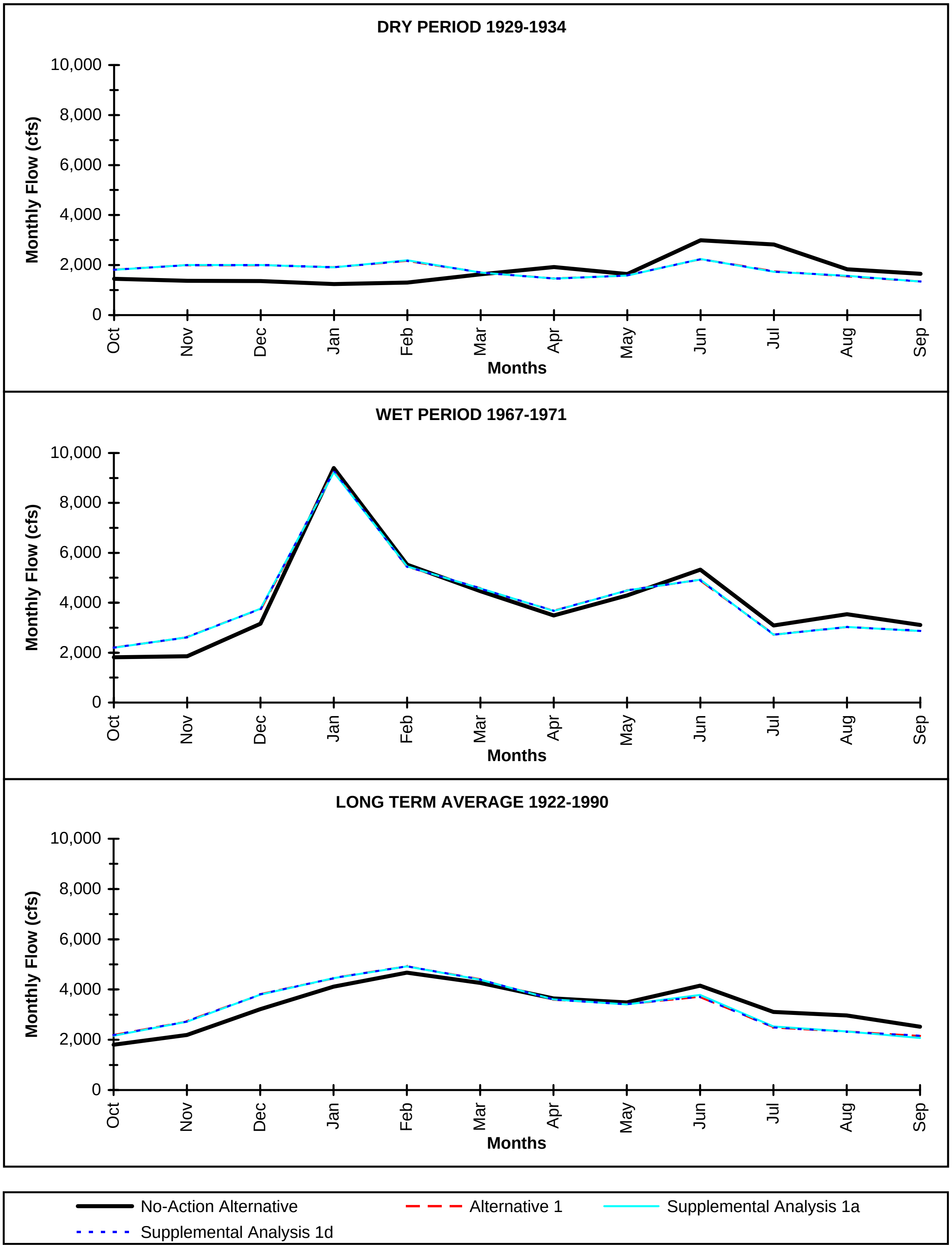


FIGURE III-32

AMERICAN RIVER BELOW NIMBUS SIMULATED AVERAGE MONTHLY FLOWS

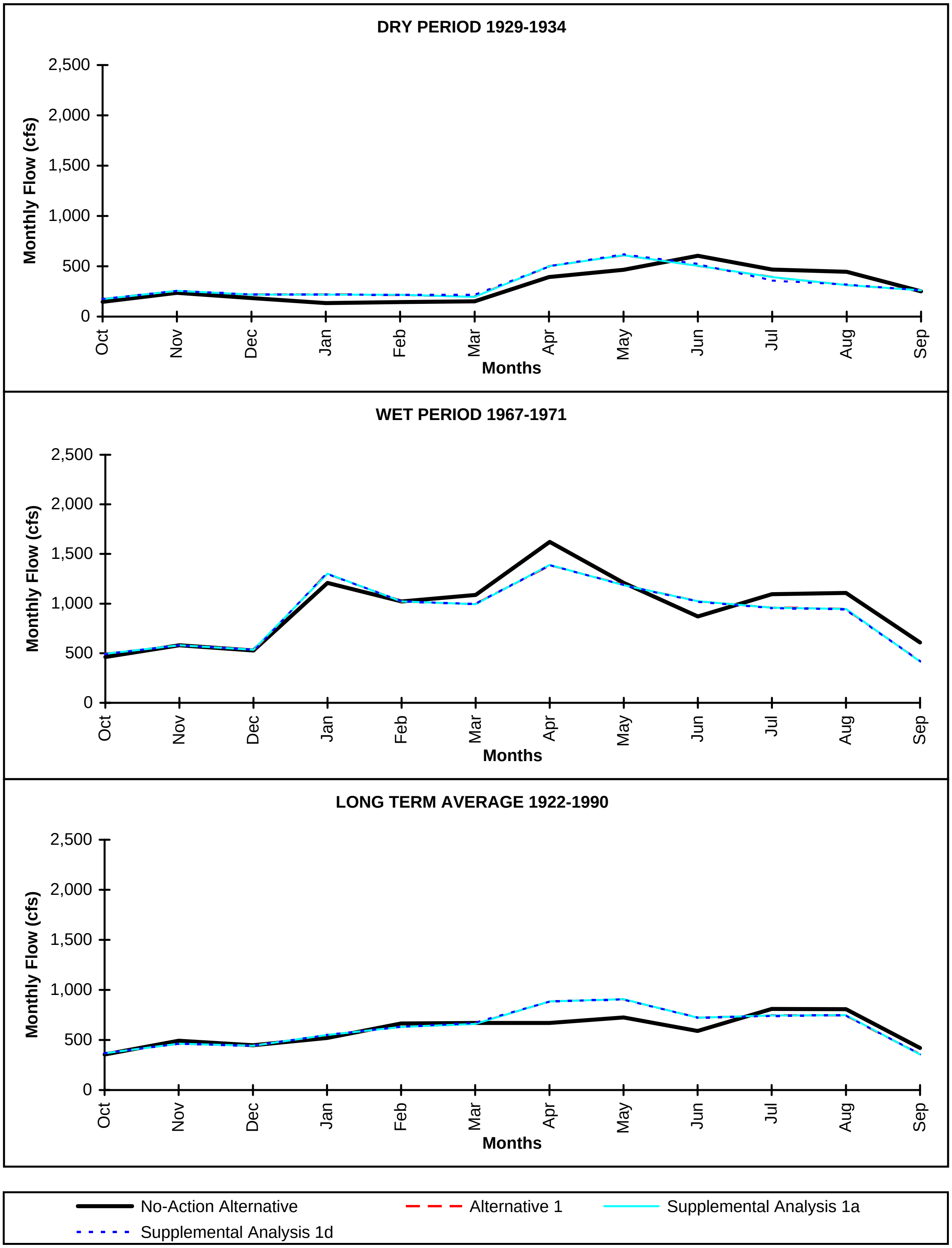


FIGURE III-33
STANISLAUS RIVER BELOW GOODWIN
SIMULATED AVERAGE MONTHLY FLOWS

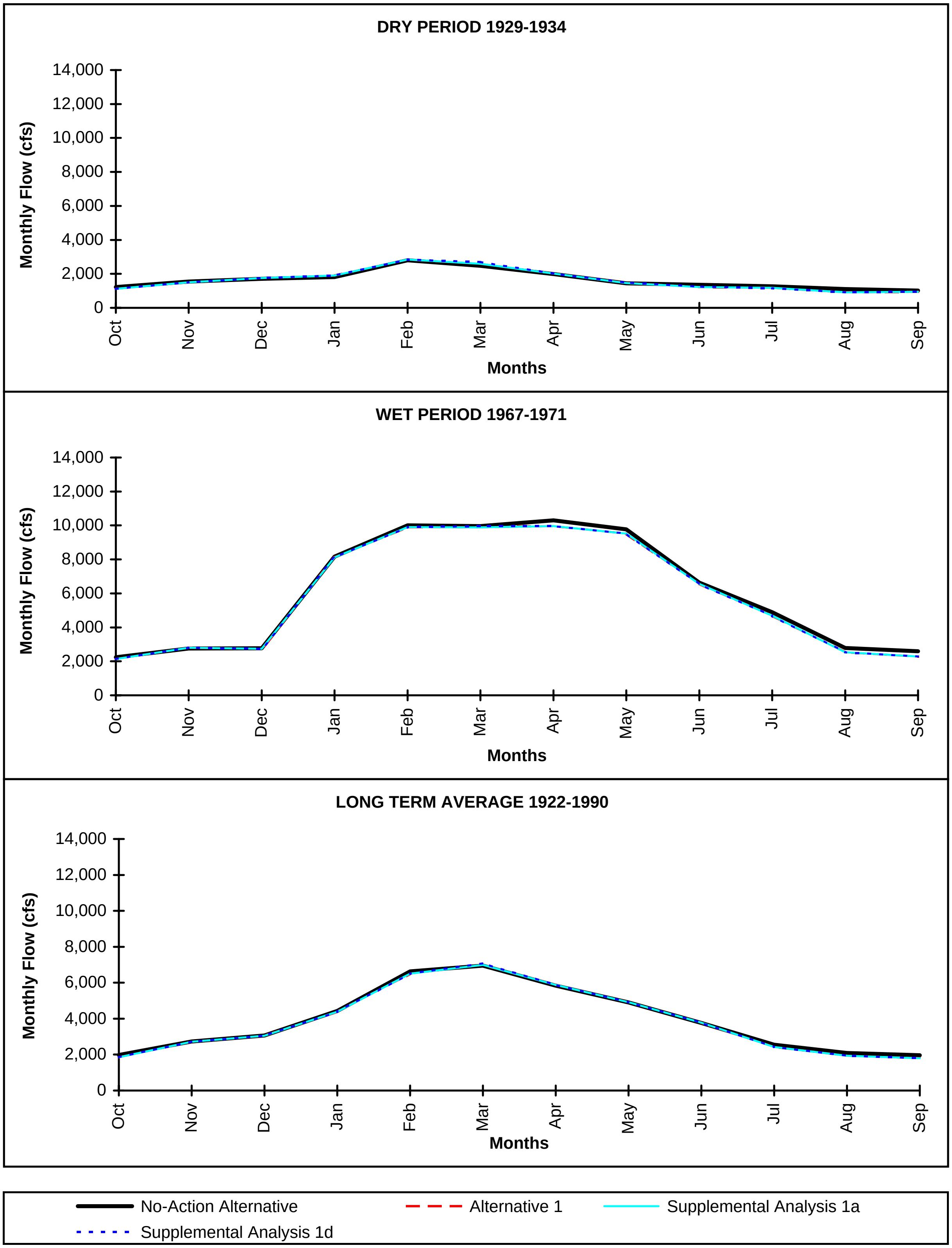


FIGURE III-34
SAN JOAQUIN RIVER AT VERNALIS
SIMULATED AVERAGE MONTHLY FLOWS

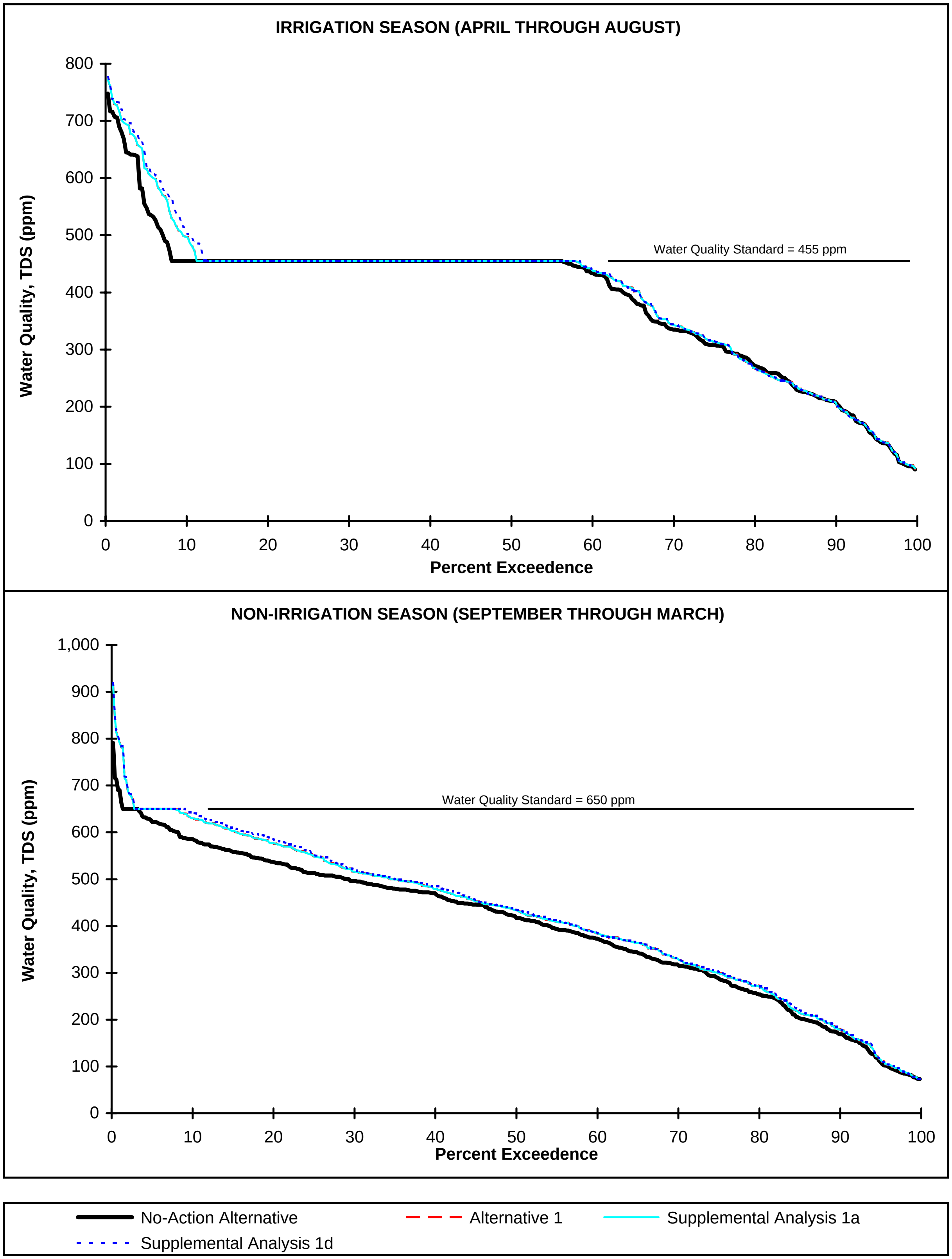


FIGURE III-35

SIMULATED MONTHLY WATER QUALITY AT VERNALIS

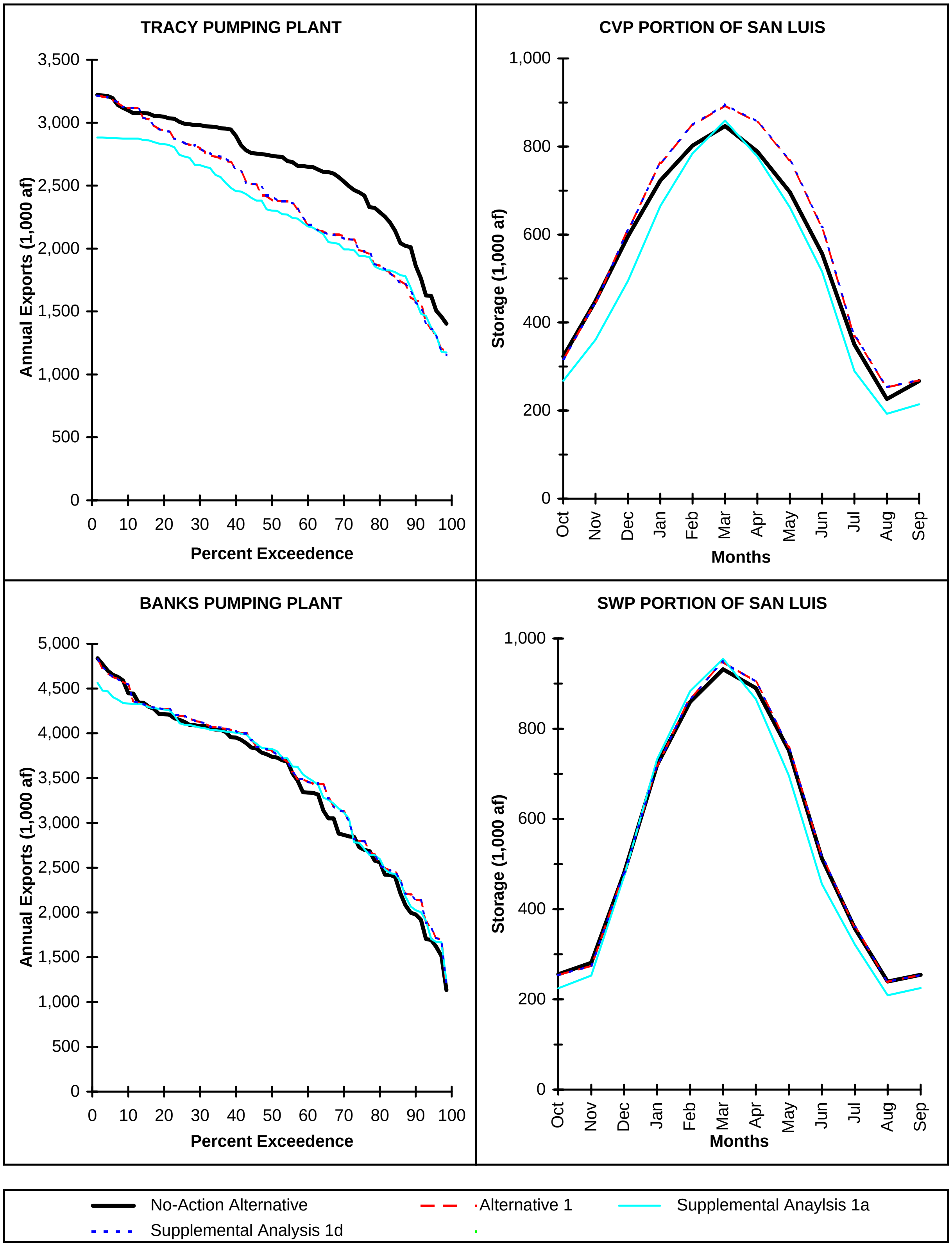


FIGURE III-36
SIMULATED ANNUAL EXPORTS AND SAN LUIS RESERVOIR AVERAGE END-OF-MONTH STORAGE 1922-1990

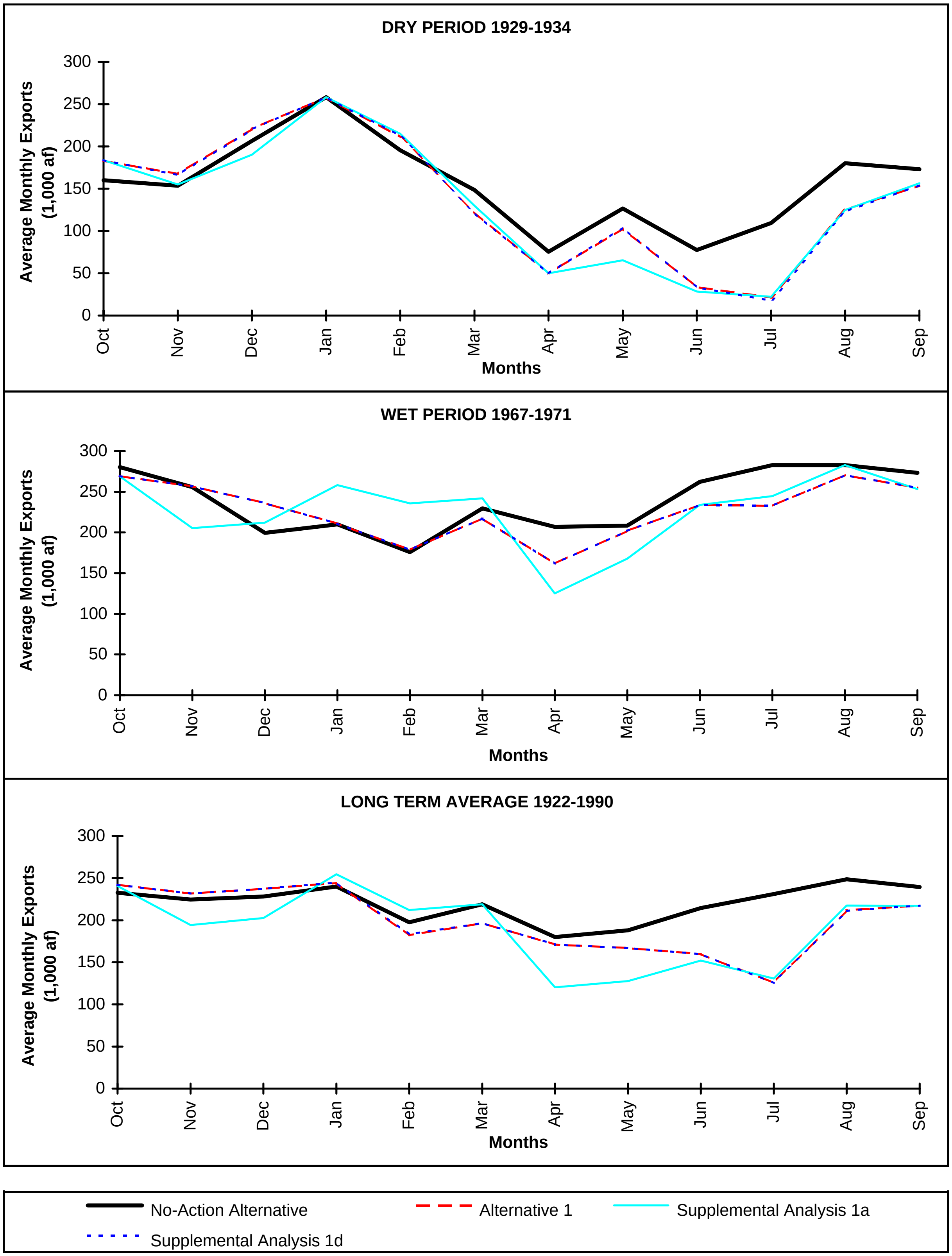


FIGURE III-37

TRACY PUMPING PLANT SIMULATED AVERAGE MONTHLY EXPORTS

decrease in exports in November and December and in April and May as compared to Alternative 1. The figure also shows increased average monthly exports in roughly January through March, to make up for reduced pumping in previous months, in the wet and long-term average periods. In Supplemental Analysis 1a the average annual Delta outflow increases by about 80,000 acre-feet per year over the No-Action Alternative, and about 140,000 acre-feet per year over Alternative 1. The slight increase in Delta outflow in April, May, and June of the wet, above normal, and below normal years is a result of the April 15 through May 15 export restrictions and the increased number of X2 days at Chipps Island in May and June. Simulated average monthly Delta outflows in Supplemental Analysis 1a are shown in Figure III-38, as compared to Alternative 1 and the No-Action Alternative. The small increase in outflow resulting from the Delta (b)(2) actions is not discernable in the figure due to the large volume of Delta outflow.

West San Joaquin Division. The Delta (b)(2) actions limiting Tracy Pumping Plant exports April 15 through May 15, and in November and December reduce the CVP's flexibility to fill the CVP portion of San Luis Reservoir in the fall and supplement San Luis Reservoir releases in the spring. Figure III-36 shows simulated average monthly San Luis Reservoir CVP storage, as compared to Alternative 1 and the No-Action Alternative.

CVP Water Contract Deliveries

Alternative 1 includes the evaluation of the use of (b)(2) water to meet target goals on CVP controlled streams, firm Level 2 refuge supplies, and revised instream fishery releases on the Trinity River. In addition, Supplemental Analysis 1a includes the use of (b)(2) water in the attempt to meet fishery objectives in the Delta, as well as on CVP controlled streams. Because of the nature of the proposed Delta (b)(2) actions, the primary impact is to CVP water deliveries south of the Delta.

CVP Water Deliveries North of the Delta. As in Alternative 1, there would be no change in CVP deliveries to Sacramento River Water Rights Contractors as compared to the No-Action Alternative. Figure III-39 shows the comparison of Supplemental Analysis 1a and No-Action Alternative total annual deliveries to CVP agricultural contractors north of the Delta, including water rights and water service contractors. The change in annual deliveries to CVP M&I Water Service Contractors as compared to the No-Action Alternative is also shown in this figure. Comparisons of the frequency distributions for percent of full delivery to CVP agricultural and CVP M&I Water Service Contractors are presented in Figure III-40. The deliveries in Alternative 1 and Supplemental analysis 1a are very similar as compared to the No-Action Alternative.

CVP Water Deliveries Eastside Division. The deliveries to CVP contractors in the Eastside Division under Supplemental Analysis 1a would be the same as those described in Alternative 1, as shown by Figures III-39 and III-40.

CVP Water Deliveries South of the Delta. Deliveries to the San Joaquin River Exchange Contractors are the same as in the No-Action Alternative and Alternative 1. The comparison of Supplemental Analysis 1a and No-Action Alternative total annual deliveries to CVP agricultural contractors south of the Delta, including exchange and water service contracts, is shown in Figure III-41. A similar comparison for CVP M&I Water Service Contractors south of the Delta is also

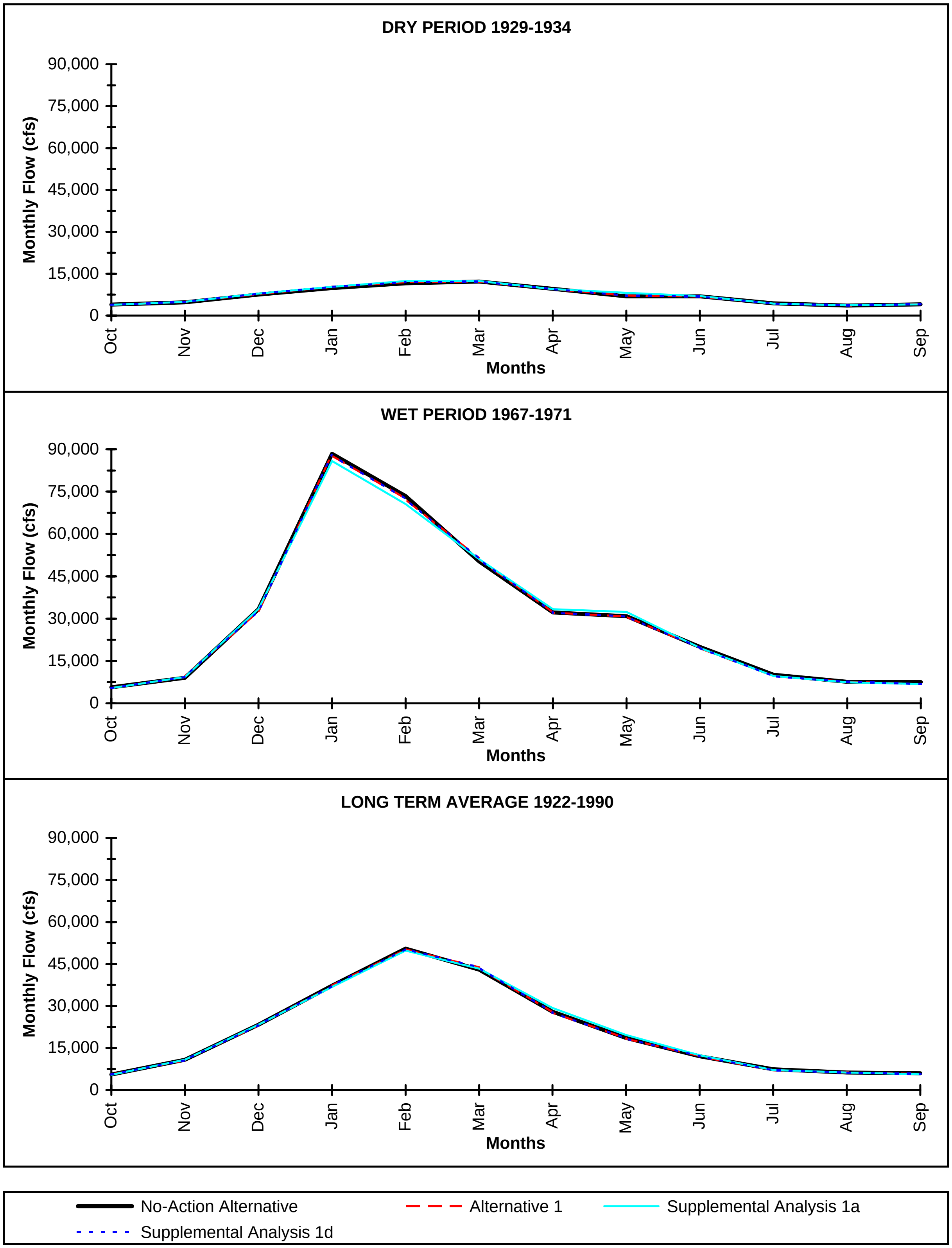
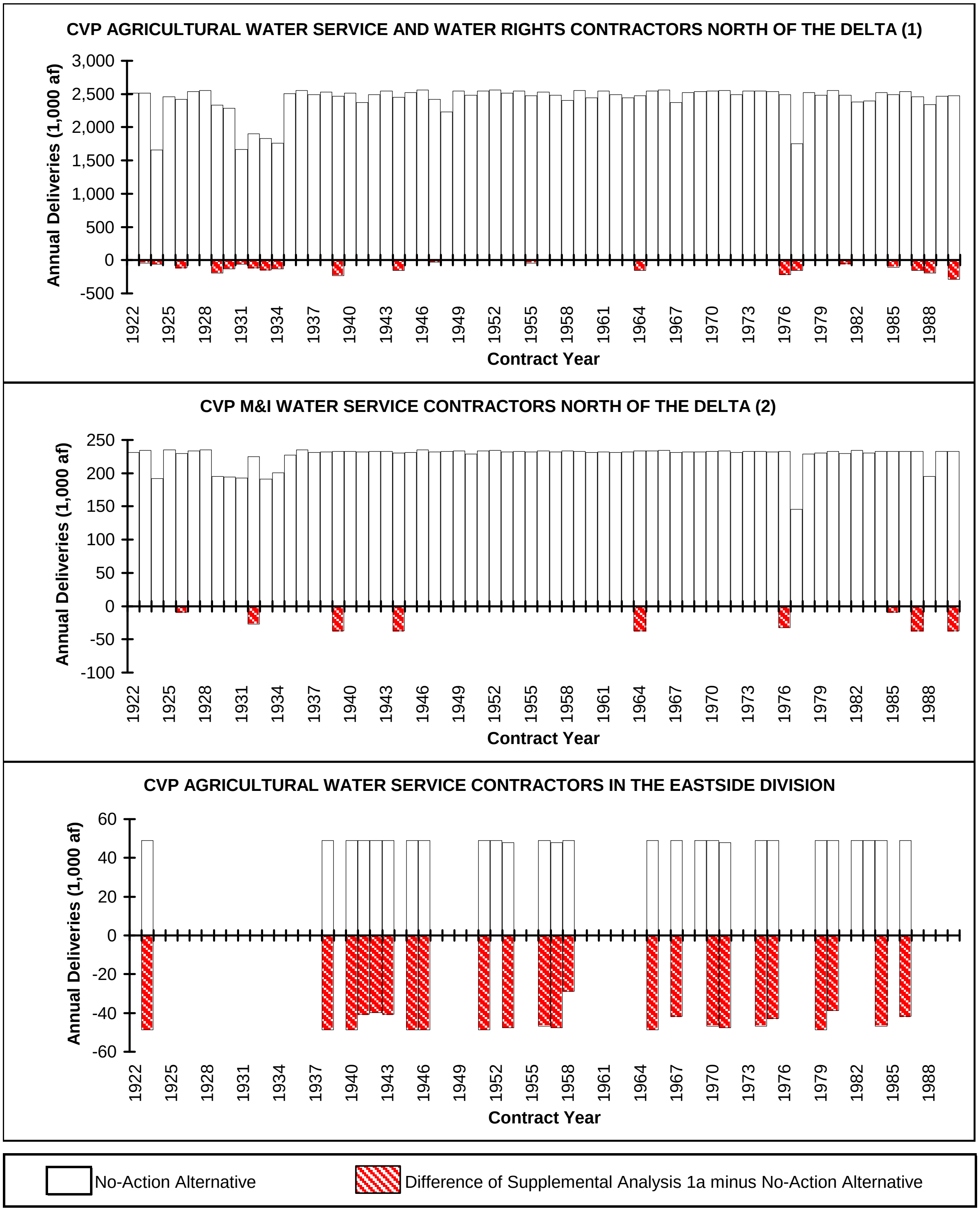


FIGURE III-38

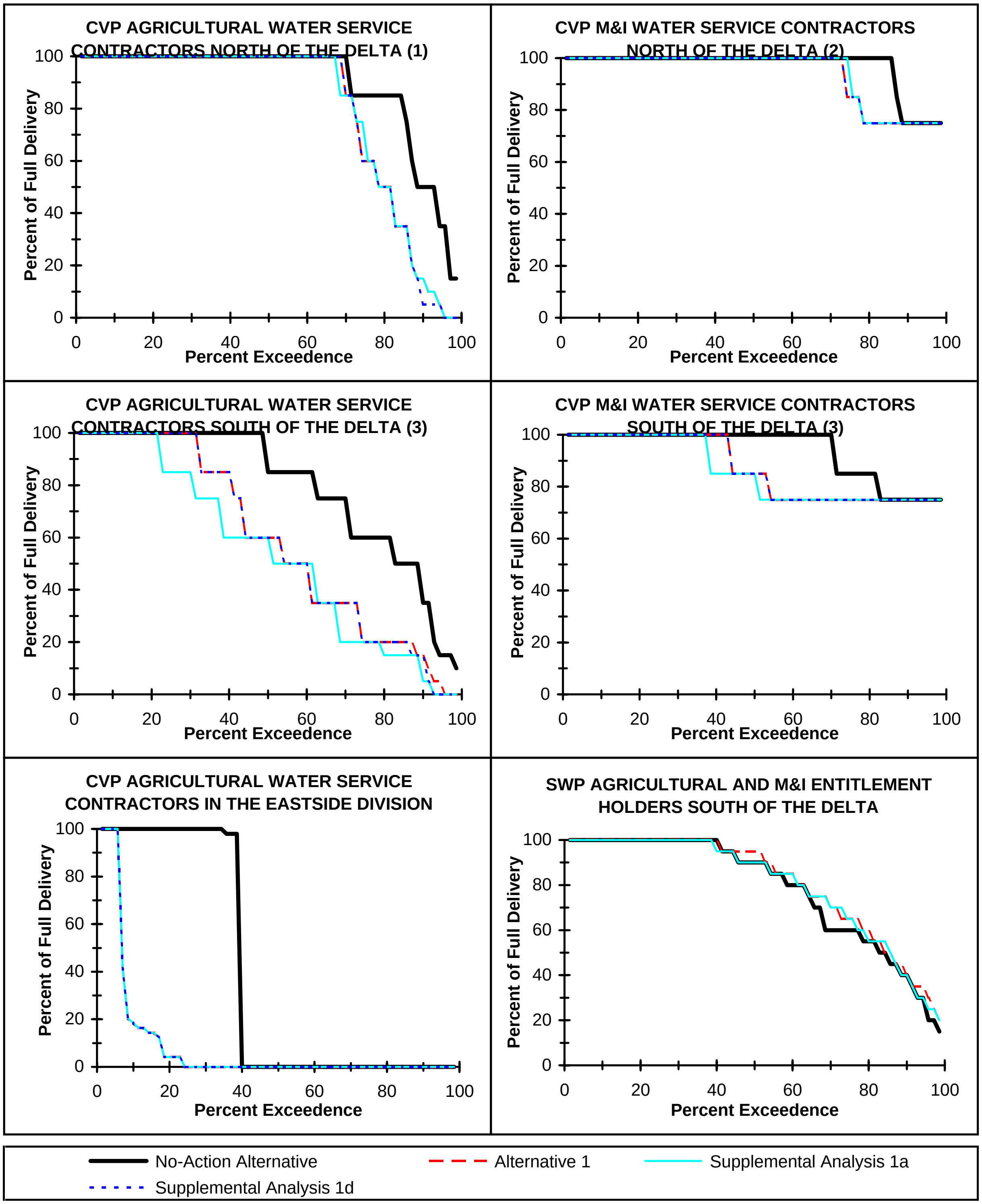
DELTA OUTFLOW SIMULATED AVERAGE MONTHLY FLOWS



NOTES: (1) Includes Sacramento River and American River Divisions.

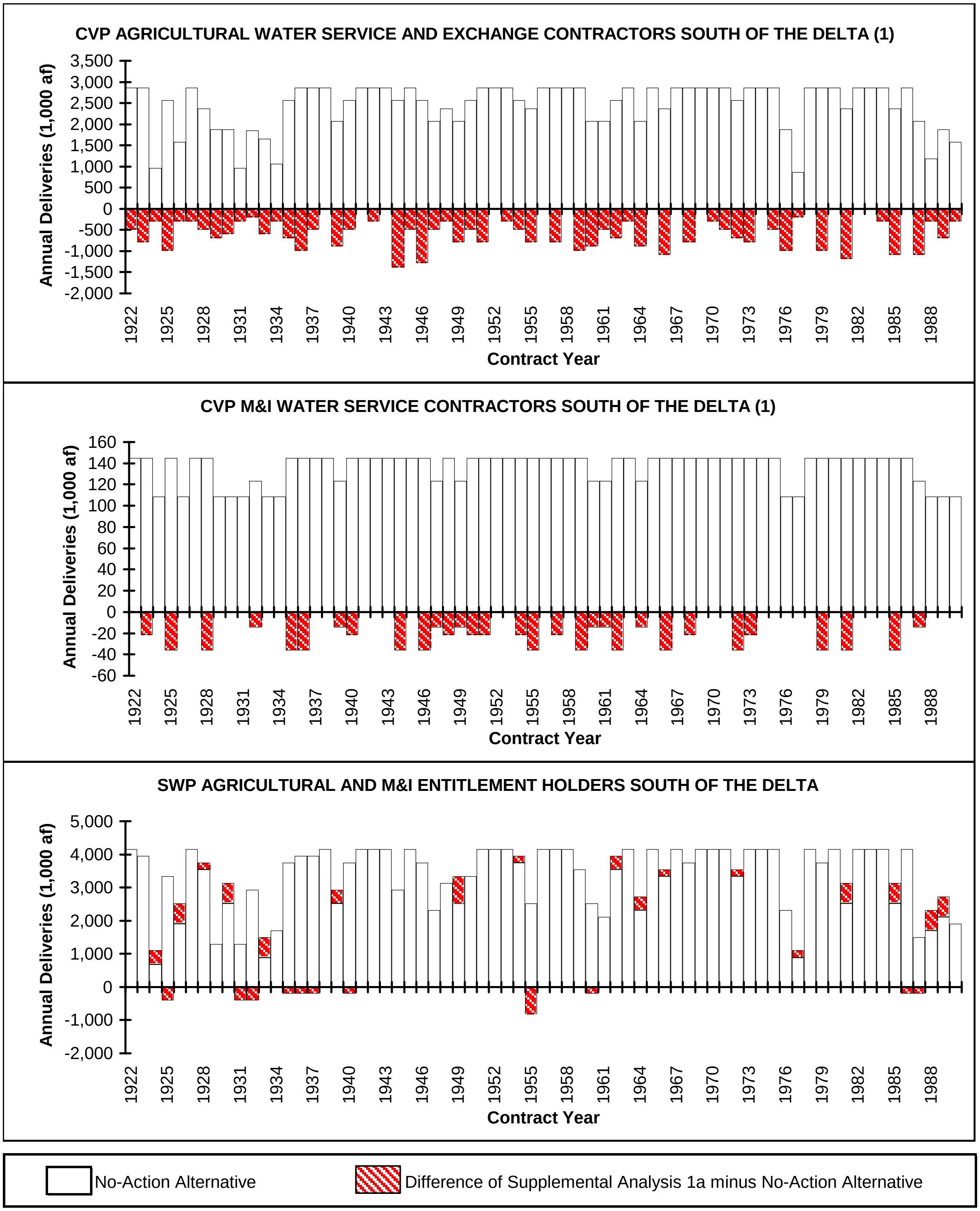
(2) Includes Sacramento River and American River Divisions plus Contra Costa exports.

FIGURE III-39
SIMULATED SUPPLEMENTAL ANALYSIS 1a DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990



NOTES: (1) Includes Sacramento River and American River Divisions.
(2) Includes Sacramento River and American River Divisions plus Contra Costa exports.
(3) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE III-40
SIMULATED FREQUENCY OF PERCENT OF FULL ANNUAL DELIVERIES 1922-1990



NOTE: (1) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE III-41
SIMULATED SUPPLEMENTAL ANALYSIS 1a DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990

shown in this figure. The frequency distributions for CVP Agricultural and M&I Water Service Contractors percent of full delivery are presented in Figure III-40 as compared to the No- Action Alternative. The figure shows about a 5 to 10 percent reduction in the frequency of delivery as compared to Alternative 1, and about a 25 to 40 percent reduction in the frequency of deliveries as compared to the No-Action Alternative, except in the 10 percent lowest delivery years.

CVP Water Deliveries to Refuges. CVP deliveries to refuges in Supplemental Analysis 1a would be the same as in Alternative 1.

SUPPLEMENTAL ANALYSIS 1a IMPACTS ON SWP OPERATIONS AND DELIVERIES

Supplemental Analysis 1a assumes that the SWP would cooperate in attempting to meet the (b)(2) actions in the Delta. This cooperation would include reducing exports during the April 15 through May 15 pulse period and making releases to contribute to additional levels of Delta protection. Table III-7 shows a comparison of SWP deliveries for Supplemental Analysis 1a, Alternative 1, and the No-Action Alternative. In Alternative 1 the SWP deliveries increase by about 150,000 acre-feet per year on an average annual basis compared to the No-Action Alternative. In Supplemental Analysis 1a the increase over the No-Action Alternative is reduced to about 90,000 acre-feet per year due to the assumption that the SWP will cooperate in helping to implement the (b)(2) actions in the Delta. A discussion of the Supplemental Analysis 1a impacts to SWP operations is provided below.

TABLE III-7
COMPARISON OF SWP DELIVERIES IN SUPPLEMENTAL ANALYSIS 1a, ALTERNATIVE 1, AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual SWP Deliveries (1,000 acre-feet)			Alternative 1a and No-Action Alternative:
		No-Action Alternative	Alternative 1	Supplemental Analysis 1a	Average Annual Change in SWP Deliveries (1,000 acre-feet)
1922 - 1990	Simulation Period	3,330	3,430	3,390	+60
1928 - 1934	Dry Period	2,050	2,200	2,140	+90
1967 - 1971	Wet Period	4,140	4,100	4,140	0

NOTES:
(1) SWP deliveries include deliveries south of the Delta to entitlement holders. SWP deliveries do not include refuge water supplies.

SWP Operations

SWP operations in Supplemental Analysis 1a are affected by the need to make higher Lake Oroville releases for the increased number of X2 days at Chipps Island, and by the limitation on Banks Pumping Plant exports April 15 through May 15. The impacts to SWP operations are described below.

Lake Oroville and Feather River Operations. The implementation of Delta (b)(2) actions in Supplemental Analysis 1a would have minimal impact on SWP upstream Lake Oroville operations, as shown in Figure III-28. Similarly, these actions would result in minimal changes to flows in the Feather River flows at Nicolaus, as shown in Figure III-42 as compared to Alternative 1 and the No-Action Alternative.

Delta Operations. The shift in average monthly Banks Pumping Plant exports is shown in Figure III-43 for the dry, wet, and 69-year simulation period. The figure show the Supplemental Analysis 1a export reductions in April and May, as well as a slight increase in fall and winter exports to make up for the April and May restrictions. The increase in Banks Pumping Plant exports is only slightly higher in November and December because the pumping plant is usually at capacity already in these months. Figure III-36 shows a comparison of the frequency distributions for annual Banks Pumping Plant exports for the simulation period 1922 through 1990.

San Luis Reservoir Operations. As a result of the limitations to Banks Pumping Plant April 15 through May 15, there would be some additional drawdown to the SWP portion of San Luis Reservoir in the spring, especially during wet years when the 1,500 cfs maximum total pumping limit has the greatest impact on exports. Figure III-36 shows a comparison of simulated average monthly SWP storage in San Luis Reservoir.

SWP Entitlement Water Deliveries

In Supplemental Analysis 1a, SWP deliveries are greater than in the No-Action Alternative, but reduced as compared to Alternative 1, due to the additional Delta (b)(2) actions. Figure III-41 shows simulated annual SWP agricultural and M&I deliveries as compared to the No-Action Alternative. The frequency distributions for the simulated percent of full contract delivery to SWP Agricultural and M&I entitlement holders south of the Delta in the No-Action Alternative, Alternative 1, and Supplemental Analysis 1a are presented in Figure III-40. Full contract delivery occurs in 40 percent of the years in all three simulations. The delivery increases in Alternative 1 and Supplemental Analysis 1a are similar, as compared to the No-Action Alternative. These increases in entitlement deliveries are a result of increased fall and winter SWP pumping through Banks Pumping Plant.

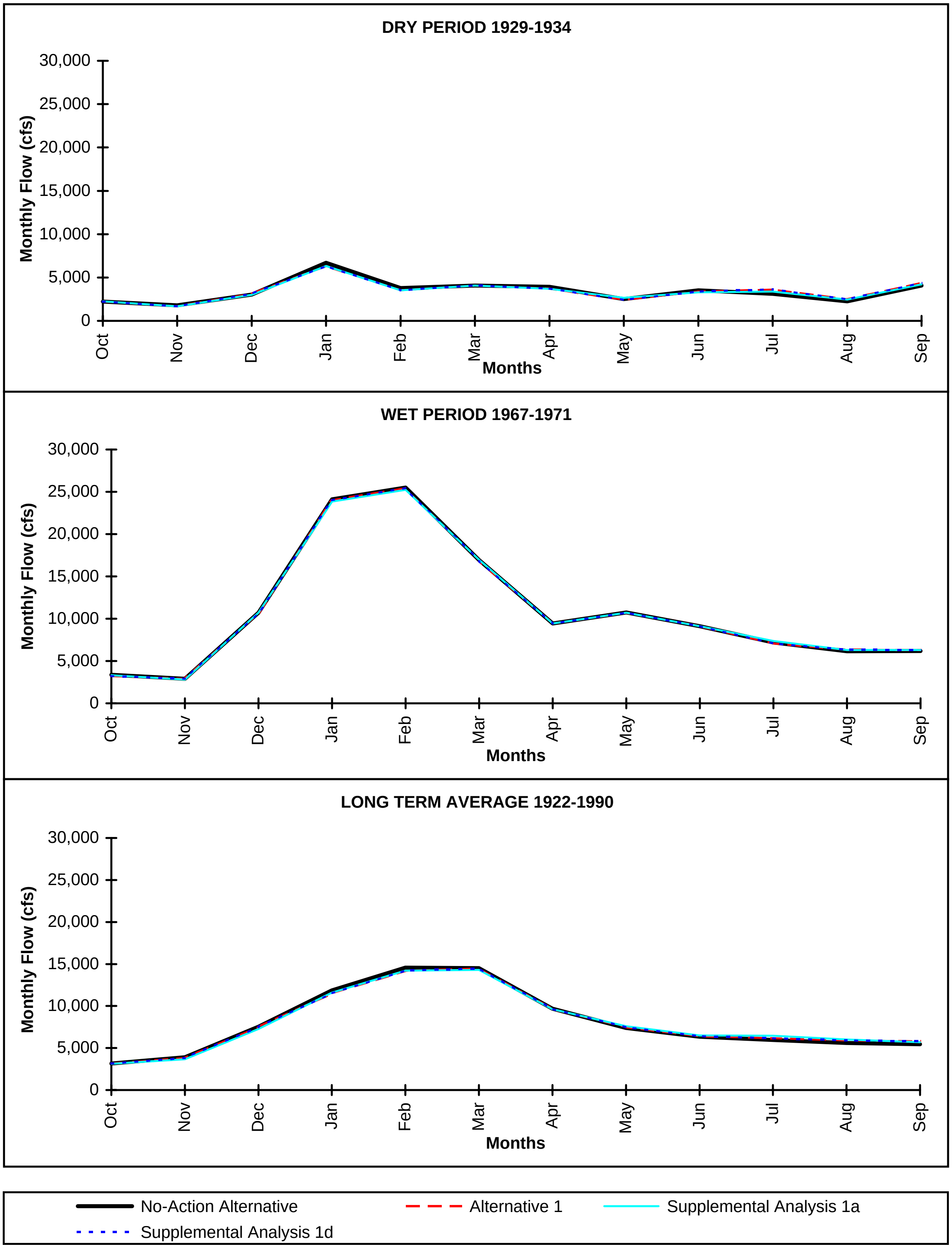


FIGURE III-42

FEATHER RIVER AT NICOLAUS SIMULATED AVERAGE MONTHLY FLOWS

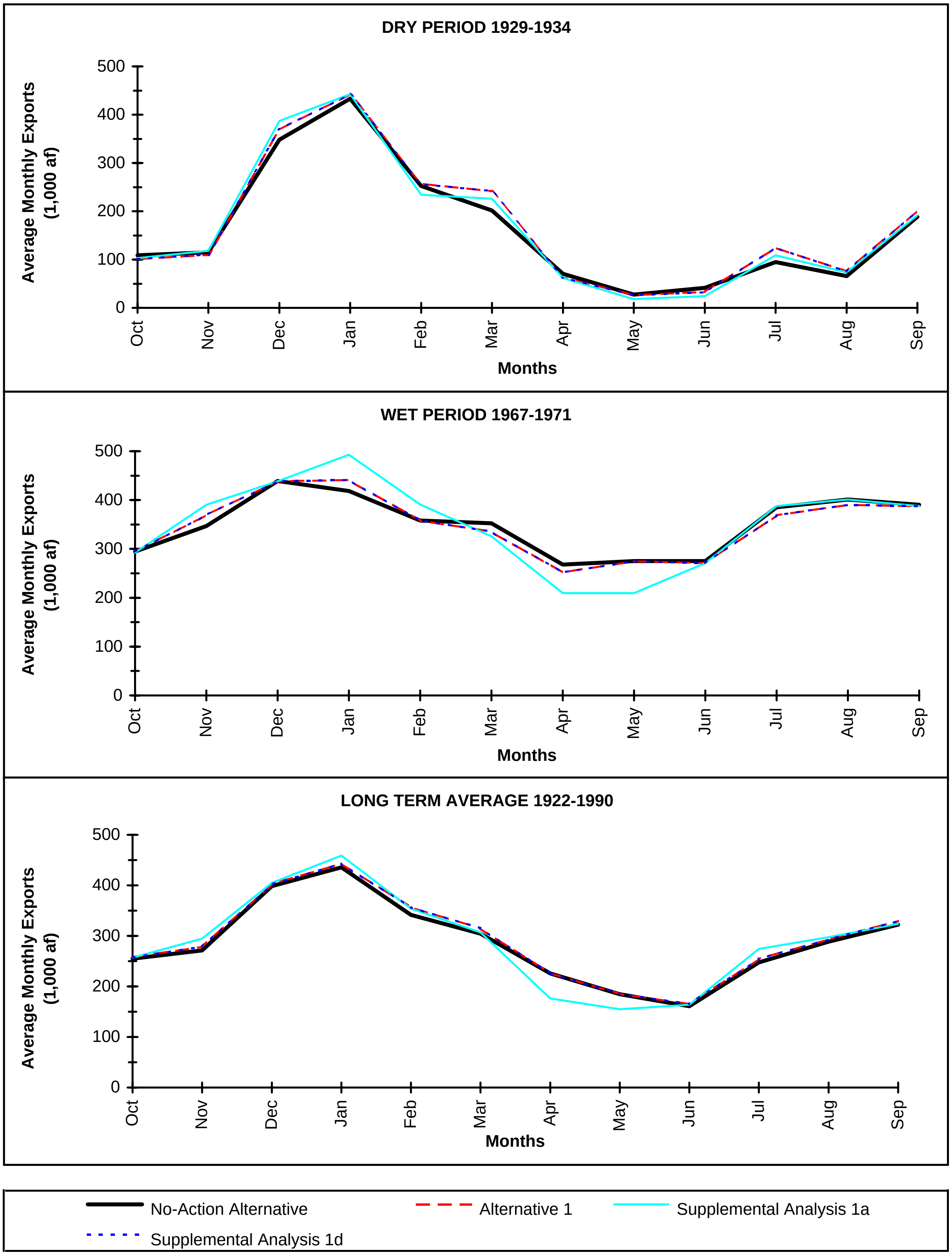


FIGURE III-43

BANKS PUMPING PLANT SIMULATED AVERAGE MONTHLY EXPORTS

SUPPLEMENTAL ANALYSIS 1d

DESCRIPTION OF SUPPLEMENTAL ANALYSIS

In Supplemental Analysis 1d, the CVP and SWP would be operated in accordance with all criteria described in the No-Action Alternative and Alternative 1, with the exception that shortages would not be applied to firm Level 2 refuge water supply deliveries. In the No-Action Alternative and Alternative 1 simulations, refuge water supplies are subject to deficiencies in accordance with the Shasta Criteria. As discussed in Chapter II, the Shasta Criteria apply when forecasted inflows to Shasta Lake fall below the defined thresholds, and water deliveries may be reduced up to 25 percent in these critical years. In the No-Action Alternative and Alternative 1, the following six years are considered critical based on the Shasta Criteria: 1924, 1931, 1932, 1933, 1934, and 1977. Unlike the No-Action Alternative and Alternative 1 simulations, Supplemental Analysis 1d does not include shortages to refuge water supplies in those six years. The Supplemental Analysis 1d delivery of Level 2 water supplies in the remaining years would be identical to Alternative 1.

In each of the six critical years, approximately 130,000 acre-feet per year of additional water would be delivered to the refuges to provide full delivery of Level 2 water supplies. In these critical years, the deliveries to CVP M&I water service contractors have already been reduced to the minimum delivery of 75 percent of full water service contracts. Therefore, the increased delivery of water to refuges would result in reduced water deliveries to agricultural water service contractors, as compared to Alternative 1.

SUPPLEMENTAL ANALYSIS 1d IMPACTS ON CVP OPERATIONS AND DELIVERIES

Supplemental Analysis 1d CVP reservoir and export operations are similar to Alternative 1, because the difference in refuge deliveries only applies to six years in the 1922 through 1990 simulation period. Agricultural water service contract deliveries would decrease in some of the critical years as a result of the increased refuge deliveries. A comparison of CVP deliveries in the Supplemental Analysis 1d, Alternative 1, and No-Action Alternative simulations is provided in Table III-8.

TABLE III-8
COMPARISON OF CVP DELIVERIES IN SUPPLEMENTAL ANALYSIS 1d, ALTERNATIVE 1 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual CVP Deliveries (1,000 acre-feet)			Analysis 1d and No-Action Alternative:
		No-Action Alternative	Alternative 1	Supplemental Analysis 1d	Average Annual Change in CVP Deliveries (1,000 acre-feet)
1922 - 1990	Simulation Period	5,770	5,300	5,290	-480
1928 - 1934	Dry Period	4,560	4,050	4,000	-560
1967 - 1971	Wet Period	6,310	6,020	6,020	-290

Notes:
(1) CVP deliveries include deliveries to agricultural and M&I water service contractors, Sacramento River water rights contractors, other water rights contractors, San Joaquin Exchange Contractors. CVP deliveries do not include refuge water supplies.

CVP Operations

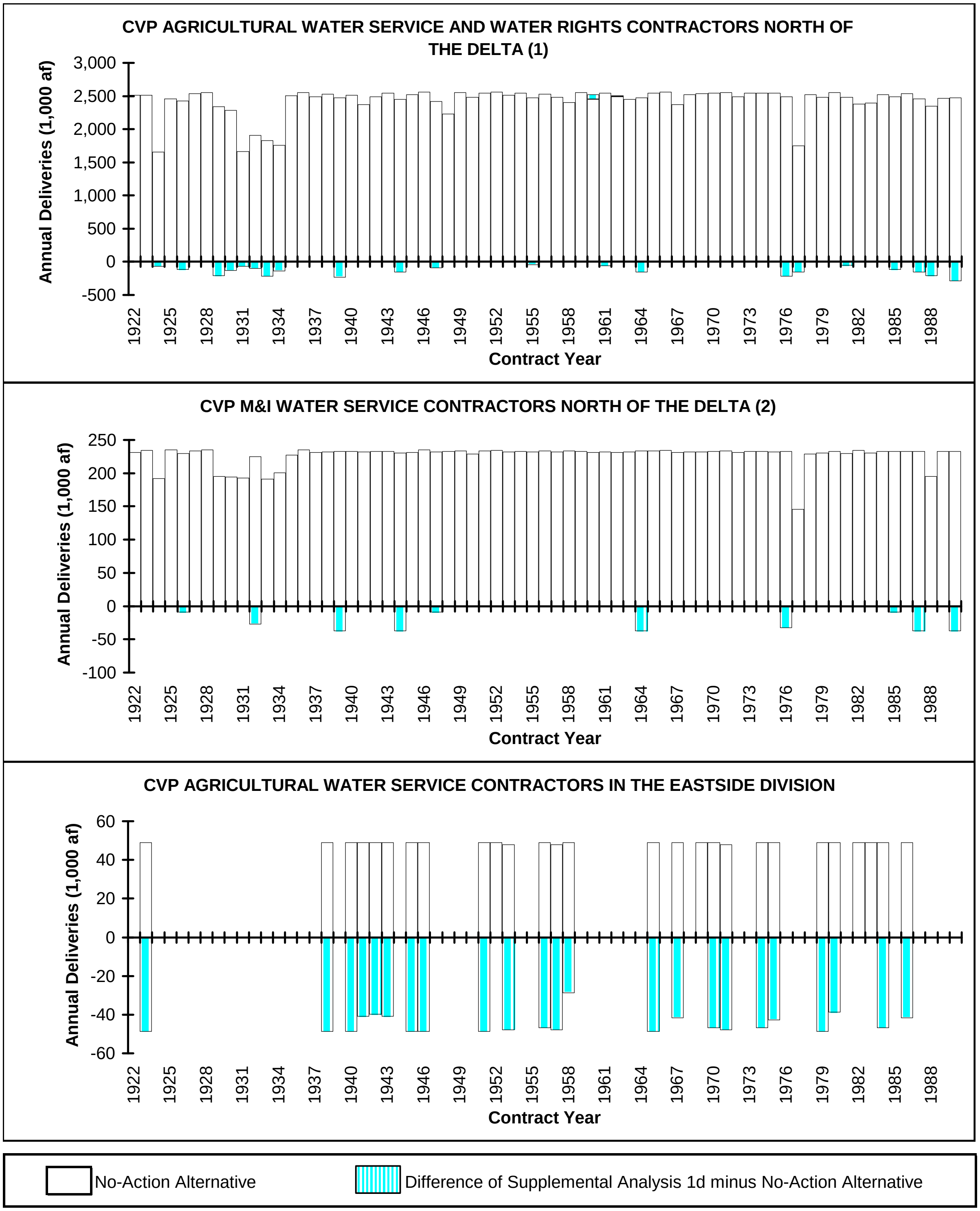
Under Supplemental Analysis 1d, reservoir operations and river flow regimes in Trinity, Shasta, Sacramento, Delta, Eastside, and West San Joaquin Divisions would be similar to those described in Alternative 1. Water quality conditions on the San Joaquin River at Vernalis would also be similar to those described in Alternative 1. Figures III-28 through III-38 show the results of Supplemental Analysis 1d CVP operations as compared to Supplemental Analysis 1a, Alternative 1, and the No-Action Alternative.

CVP Water Contract Deliveries

Frequency distributions of the simulated percent of full contract delivery to CVP contractors in the No-Action Alternative, Alternative 1, and Supplemental Analyses 1a and 1d simulations are presented in Figure III-40. Annual deliveries to CVP contractors under Supplemental Analysis 1d, as compared to the No-Action Alternative, are shown in Figures III-44 and III-45.

CVP Water Deliveries North of the Delta. CVP water deliveries to Sacramento River Water Rights Contractors do not change in Supplemental Analysis 1d. Deliveries to water service contractors in Supplemental Analysis 1d are similar to those in Alternative 1, except in critical dry years when deliveries are further reduced to provide full refuge water supplies.

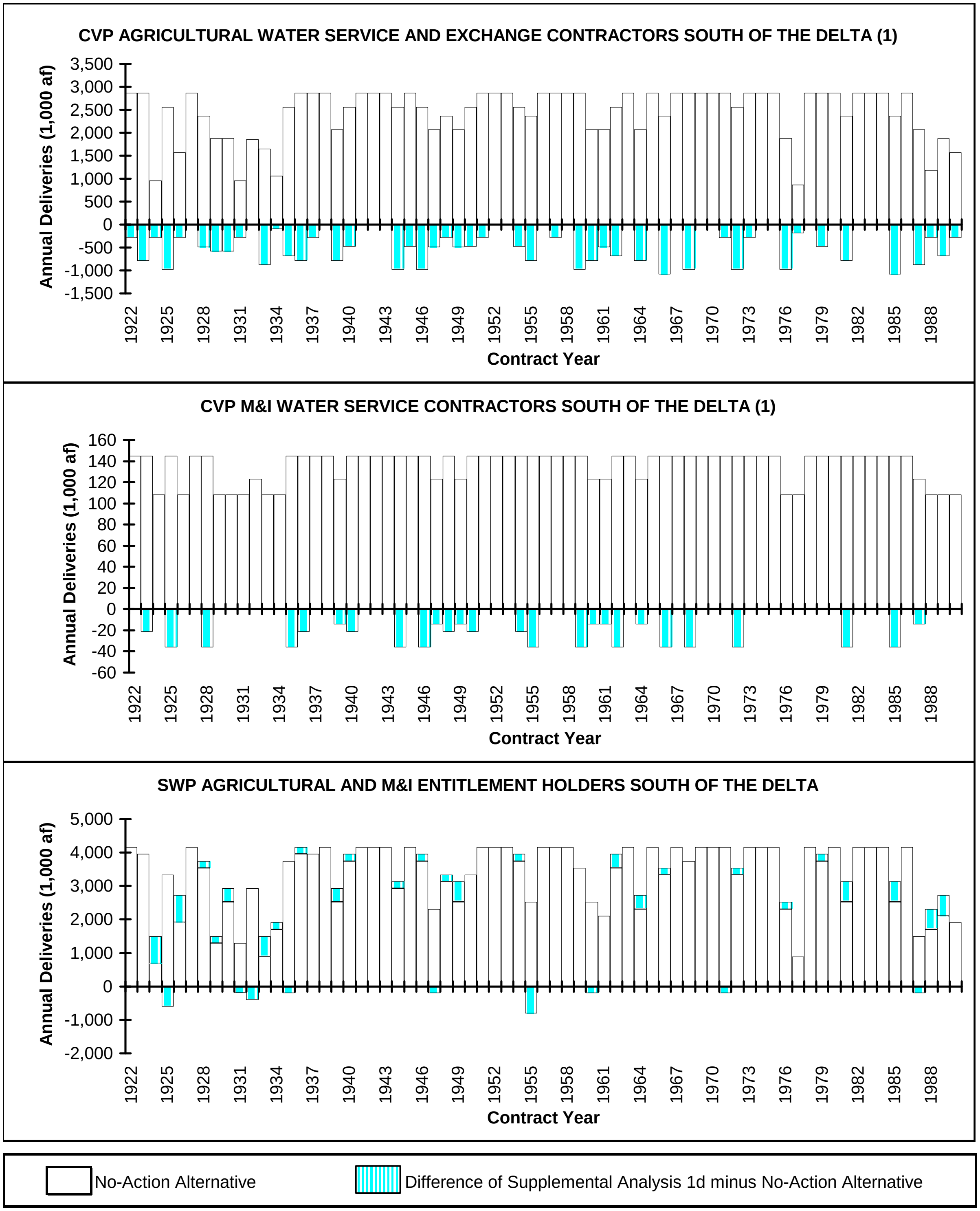
CVP Water Deliveries Eastside Division. The deliveries to CVP agricultural water service contractors on the Stanislaus River in Alternative 1d would be similar to those described in Alternative 1.



NOTES: (1) Includes Sacramento River and American River Divisions.

(2) Includes Sacramento River and American River Divisions plus Contra Costa exports.

FIGURE III-44
SIMULATED SUPPLEMENTAL ANALYSIS 1d DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990



NOTE: (1) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE III-45
SIMULATED SUPPLEMENTAL ANALYSIS 1d DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990

CVP Water Deliveries South of the Delta. CVP deliveries to San Joaquin River Exchange Contractors do not change in Supplemental Analysis 1d because their delivery deficiencies are based on the Shasta Criteria. Deliveries to water service contractors in Supplemental Analysis 1d are similar to those in Alternative 1, except in critical dry years.

CVP Water Deliveries To Refuges. Supplemental Analysis 1d includes delivery of firm Level 2 water supplies to refuges in all years without shortage.

SUPPLEMENTAL ANALYSIS 1d IMPACTS ON SWP OPERATIONS AND DELIVERIES

Supplemental Analysis 1d SWP Lake Oroville and Banks Pumping Plant operations would be very similar to operations in the Alternative 1, because the changes in refuge deliveries in critical years would have no impact on the operation of the SWP. A summary of impacts to SWP deliveries for Supplemental Analysis 1d, Alternative 1, and the No-Action Alternative is provided in Table III-9.

SWP Operations

As explained above, Supplemental Analysis 1d reservoir operations for Lake Oroville and the SWP portion of San Luis Reservoir are similar to those in Alternative 1. Releases from Lake Oroville on the Feather River below Gridley and Nicolaus are similar to those in the Alternative 1. Exports through Banks are similar in those of Alternative 1.

TABLE III-9
COMPARISON OF SWP DELIVERIES IN SUPPLEMENTAL ANALYSIS 1d, ALTERNATIVE 1 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual SWP Deliveries (1,000 af)			Analysis 1d and No-Action Alternative:
		No-Action Alternative	Alternative 1	Supplemental Analysis 1d	Average Annual Change in SWP Deliveries (1,000 af)
1922 - 1990	Simulation Period	3,330	3,430	3,430	+100
1928 - 1934	Dry Period	2,050	2,200	2,200	+150
1967 - 1971	Wet Period	4,140	4,100	4,100	-40

NOTES:
(1) SWP deliveries include deliveries south of the Delta to entitlement holders. SWP deliveries do not include refuge water supplies.

SWP Entitlement Water Deliveries

Supplemental Analysis 1d deliveries to SWP agricultural and M&I entitlement holders south of the Delta would be similar to those in Alternative 1. Figure III-40 shows a comparison of frequency distributions for SWP deliveries in Supplemental Analyses 1d and 1a, Alternative 1, and the No-Action Alternative. Figure III-45 shows the difference between SWP deliveries in Supplemental Analysis 1d and the No-Action Alternative.

ALTERNATIVE 2

DESCRIPTION OF ALTERNATIVE

Alternative 2 includes the CVPIA provisions in Alternative 1, plus the acquisition of surface water from willing sellers toward meeting the delivery of Level 4 water supplies to refuges and meeting target flows for chinook salmon and steelhead trout in Central Valley streams. The Re-operation and (b)(2) Water Management components of Alternative 2 are similar to these components in Alternative 1. Alternative 2 also includes the implementation of the same habitat restoration actions included in Alternative 1.

Under Alternative 2, water would be acquired to provide delivery of Level 4 water supply requirements to wildlife refuges. It is assumed that this water would be acquired from reliable sources within the same geographic region as the refuges.

In addition, Alternative 2 includes the acquisition of water on the Stanislaus, Tuolumne, and Merced rivers, and the release of this water to help meet salmon and steelhead target flows on these streams, primarily in the April through June period, and to provide increased Delta outflow. Because this water would be acquired for both instream flows and Delta outflow, it could not be pumped by export facilities in the Delta. It is recognized that this assumption, in practice, would require a SWRCB review process to establish instream flow and Delta outflow as beneficial uses of acquired water. The release of acquired water to increase flows on the Stanislaus, Tuolumne, and Merced rivers would result in increased flows in the San Joaquin River at Vernalis. Increased flows during April and May would decrease the number of occurrences when the Bay-Delta Plan Accord pulse flow requirements on the San Joaquin River at Vernalis would not be met.

Similar to Alternative 1, the CVP would be operated under Alternative 2 in an attempt to increase end-of-month storage levels in September in Shasta and Folsom lakes in order to provide increased river releases during the fall in the Sacramento and American rivers. Increased reservoir releases would also be made from Whiskeytown Lake to increase Clear Creek minimum flows year round, and from New Melones Reservoir to provide higher flows on the Stanislaus River to attempt to meet target flows. Increased Clair Engle Lake releases, to meet increased Trinity River instream fishery flow releases in this alternative, result in a decrease in spring and early summer imported flows to the Sacramento River.

Also similar to Alternative 1, Alternative 2 includes implementation of the habitat restoration actions, as described in Attachment F to the Draft PEIS.

WATER ACQUISITION IN ALTERNATIVE 2

Water would be acquired in Alternative 2 for two purposes: Level 4 refuge water supplies, and instream flows on the Stanislaus, Tuolumne, and Merced rivers. A description of the assumptions for the acquisition of water in Alternative 2 is provided below.

Water Acquisition for Level 4 Refuge Water Supplies

Level 4 refuge water supplies are defined in the 1989 and 1992 Refuge Water Supply Studies as the amount of water necessary to support full development of the refuges based upon management goals developed in the 1980s. The Level 4 refuge water supply requirements are presented in Table III-10.

In Alternative 2, water would be acquired from willing sellers to provide the difference between Level 2 and Level 4 refuge water supply requirements. It is assumed that surface water for refuges north of the Delta would be acquired from the Sacramento River Water Rights Contractors. It is assumed that surface water for refuges south of the Delta, with the exceptions of Kern NWR, Pixley NWR, Merced NWR, and the East Gallo Unit, would be acquired from San Joaquin River Exchange Contractors. Surface water for Kern and Pixley NWRs would be acquired from local supplies or from SWP contractors in the Tulare Basin. Water would be acquired for the Merced NWR and the East Gallo Unit from water rights holders on the Merced River. A summary of assumed acquisition quantities is presented in Table III-11.

As a condition of the acquisition of water from willing sellers, it is assumed that shortage criteria applied to the source of the water would also apply to the acquired quantities. Because the release pattern of acquired water would be shifted within an annual period, and the quantity of water would be subject to the same shortage criteria as the seller, end-of-year reservoir storage levels would be similar to those described in the Alternative 1 simulation.

It is also assumed that as a condition of long-term water acquisition, willing sellers could not replace the sold surface water supplies with additional groundwater pumping.

Water Acquisition for Instream Flows and Delta Outflow

In Alternative 2, surface water would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced rivers, and would be released in a manner to help meet target flows on these streams and increase Delta outflow. For the purposes of this analysis, it is assumed that the maximum quantity of water to be acquired from each source would be the same in all years. Depending on hydrologic conditions, the actual amount of water that would be acquired in any year could be less than the maximum quantity.

TABLE III-10
LEVEL 4 REFUGE WATER SUPPLIES

Refuge	Level 4 Water Supplies (1,000 acre-feet)			Notes
	At Boundary	Conveyance Loss	To Be Diverted	
SACRAMENTO VALLEY REFUGES				
Sacramento NWR	50.0	16.7	66.7	Source: Conveyance loss on CVP and Level 4 water is 25 percent.
Delvan NWR	30.0	10.0	40.0	Source: Conveyance loss on CVP and Level 4 water is 25 percent.
Colusa NWR	25.0	8.3	33.3	Source: Conveyance loss on CVP and Level 4 water is 25 percent.
Sutter NWR	30.0	3.3	33.3	Source: CVP provides Level 2 through exchanges. Conveyance loss on CVP and Level 4 water is 10 percent..
Grey Lodge NWR	44.0	7.0	51.0	Source: BWGID provides Level 1. CVP through exchanges provides remaining Level 2. Conveyance loss on CVP and Level 4 water is 17 percent.
TOTAL FOR SACRAMENTO VALLEY REFUGES	**179.0**	**45.3**	**224.3**	
SAN JOAQUIN VALLEY REFUGES				
San Luis NWR	19.0	6.3	25.3	Source: Conveyance loss on CVP water is 15 percent.
Kesterson NWR	10.0	1.1	11.1	Source: Conveyance loss on 6,500 af of CVP water is 15 percent.
Volta WMA	16.0	0.0	16.0	Source: No loss due to delivery through Volta Wasteway, including Level 4 water.
Los Banos WMA	25.5	5.1	30.6	Source: Conveyance loss on 19.3 af of CVP and Level 4 water is 21 percent. No loss for 6,200 acre-feet.
San Joaquin Basin Action Plan Lands				
Freitas	5.3	1.8	7.1	Source: Conveyance loss on CVP water is 25 percent.
East Gallo	13.3	4.4	17.7	Source: Merced River users. Conveyance loss on water is 25 percent.
West Gallo	10.8	3.6	14.4	Source: Conveyance loss on CVP water is 25 percent.
Salt Slough	10.0	1.8	11.8	Source: Conveyance loss on CVP and Level 4 water is 15 percent.
China Island	10.5	1.8	12.3	Source: Conveyance loss on CVP and Level 4 water is 15 percent.
Grasslands RCD	180.0	31.8	211.8	Source: Conveyance loss on CVP and Level 4 water is 15 percent.
Mendota WMA	29.6	0.0	29.6	Source: No losses due to delivery at Mendota Pool.
Merced NWR	16.0	5.3	21.3	Source: Merced Irrigation District in accordance wit a FERC agreement. Losses for Levels 2 and 4 water are 25 percent.
Kern NWR	25.0	3.7	28.7	Source: Conveyance loss on CVP and Level 4 water is 13 percent.
Pixley NWR	6.0	0.8	6.8	Source: Conveyance loss of CVP and Level 4 water is 15 percent.
TOTAL FOR SAN JOAQUIN VALLEY REFUGES	**377.0**	**67.5**	**444.5**	
TOTAL FOR ALL REFUGES	**556.0**	**112.8**	**668.8**	

TABLE III-11
SURFACE WATER ACQUISITION FOR LEVEL 4 REFUGE WATER SUPPLIES

Refuge(s)	Annual Acquisition Amount (1,000 acre-feet)
Refuges North of the Delta	34.5
Refuges South of the Delta	130.8

The acquisition targets and long-term average acquisition quantities for water purchased from willing sellers for instream flows on the Stanislaus, Tuolumne, and Merced rivers is shown in Table III-12. The acquisition of up to 50,000 acre-feet per year from sources on the Merced River would occur in addition to the acquisition of 19,000 acre-feet per year for Level 4 refuge water supplies to the Merced NWR and East Gallo Unit. Therefore, the total amount of water acquired from willing sellers on the Merced River would be up to 69,000 acre-feet per year.

It is assumed that water would be acquired from water rights holders on the Stanislaus, Tuolumne, and Merced rivers that possess diversion and storage rights on these rivers. The acquired water would be stored during the period of a contract year (March - February), and released in a manner to increase flows toward meeting the instream flow targets on these rivers and to increase Delta outflow. In effect, the acquisition of water would involve a shift in the release pattern from storage reservoirs, combined with a reduction in diversions by the willing sellers. It is assumed that acquired water would be stored and released from New Melones Reservoir on the Stanislaus River, New Don Pedro Reservoir on the Tuolumne River, and Lake McClure on the Merced River.

TABLE III-12
SUMMARY OF LONG-TERM AVERAGE ANNUAL WATER ACQUISITION QUANTITIES FOR INSTREAM FLOWS (IN 1,000 ACRE-FEET)

	Alternative 2		Alternatives 3 and 4	
Location	Target	Long-Term Average	Target	Long-Term Average
Merced River	50	50	200	194
Tuolumne River	60	60	200	197
Stanislaus River	60	49	200	194
Calaveras River	--	--	30	27
Mokelumne River	--	--	70	62
Yuba River	--	--	100	87

In Alternative 2, the acquisition of water from willing sellers would be associated with reduced agricultural water use, and would therefore result in reduced return flows to downstream portions of the rivers. This could result in reductions of flows required to meet water rights obligations to downstream areas (base flows). To avoid unintended impacts to downstream water users, base flow conditions would be maintained in portions of rivers that would be affected by the use of acquired water. To accomplish this, a portion of the acquired water would be released from the reservoirs to maintain base flow conditions similar to those conditions in the No-Action Alternative. In the simulation of this alternative, this ensures that downstream users would have access to flows consistent with their water rights.

The accounting of acquired surface water for instream and Delta outflow purposes is computed on a contract year basis. The maximum quantity of water to be acquired in each year would be determined at the beginning of March. The quantity would be based on the fishery flow targets that would be applicable from March through the following February. These flow targets would be based on the water year type, as determined on March 1. The quantity of water that would be acquired on each river would be limited to either the maximum acquisition quantity assumed in the alternative, or the maximum quantity needed to meet the target instream flows for the particular year, whichever is less. It is therefore assumed that acquired water would not be carried over to subsequent years. Releases of acquired water from reservoir storage would begin at the start of the contract year in March, and continue through the end of the contract year in the following February. Irrigation diversions from March through October would be reduced to provide the water to be released over the contract year.

Rescheduling releases of acquired water could affect storage conditions in reservoirs during the irrigation season, as compared to the No-Action Alternative. If the acquired water is released toward meeting target flows in the spring, releases in the early part of the irrigation season would generally be greater than in the No-Action Alternative, and storage conditions through the summer months would be lower than in the No-Action Alternative. As a result, some of the late summer releases that would be made to evacuate flood control storage in the No-Action Alternative would not be as large, or would not occur. Because the flows during the late summer months could be reduced due to this condition, water quality conditions in the San Joaquin River at Vernalis could become degraded to the extent that the water quality standards would be exceeded, as compared to the No-Action Alternative. Therefore, in such cases, portions of the acquired water would be released in a manner to maintain the water quality conditions equal to the No-Action Alternative on a percent exceedence basis.

Changes in storage in New Melones Reservoir are described in the discussion of the impacts of Alternative 2 on CVP operations. This information is provided because New Melones is a CVP facility and is simulated in the Draft PEIS analysis for all authorized purposes. On non-CVP facilities, such as New Don Pedro Reservoir and Lake McClure, simulation for the Draft PEIS analysis only addresses releases for diversions and instream flow requirements, and does not consider potential changes to operations to accommodate power generation, recreation, or coordinated operations with upstream facilities. Therefore, only releases below these facilities are provided in this analysis.

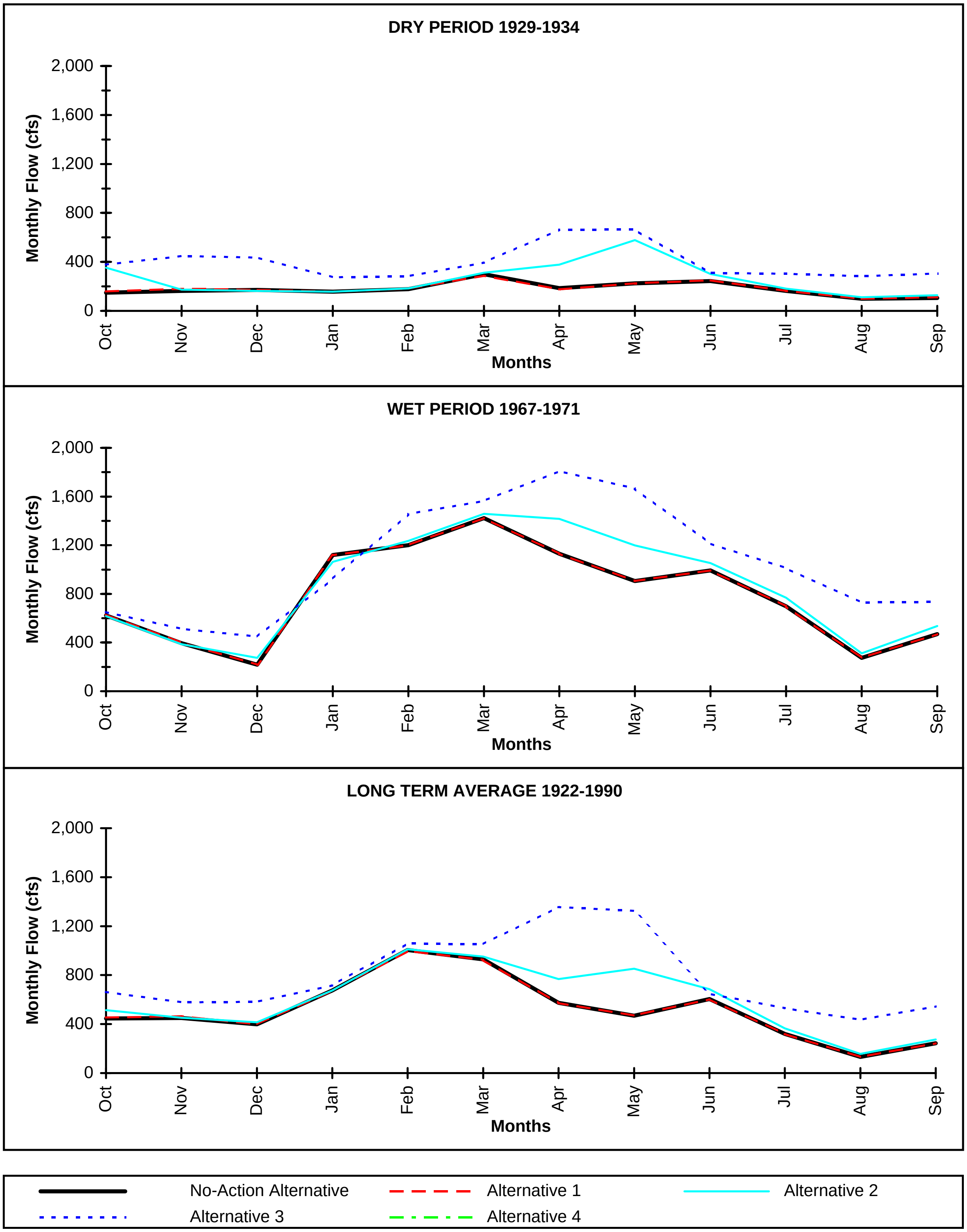
As a condition of water acquisition, it is assumed that the reduction in surface water deliveries to sellers cannot be offset with additional groundwater pumping, to prevent negative impacts to local groundwater supplies. Also, it is assumed that all water is acquired for instream flow and Delta outflow purposes. Therefore, none of the acquired water may be pumped by the CVP or SWP as it enters the Delta. It is recognized that this assumption, in practice, would require a SWRCB review process to establish instream flow and Delta outflow as beneficial uses of acquired water.

Merced River Below Crocker Huffman Diversion Dam. Based on the prioritization for the use of acquired water on the Merced River, as presented in Attachment G-4 of the Draft PEIS, the primary emphasis for use of acquired water in Alternative 2 is to help meet pulse flow objectives during April, May, and June. Simulated average monthly flows in the Merced River Below Crocker Huffman Diversion, shown in Figure III-46, illustrate an increase in spring flows under Alternative 2, as compared to the No-Action Alternative. Monthly flows during dry and wet portions of the simulation period are shown in Figure III-47.

Tuolumne River Below La Grange Dam. The highest priority for the use of acquired water on the Tuolumne River flows is also to increase flows during April and May, with smaller increases in the summer months. Simulated average monthly flows in the Tuolumne River below La Grange Dam, shown in Figure III-48, illustrate an increase in spring flows under Alternative 2, as compared to the No-Action Alternative. Monthly flows during dry and wet portions of the simulation period are shown in Figure III-49.

ALTERNATIVE 2 IMPACTS ON CVP OPERATIONS AND DELIVERIES

This section provides a comparison of conditions under Alternative 2 to the No-Action Alternative. The discussion focuses on reservoir operations, resulting releases, and deliveries of water to CVP contractors. A comparison of deliveries to CVP contractors in the Alternative 2 simulation, as compared to deliveries in the No-Action Alternative simulation is provided in Table III-13. Discussions of the operations of CVP facilities and deliveries to CVP contractors north of the Delta, south of the Delta, and on the Stanislaus River are provided in the following sections.



NOTE: Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE III-46
MERCED RIVER BELOW CROCKER HUFFMAN
SIMULATED AVERAGE MONTHLY FLOWS

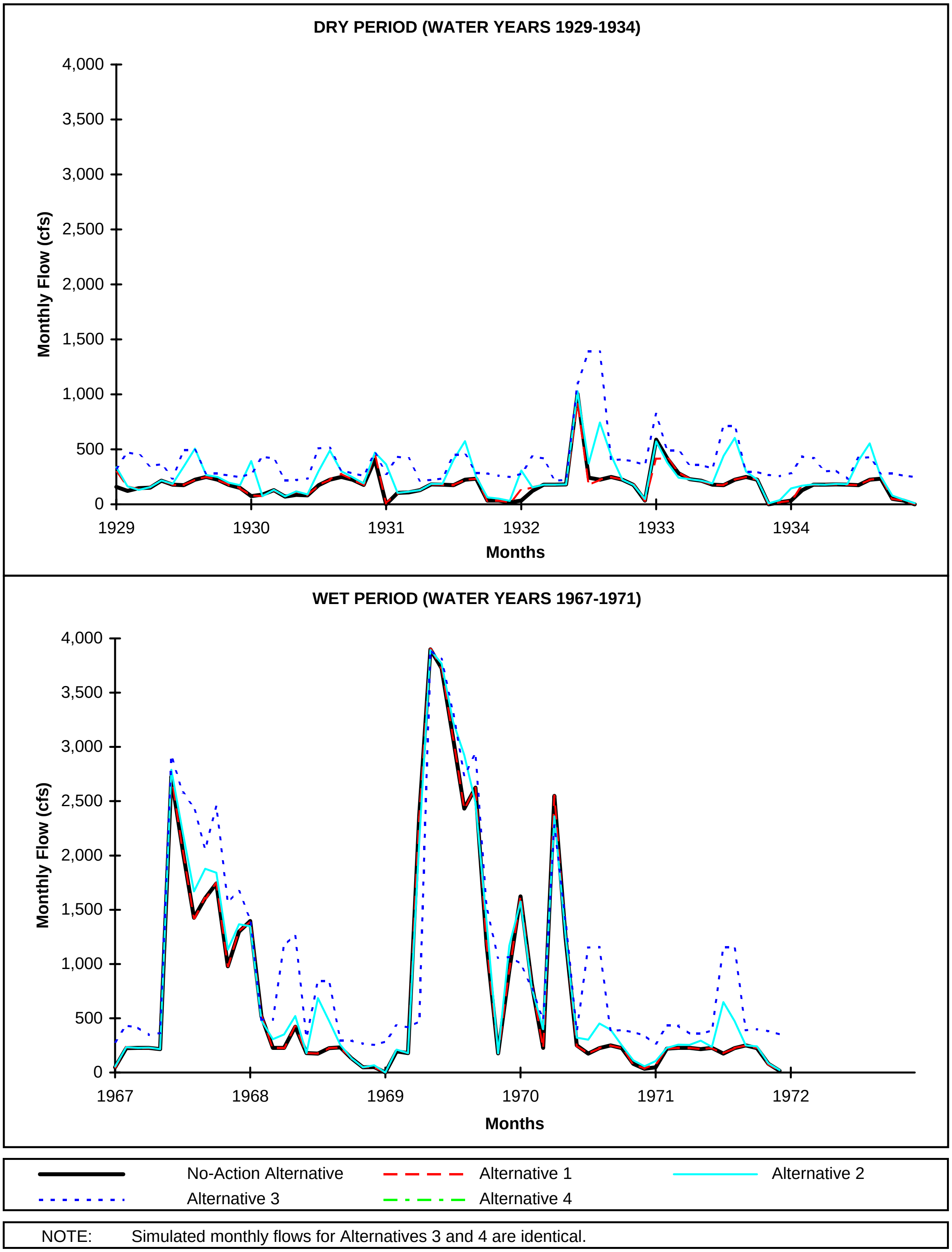
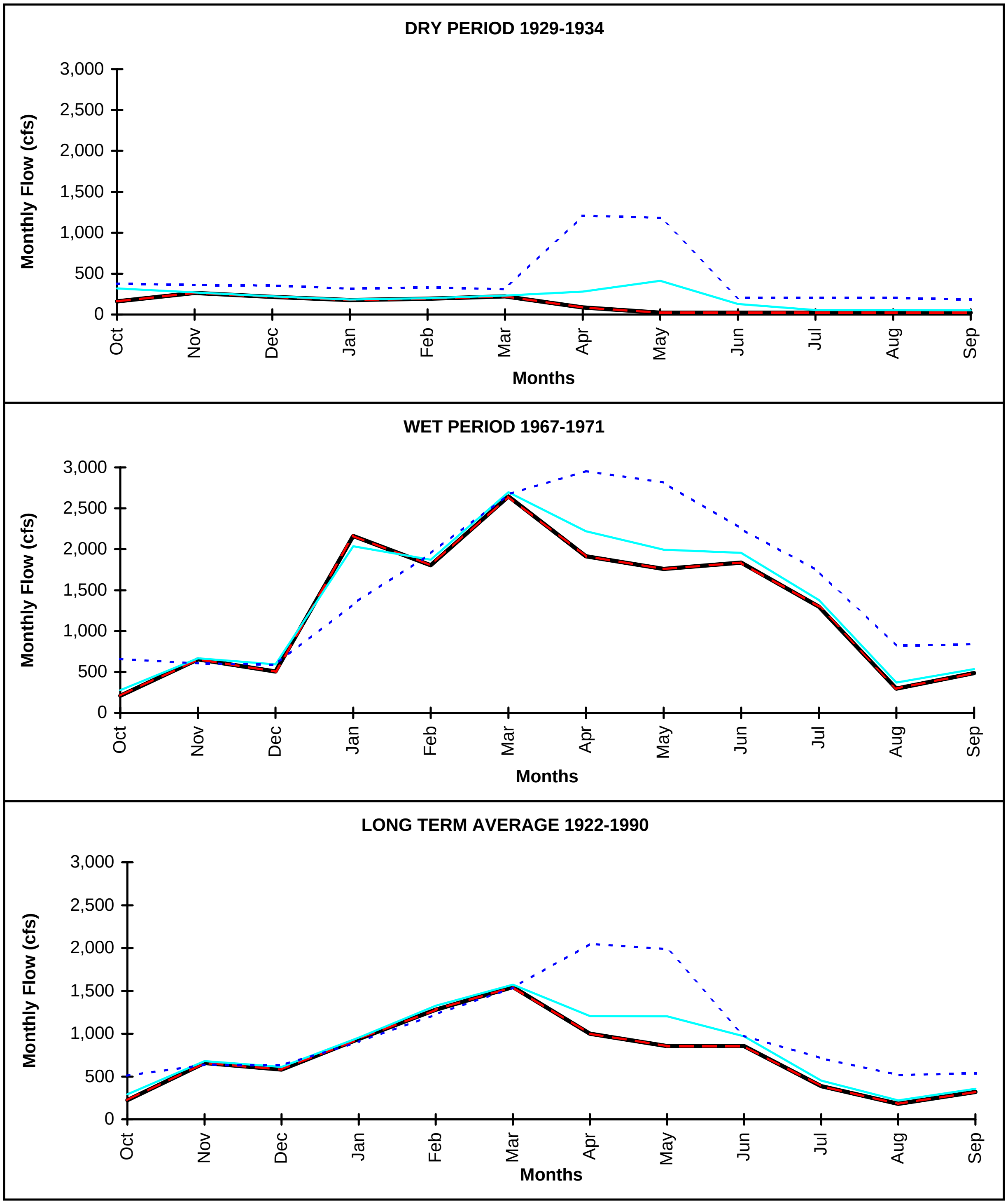


FIGURE III-47

MERCED RIVER BELOW CROCKER HUFFMAN SIMULATED MONTHLY FLOWS

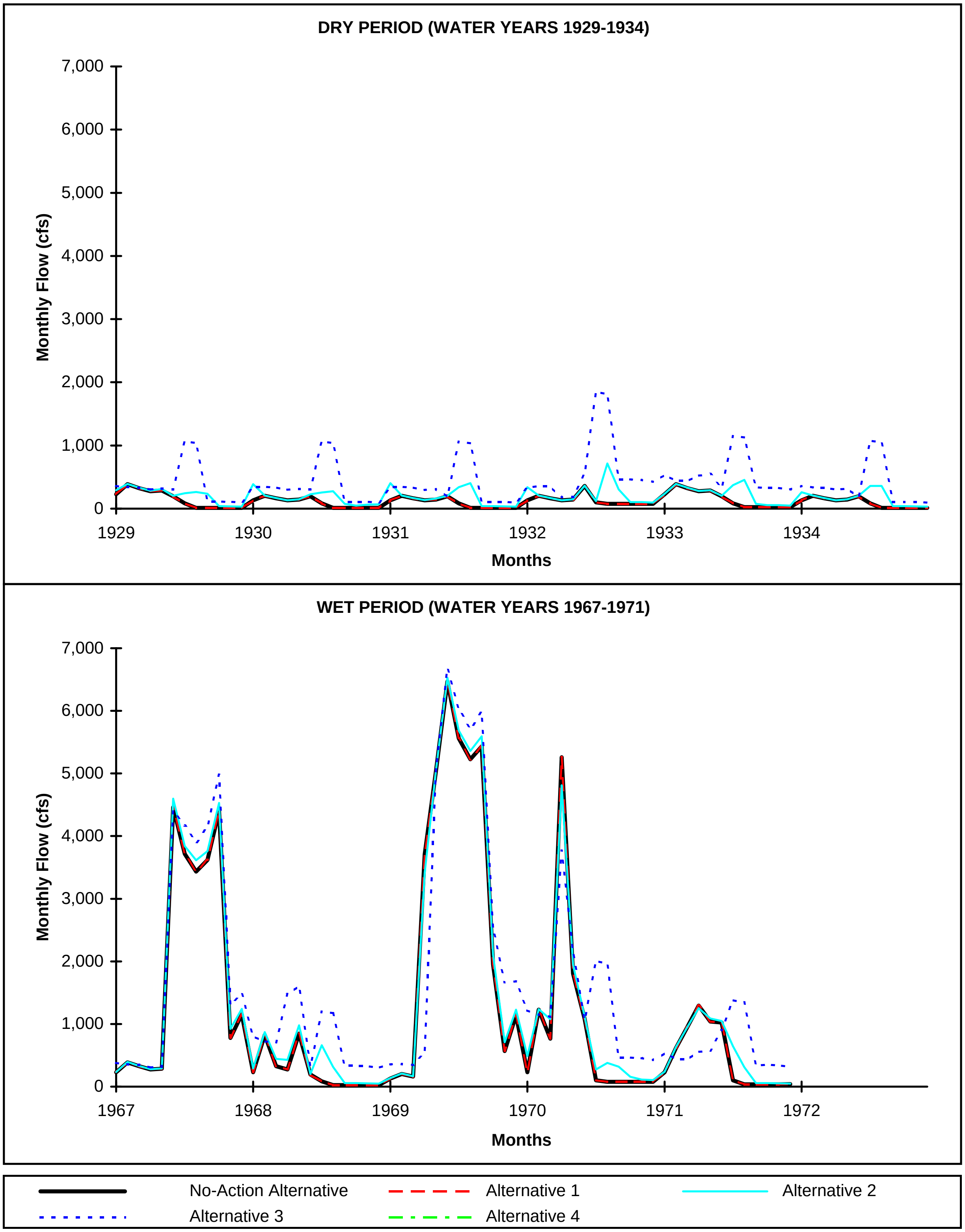


No-Action Alternative — Alternative 1 — Alternative 2

Alternative 3 — Alternative 4

NOTE: Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE III-48
TUOLUMNE RIVER BELOW LAGRANGE
SIMULATED AVERAGE MONTHLY FLOWS



NOTE: Simulated monthly flows for Alternatives 3 and 4 are identical.

FIGURE III-49

TUOLUMNE RIVER BELOW LAGRANGE SIMULATED MONTHLY FLOWS

TABLE III-13
COMPARISON OF CVP DELIVERIES IN THE
ALTERNATIVE 2 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual CVP Deliveries (1,000 acre-feet)		Average Annual Change in CVP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 2	
1922 - 1990	Simulation Period	5,770	5,180	-590
1928 - 1934	Dry Period	4,560	3,940	-620
1967 - 1971	Wet Period	6,310	5,900	-410

NOTES:
(1) CVP deliveries include deliveries to agricultural and M&I water service contractors, Sacramento River water rights contractors, other water rights contractors, San Joaquin Exchange Contractors. CVP deliveries do not include refuge water supplies.
(2) Alternative 2 assumes purchase of up to 130,000 acre-feet of water per year for level 4 refuges from the Sacramento River Water Rights and San Joaquin River Exchange Contractors.

CVP Operations

Under surface water acquisitions for target flows and refuge water supplies in Alternative 2, CVP reservoir operations and river flow regimes in the Trinity, Shasta, Sacramento, and West San Joaquin divisions would be similar to those described in Alternative 1. There would be a minor difference in operations due to the possible shift in reservoir releases for Level 4 refuge supplies. The Delta and Eastside divisions would be affected by the water acquisitions on the Stanislaus, Tuolumne, and Merced rivers to help meet target flows on these streams, and increase Delta outflow as described below.

Eastside Division. As described under the operations under Alternative 1, target flows on the Stanislaus River would be met in the July through March period through re-operation and the use of (b)(2) water. Therefore, acquired water would not be required after June to meet Alternative 2 target flows in later months. The acquisition and use of surface water on the Stanislaus River in Alternative 2 would result in little or no change in end-of-water year storage levels in New Melones Reservoir, as compared to Alternative 1 as shown in Figure III-2.

Under Alternative 2, acquired water would be released to increase stream flows in the Stanislaus River primarily in the April through June period, as shown in Figure III-12. On an average monthly basis, target flows would be met in nearly all months of above and below normal, dry, and critical year types. Although average monthly flows increase in the April through June period in wet year types, they would not meet the target flows.

The releases of acquired water on the Stanislaus, Tuolumne, and Merced rivers in the April through June period would result in increased flows in the San Joaquin River at Vernalis. Simulated average monthly flows in the San Joaquin River at Vernalis are shown in Figure III-14.

During July through March, average monthly flows under Alternative 2 would be similar to those in the No-Action Alternative.

Frequency distributions of simulated monthly water quality on the San Joaquin River at Vernalis during the irrigation and non-irrigation seasons are shown in Figure III-16. Under Alternative 2 operations, water quality at Vernalis would exceed the applicable water quality standards in approximately the same number of months during the simulation period, as in the No-Action Alternative. During the irrigation season, water quality would be at concentrations below the standard (improved water quality) more frequently under Alternative 2, as compared to the No-Action Alternative. The water quality standard would be exceeded less frequently during the non-irrigation season than under the No-Action Alternative.

Delta Division. Releases of acquired water during April and May would provide increased flows at Vernalis, which would contribute toward meeting the Bay-Delta Plan Accord pulse flow requirements. In Alternative 2, the increase in Delta inflow from the San Joaquin River would not be exported by the CVP or SWP. Therefore, the additional inflows would contribute directly to Delta outflow, increasing average annual Delta outflow by about 80,000 acre-feet per year.

Friant Division. Because the objectives in Alternative 2 would not affect operations of Millerton Lake, Friant Division operations would be similar to the No-Action Alternative.

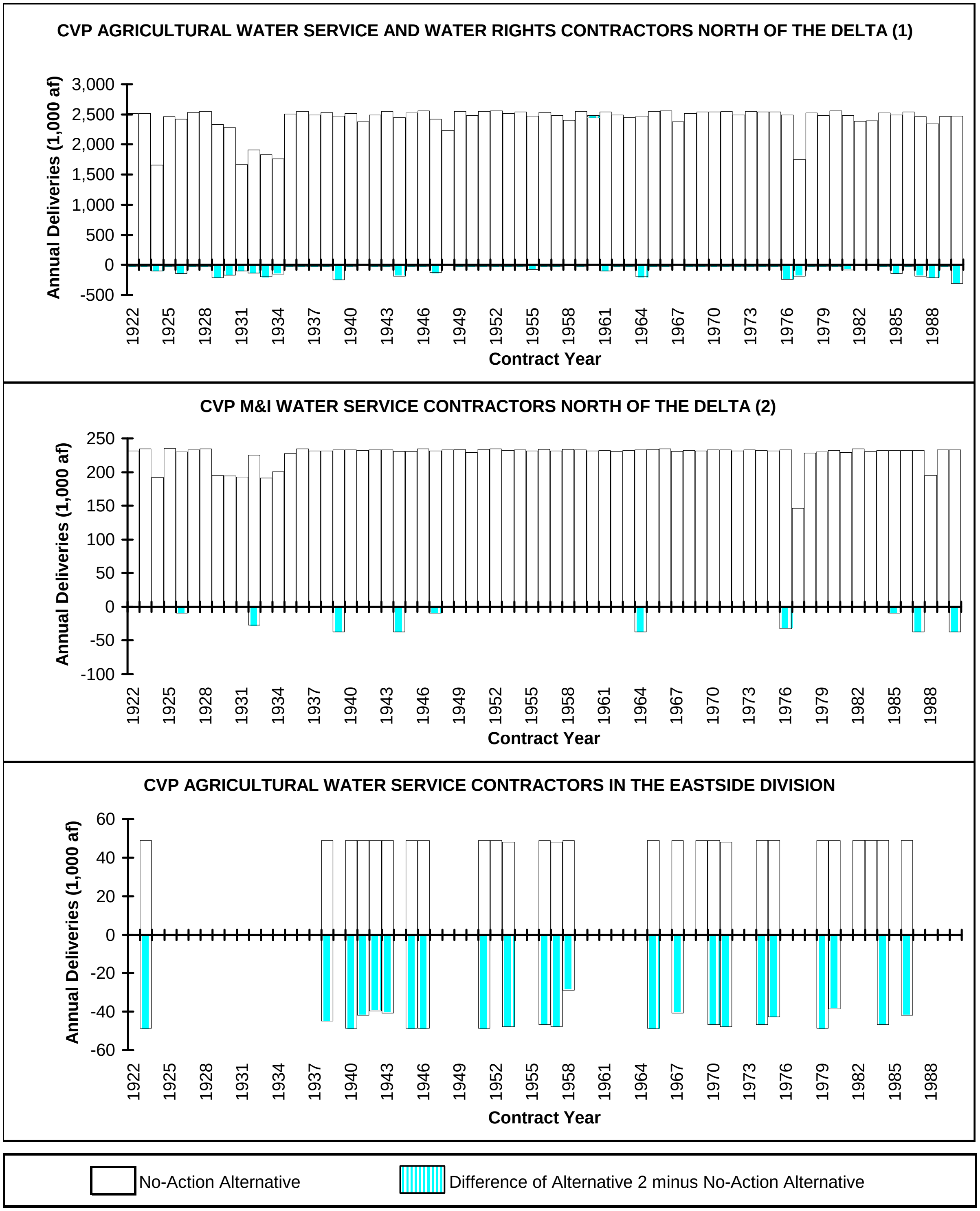
CVP Deliveries

In Alternative 2, water would be acquired from willing sellers for delivery to refuges and for release toward meeting the target flows. The release of acquired water on the Stanislaus, Tuolumne, and Merced rivers would not be available for export because this water would be released for both instream flow needs and for Delta outflow purposes The amount of water that would be available for delivery to the CVP contractors would not be affected, except for the small amount that is assumed to be acquired from willing sellers for Level 4 refuge supplies.

CVP Water Deliveries North and South of the Delta. Deliveries to CVP Sacramento River Water Rights Contractors and San Joaquin River Exchange Contractors would be similar to those described in the No-Action Alternative. Deliveries to CVP agricultural and M&I water service contractors north and south of the Delta would be similar to those in Alternative 1, as shown in Figures III-2, III-50, and III-51.

CVP Water Deliveries Eastside Division. The deliveries to CVP agricultural water service contractors on the Stanislaus River in Alternative 2 would be similar to those described in Alternative 1.

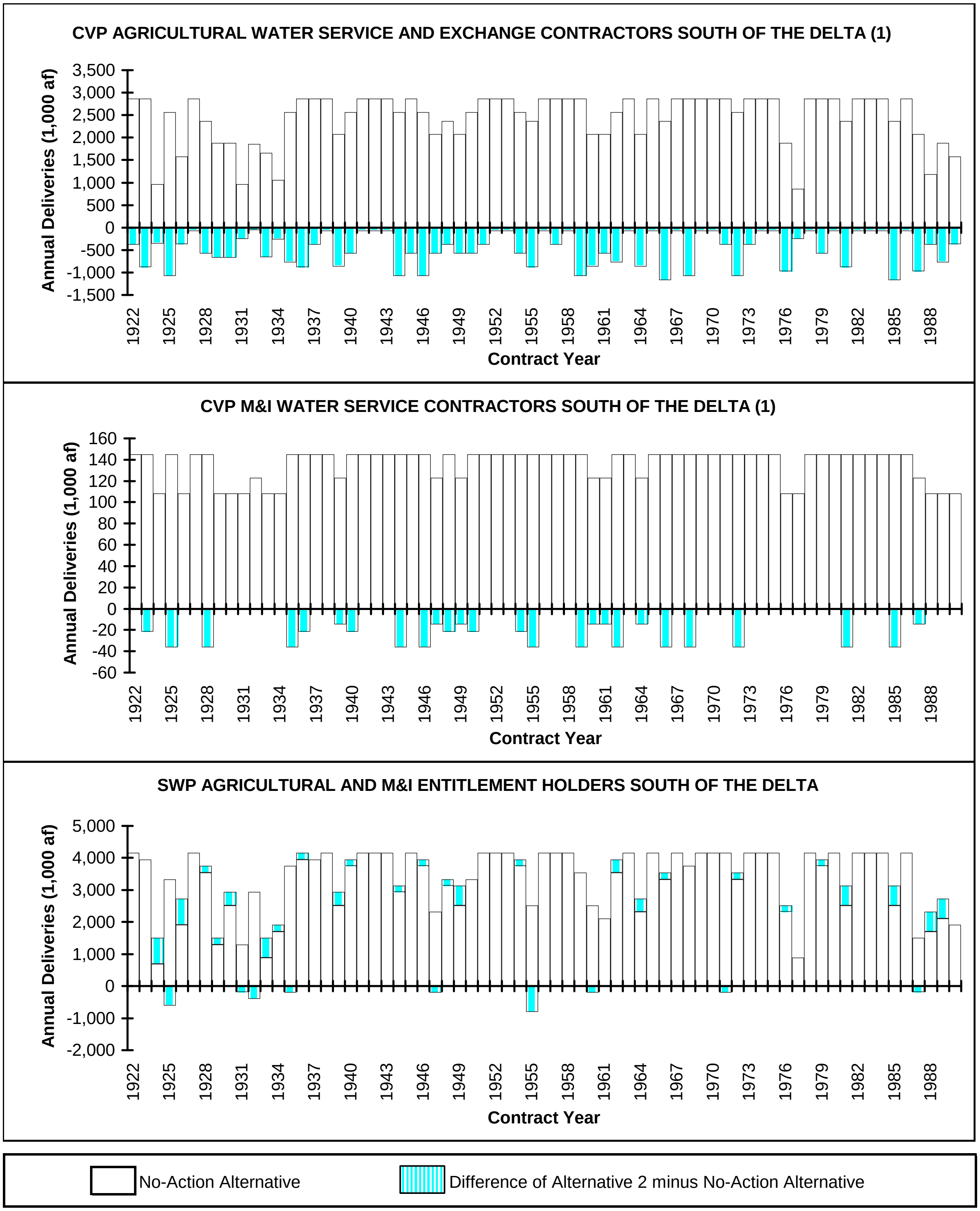
CVP Water Deliveries To Refuges. Alternative 2 includes annual deliveries of Level 4 water supplies to refuges as shown in Figure III-24, in comparison to the No-Action Alternative.



NOTES: (1) Includes Sacramento River and American River Divisions.

(2) Includes Sacramento River and American River Divisions plus Contra Costa exports.

FIGURE III-50
SIMULATED ALTERNATIVE 2 DELIVERIES AS
COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990



NOTE: (1) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE III-51
SIMULATED ALTERNATIVE 2 DELIVERIES AS
COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990

ALTERNATIVE 2 IMPACTS ON SWP OPERATIONS AND DELIVERIES

In Alternative 2, it is assumed that the SWP would not participate as a willing seller. In addition, the release of acquired water would be prescribed for instream and Delta outflow purposes. Therefore, the impacts to the SWP in Alternative 2 would be similar to the impacts associated with Alternative 1. A comparison of average annual SWP deliveries in Alternative 2 and in the No-Action Alternative is provided in Table III-14.

TABLE III-14
COMPARISON OF SWP DELIVERIES IN THE
ALTERNATIVE 2 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual SWP Deliveries (1,000 acre-feet)		Average Annual Change in SWP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 2	
1922 - 1990	Simulation Period	3,330	3,410	+80
1928 - 1934	Dry Period	2,050	2,190	+140
1967 - 1971	Wet Period	4,140	4,070	-70

NOTES:
(1) SWP deliveries include deliveries south of the Delta to entitlement holders. SWP deliveries do not include refuge water supplies.

SWP Operations

Releases from Lake Oroville to the Feather River and flows on the Feather River below Nicolaus would be similar to those described in Alternative 1. Exports through Banks Pumping Plant would also be similar to those described for Alternative 1.

SWP Entitlement Water Deliveries

As described above, the delivery of water to SWP entitlement holders under Alternative 2 would be similar to those described in Alternative 1.

ALTERNATIVE 3

DESCRIPTION OF ALTERNATIVE

Water management provisions in Alternative 3 include all of the provisions included in Alternative 1, as well the acquisition of surface water from willing sellers toward meeting Level 4 water supplies for refuges, and the acquisition of water for increasing instream flows toward flow targets identified in Attachment G-4 to the Draft PEIS. Water would be acquired to improve instream flow conditions on the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Yuba rivers. Under Alternative 3, water acquired for instream purposes may be exported by the CVP and SWP when it flows into the Delta.

The Re-operation and (b)(2) Water Management components of Alternative 3 would be similar to these components in Alternative 1. In Alternative 3, (b)(2) water is used for upstream actions on CVP-controlled rivers only, and towards meeting 1995 Water Quality Control Plan requirements.

Similar to Alternative 1, the CVP would be operated under Alternative 3 in an attempt to increase end-of-month storage in September in Shasta and Folsom lakes to provide increased river releases during the fall in the Sacramento and American rivers. As compared to the No-Action Alternative, increased reservoir releases would also be made from Whiskeytown Lake to increase Clear Creek minimum flows year round, and from New Melones Reservoir to provide higher flows on the Stanislaus River to attempt to meet target flows. An increase in Clair Engle Lake releases, to meet increased Trinity River flow releases in this alternative, would result in a decrease in spring and early summer diversions to the Sacramento River. Also similar to Alternative 1, Alternative 3 includes implementation of the habitat restoration actions.

WATER ACQUISITION IN ALTERNATIVE 3

As indicated above, in addition to water acquired for Level 4 refuges, water would be acquired in Alternative 3 for instream flow purposes on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba rivers. A description of the assumptions for the acquisition of water in Alternative 3 is provided below.

Water Acquisition for Level 4 Refuge Water Supplies

Water acquisition in Alternative 3 includes the acquisition of the same quantities of water from the same sources to provide Level 4 refuge water supplies as described in Alternative 2.

Water Acquisition for Instream Flows

In Alternative 3, surface water would be acquired from willing sellers on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba rivers for instream flow purposes. The methodology regarding the management and release of acquired water under Alternative 2 would also be applied to water acquisitions in Alternative 3.

In Alternative 3, maximum acquisition quantities for instream flows on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba rivers are shown in Table III-12. It is assumed that water would be acquired from water rights holders on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba rivers that possess storage and diversion rights on these rivers. The acquired water would be stored during the period of a contract year, and released in a manner to increase flows toward the instream flow targets on these rivers. In effect, the acquisition of water would involve a shift in the release pattern from storage reservoirs, combined with a reduction in the diversion of the released water. It is assumed that acquired water would be stored and released from New Melones Reservoir on the Stanislaus River, New Don Pedro Reservoir on the Tuolumne River, Lake McClure on the Merced River, New Hogan Reservoir on the Calaveras River, Camanche Reservoir on the Mokelumne River, and New Bullards Bar Reservoir on the Yuba River.

Merced River Below Crocker Huffman Diversion Dam. The use of acquired water on the Merced River under Alternative 3 would result in increased flows in all months with the primary emphasis in April and May, as compared to the No-Action Alternative as shown Figure III-46. During the wet period of 1967-1971, a slight reduction in average flows during January would occur under Alternative 3, as compared to the No-Action Alterative, primarily as a result of reduced storage conditions that would decrease winter flood control releases. During dry periods, flows would increase in all months. Monthly flows during dry and wet portions of the simulation period are shown in Figure III-47.

Tuolumne River Below La Grange Dam. Tuolumne River flows would also be increased in April through May, with smaller increases in the summer months. As shown in Figure III-48, flows would be increased primarily during the April-May spring pulse flow period. Reduced storage levels would reduce required releases for flood control in January. During dry periods, flows would increase in all months. Monthly flows during dry and wet portions of the simulation period are shown in Figure III-49.

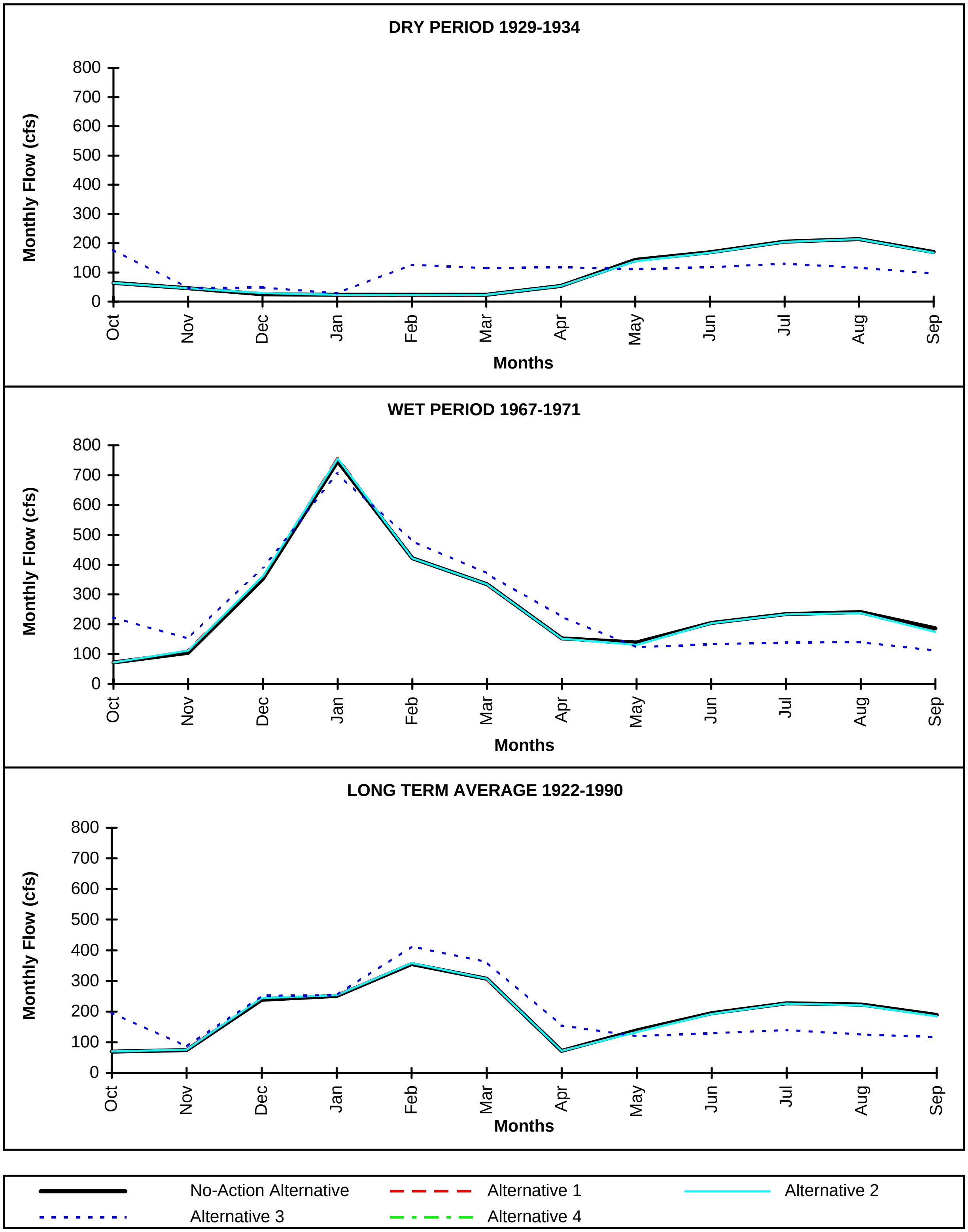
Stanislaus River at Goodwin Dam. The acquired water on the Stanislaus River would be used primarily to increase spring pulse flows. As shown of Figure III-12, simulated monthly flows below Goodwin Dam under Alternative 3 would increase in April through June, with additional increases through the fall and winter months as compared to the No-Action Alternative. As discussed in the section addressing CVP operations, the increased Stanislaus River flows under Alternative 3 would occur from the combination of acquired water, re-operation of New Melones Reservoir, and a revised (b)(2) Water Management, as compared to Alternative 1. The opportunity for re-operation of New Melones Reservoir and a revised (b)(2) Water Management under Alternative 3 would occur due to increased San Joaquin River flows that would result from the release of acquired water on the Merced and Tuolumne rivers.

Figures III-12 and III-13 indicate that the use of acquired water in accordance with biological priorities under Alternative 3 would result in flows below Goodwin Dam greater than 1,500 cfs more frequently than under the No-Action Alternative, or under Alternatives 1 and 2. Historical operations have indicated that flows above 1,500 cfs in this portion of the Stanislaus River can cause seepage and flooding problems to lands adjacent to the river.

Calaveras River at New Hogan Dam. The flow targets on the Calaveras River in Alternative 3 were established for the reach between New Hogan Dam and the Bellota Weir. This section of the river conveys releases for downstream agricultural diversion during the summer months. Consequently, the acquisition of water from downstream diversion demands enables the releases to be rescheduled, but would not result in an increase in total annual flow in this section of the river. As shown in Figure III-52, flows on the Calaveras River would increase in the winter and early spring months and decrease in the summer and fall months under Alternative 3 with the use of acquired water. Monthly flows during dry and wet portions of the simulation period are shown in Figure III-53.

Mokelumne River at Woodbridge. On the Mokelumne River, releases of acquired water would result in increased flows in the fall through spring periods, with the greatest increases in April and May. As shown in Figure III-54, flows during dry years would not change, due to the limited acquisition quantities during dry years. Monthly flows during dry and wet portions of the simulation period are shown in Figure III-55.

Yuba River at Marysville. On the Yuba River, releases from New Bullards Bar Reservoir and downstream diversions would be re-operated to provide water toward the flow targets under Alternative 3. As shown in Figure III-56, the releases of acquired water would result in increased flows in the spring, summer, and fall months, as compared to flows under the No-Action Alternative. Monthly flows during dry and wet portions of the simulation period are shown in Figure III-57.



NOTE: Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE III-52
CALAVERAS RIVER BELOW NEW HOGAN
SIMULATED AVERAGE MONTHLY FLOWS

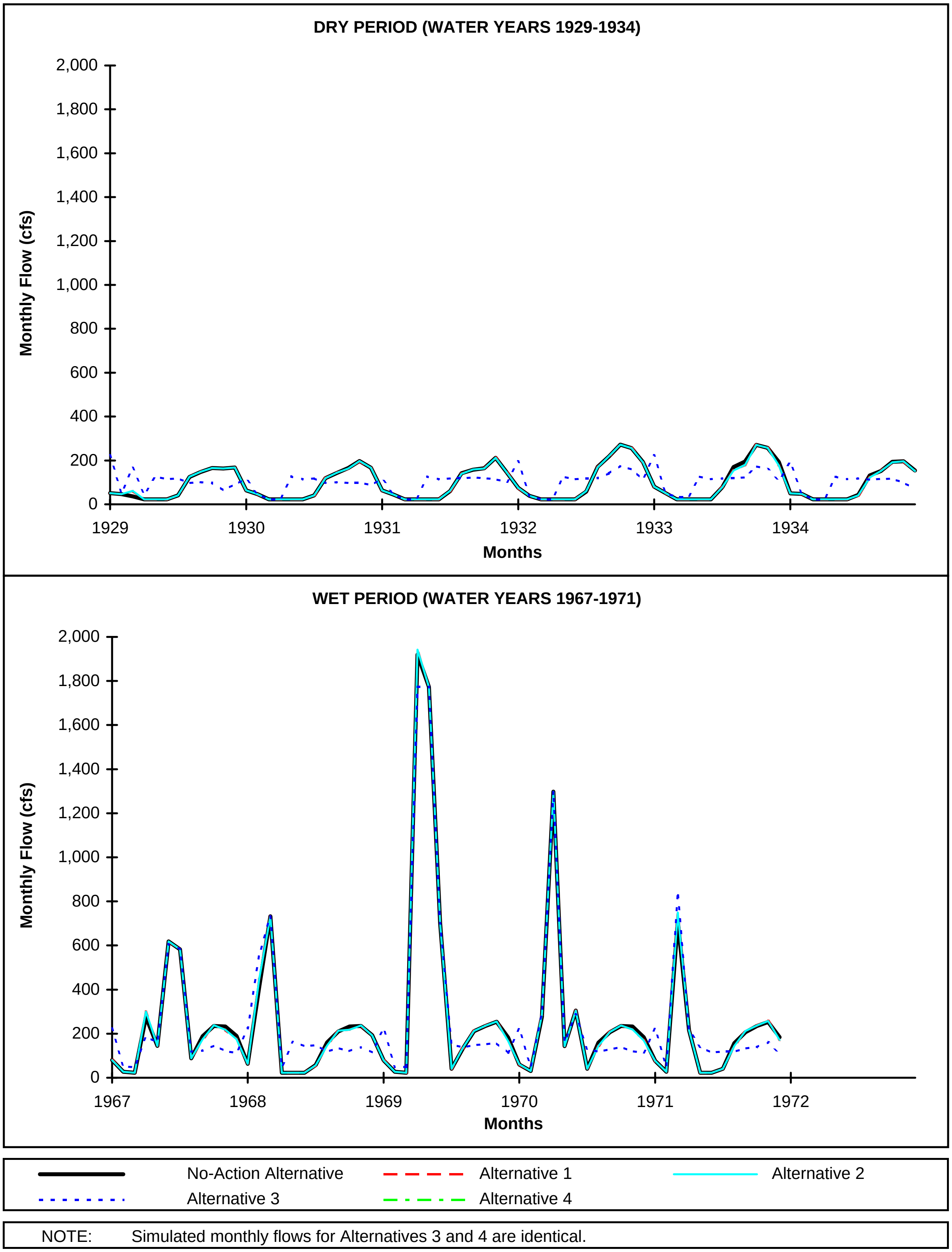
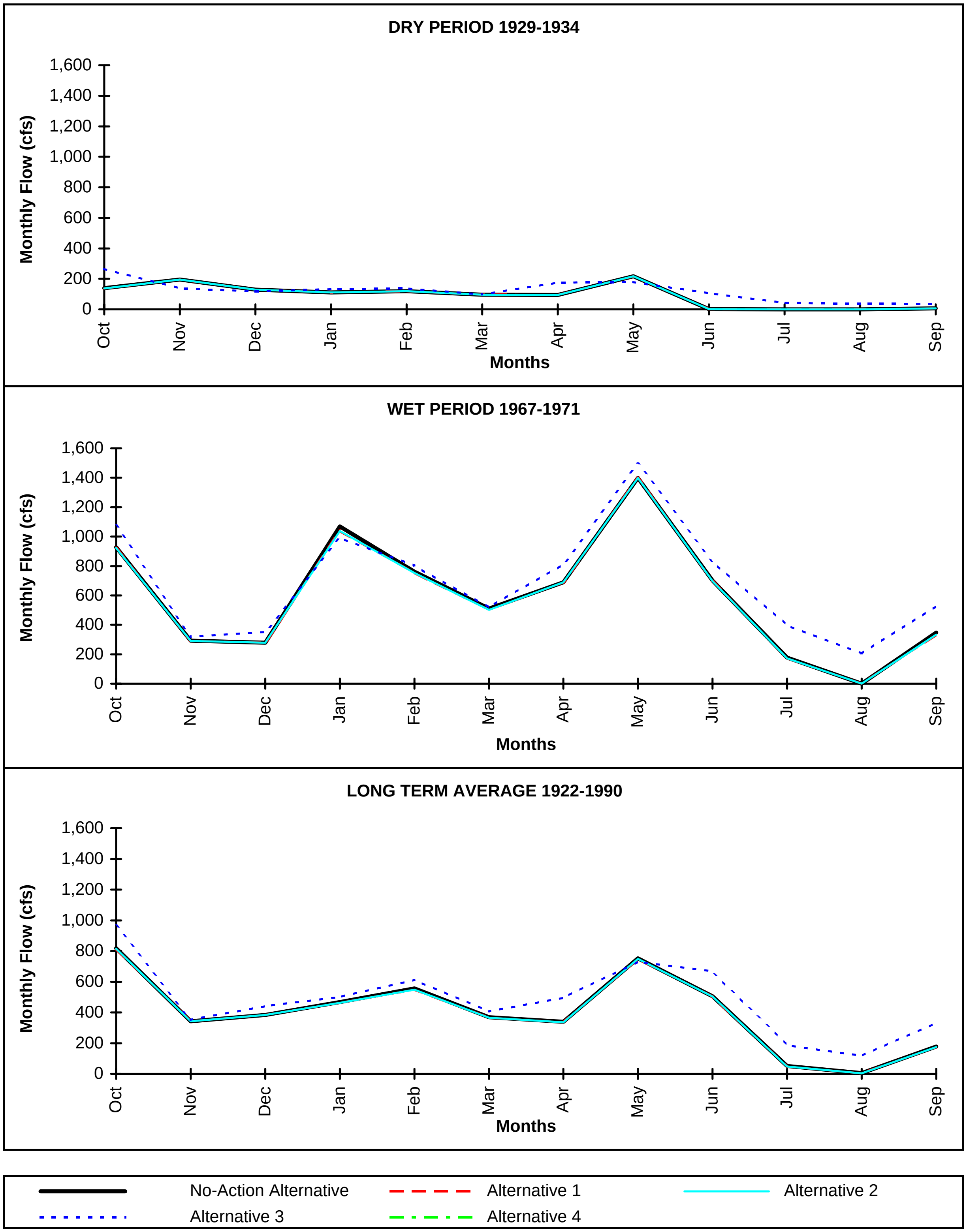


FIGURE III-53

CALAVERAS RIVER BELOW NEW HOGAN SIMULATED MONTHLY FLOWS



NOTE: Simulated average monthly flows for Alternatives 3 and 4 are identical.

FIGURE III-54
MOKELUMNE RIVER BELOW WOODBRIDGE
SIMULATED AVERAGE MONTHLY FLOWS

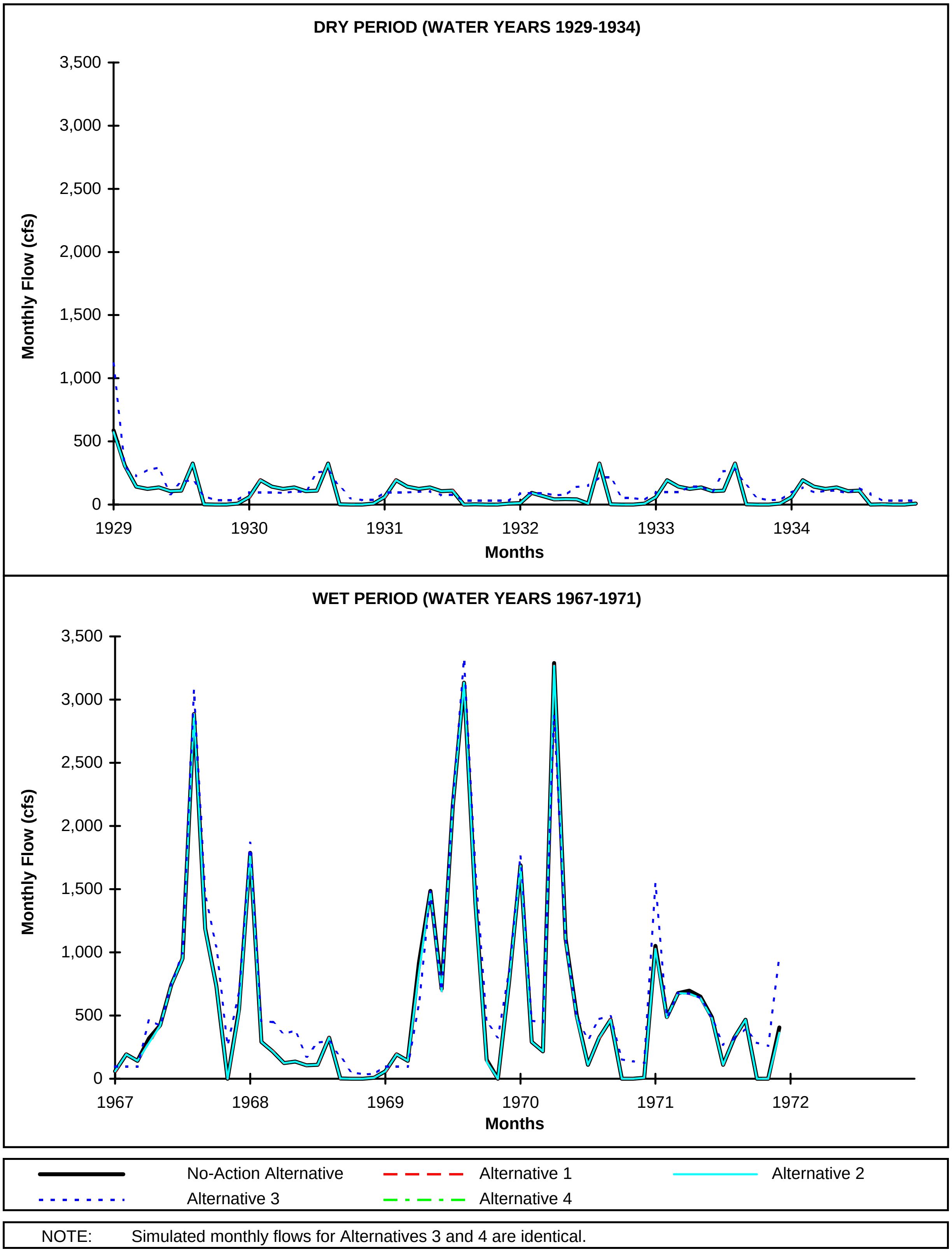
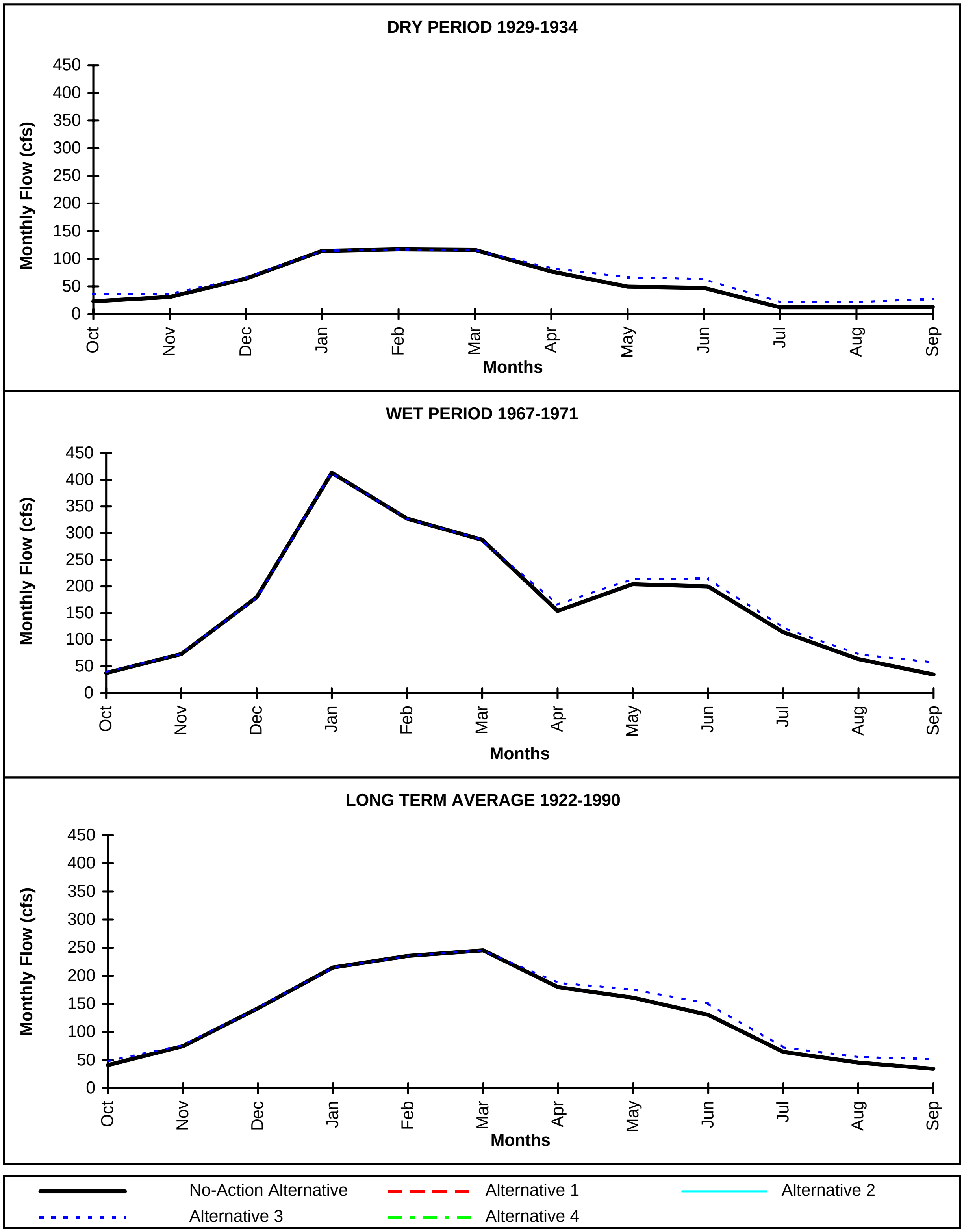


FIGURE III-55

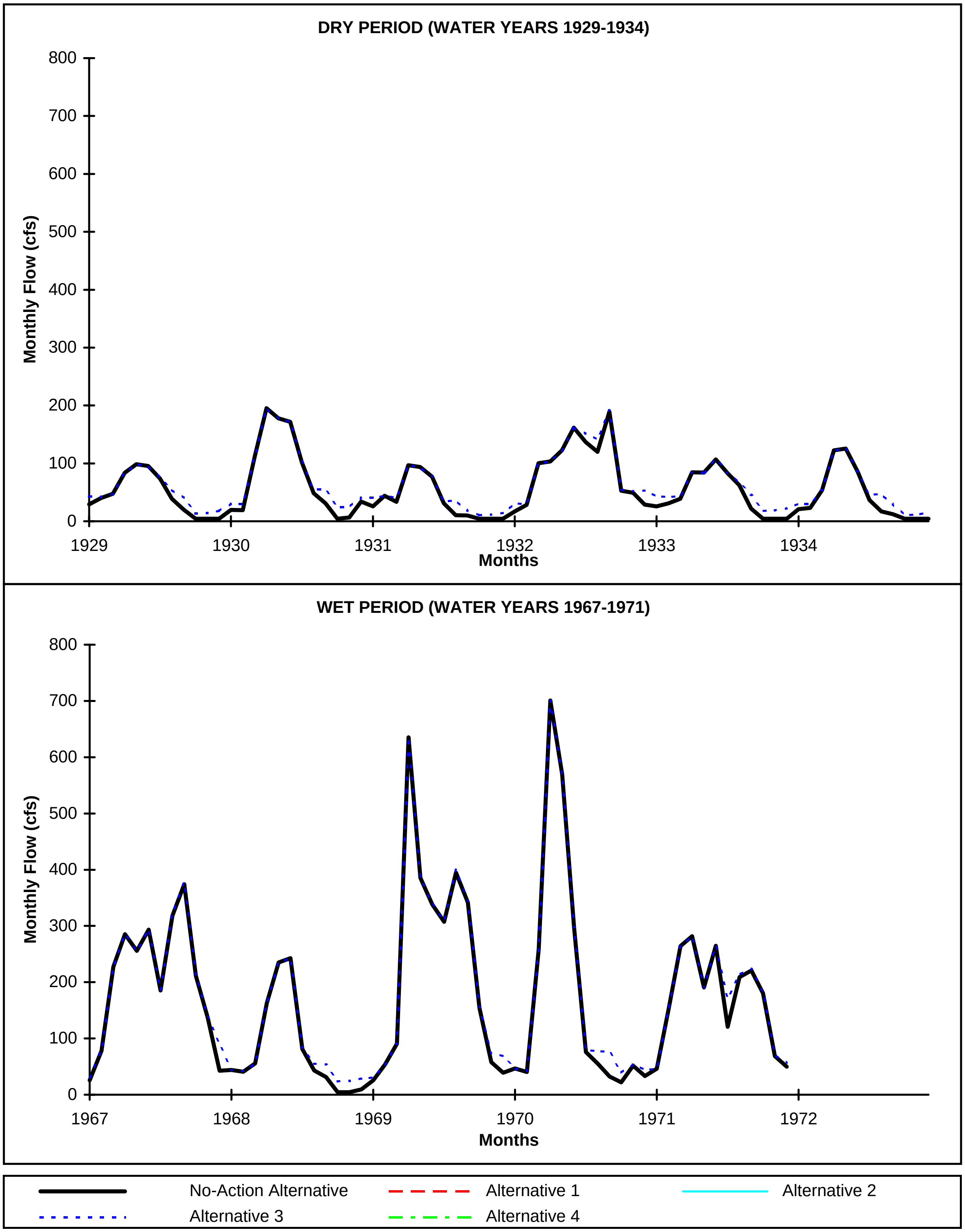
MOKELUMNE RIVER BELOW WOODBRIDGE SIMULATED MONTHLY FLOWS



NOTE: No-Action Alternative, Alternative 1, and Alternative 2 are identical. Alternatives 3 and 4 are identical.

FIGURE III-56

YUBA RIVER AT MARYSVILLE SIMULATED AVERAGE MONTHLY FLOWS



NOTE: No-Action Alternative, Alternative 1, and Alternative 2 are identical. Alternatives 3 and 4 are identical.

FIGURE III-57

YUBA RIVER AT MARYSVILLE SIMULATED MONTHLY FLOWS

ALTERNATIVE 3 IMPACTS ON CVP OPERATIONS AND DELIVERIES

Alternative 3 CVP operations and water deliveries would be similar to those described in Alternative 1. Changes in delivery of water to CVP contractors between Alternative 3 and the No-Action Alternative are summarized in Table III-15. A brief summary of CVP operations and deliveries is provided below.

TABLE III-15
COMPARISON OF CVP DELIVERIES IN THE
ALTERNATIVE 3 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual CVP Deliveries (1,000 acre-feet)		Average Annual Change in CVP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 3	
1922 - 1990	Simulation Period	5,770	5,380	-390
1928 - 1934	Dry Period	4,560	4,220	-340
1967 - 1971	Wet Period	6,310	6,010	-300

NOTES:
(1) CVP deliveries include deliveries to agricultural and M&I water service contractors, Sacramento River water rights contractors, other water rights contractors, San Joaquin Exchange Contractors. CVP deliveries do not include refuge water supplies.
(2) Alternative 3 assumes purchase of up to 130,000 acre-feet of water per year for level 4 refuges from the Sacramento River Water Rights and San Joaquin River Exchange Contractors.

CVP Operations

In Alternative 3, CVP operations in the Trinity, Shasta, Sacramento River, and American River divisions would be similar to Alternative 1. Friant Division operations would be similar to the No-Action Alternative. However, CVP operations in the Delta, Eastside, and West San Joaquin Divisions would be affected due to higher San Joaquin River flows and the ability to export acquired water through Tracy Pumping Plant once it reaches the Delta. The operations of these divisions are discussed below.

Eastside Division. Frequency distributions of simulated end-of-water year storages in New Melones Reservoir are presented in Figure III-2. As shown on this figure, reservoir storages in Alternative 3 are generally lower than storage levels in the No-Action Alternative, except during periods of near flood control storage levels, where the frequency is increased. Storage levels under Alternative 3 are generally higher than storage levels under Alternative 1. The increase in storage levels results from a combination of improved flexibility in the operation of New Melones Reservoir due to higher flows on the San Joaquin River upstream of the Stanislaus River, and the management of acquired water.

The additional flow in the San Joaquin River due to the release of acquired water on both the Merced and Tuolumne rivers would result in improved water quality conditions at Vernalis as compared to the No-Action Alternative. The improvement in San Joaquin River water quality would reduce the quantity of required releases from New Melones Reservoir necessary to maintain water quality conditions at Vernalis. As a result, New Melones Reservoir operations under Alternative 3 result in increasing the frequency that target flows on the Stanislaus River would be met through re-operation and (b)(2) Water Management. The combination of re-operation of New Melones Reservoir and the management of acquired water would result in greater releases during spring months and lower storage levels during summer months. In some years, end-of-year storage levels in New Melones Reservoir would be slightly higher than storage levels in Alternative 1, because a portion of the acquired water would be held in storage for subsequent release in October through December.

The combined contribution of acquired water released on the Merced, Tuolumne, and Stanislaus rivers would result in increased flow in the San Joaquin River at Vernalis, as shown in Figure III-14. On an average monthly basis, flows in the San Joaquin River at Vernalis would increase in nearly all months, with the largest increases during April and May. The increased flow would also result in improved monthly water quality conditions, as shown in Figure III-16. Under Alternative 3, water quality conditions at Vernalis would meet the monthly standards during both the irrigation and non-irrigation seasons in nearly all months of the simulation period.

Delta Division. As a result of upstream water acquisitions, simulated Delta inflows increase by about 400,000 acre-feet per year in Alternative 3 as compared to the No-Action Alternative. In Alternative 3 this additional inflow may be exported by the CVP and SWP, as available under the COA. Figure III-18 shows a comparison of the frequency distributions for simulated Tracy Pumping Plant annual exports. Tracy Pumping Plant exports decrease by about 90,000 acre-feet per year as compared to the No-Action Alternative, and increase by about 170,000 acre-feet per year as compared to Alternative 1. The CVP ability to export the acquired water is limited because the majority of the acquired water is released in the fall and the spring when Tracy Pumping Plant is already pumping at maximum regulatory or physical capacity. In addition, CVP releases from upstream reservoirs cannot be reduced to take advantage of acquired water in the Delta, since (b)(2) water must be released in the fall and spring for upstream flow objectives. Figure III-17 shows the change in average monthly exports as compared to the No-Action Alternative.

Simulated Delta outflow increases by about 200,000 acre-feet per year as compared to the No-Action Alternative. Average monthly Delta outflows in the No-Action Alternative and Alternative 3 simulations are presented in Figure III-19.

West San Joaquin Division. Operations of the CVP portion of San Luis Reservoir are similar to Alternative 1. As shown in comparison in Figure III-18, Alternative 3 simulated average monthly storage is greater than in the No-Action Alternative, due to a combination of higher fall exports as part of (b)(2) Water Management and higher spring exports of acquired water.

CVP Contract Water Deliveries

In Alternative 3, water would be acquired from willing sellers for delivery to refuges and for release toward meeting the flow objectives. The acquired water released on the Stanislaus, Tuolumne, Merced, Calaveras, Mokelumne, and Yuba rivers would be available for export when it reaches the Delta. As described above, the CVP's ability to export acquired water is limited due to timing, and physical and regulatory limitations. The resulting changes in CVP deliveries are discussed below.

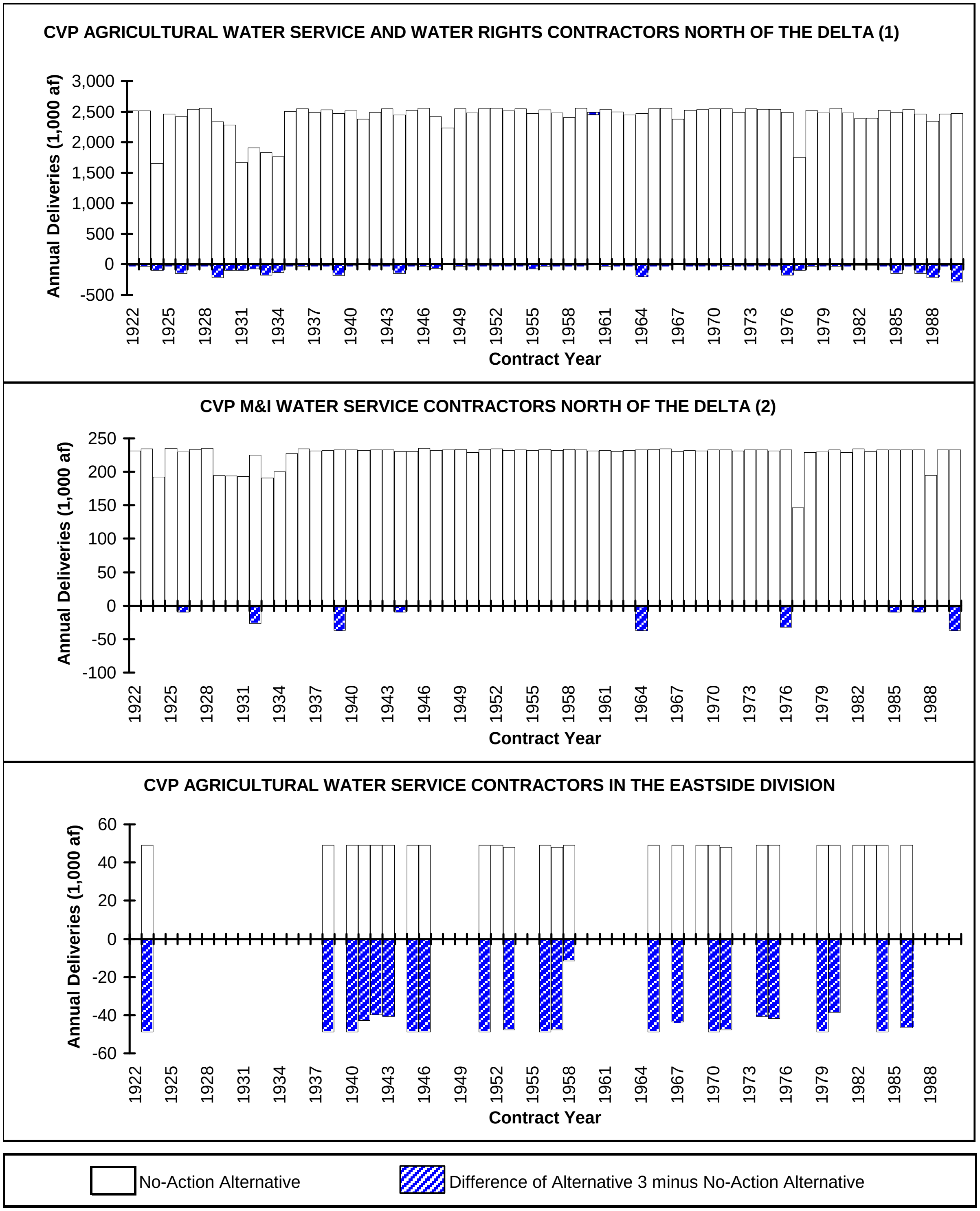
CVP Water Deliveries North of the Delta. Deliveries to CVP Sacramento River Water Rights Contractors would be similar to those described in the No-Action Alternative. Deliveries to CVP agricultural and M&I water service contractors north of the Delta would be similar to those in Alternative 1, as shown in Figure III-58.

CVP Water Deliveries Eastside Division. As described above, the increased flow in the San Joaquin River above the confluence with the Stanislaus River, due to water acquisition on the Tuolumne and Merced rivers, would improve San Joaquin River water quality. This would reduce the quantity of water required from New Melones Reservoir to maintain water quality conditions at Vernalis, and would enable greater releases to the Stanislaus River as part of (b)(2) Water Management.

The (b)(2) Water Management operation of New Melones Reservoir under in Alternative 3 would result in similar deliveries to CVP agricultural water service contractors based on firm water supply as under the (b)(2) Water Management operation described in Alternative 1, as shown in Figure III-58. However, this revised operation, in combination with releases of acquired water from New Melones Reservoir, would result in lower storage levels during the spring and summer months, and would reduce the frequency of snow-melt induced flood control releases. Consequently, opportunities for delivery to CVP contracts based on an interim water supply would be reduced, as compared to the No-Action Alternative and to Alternative 1.

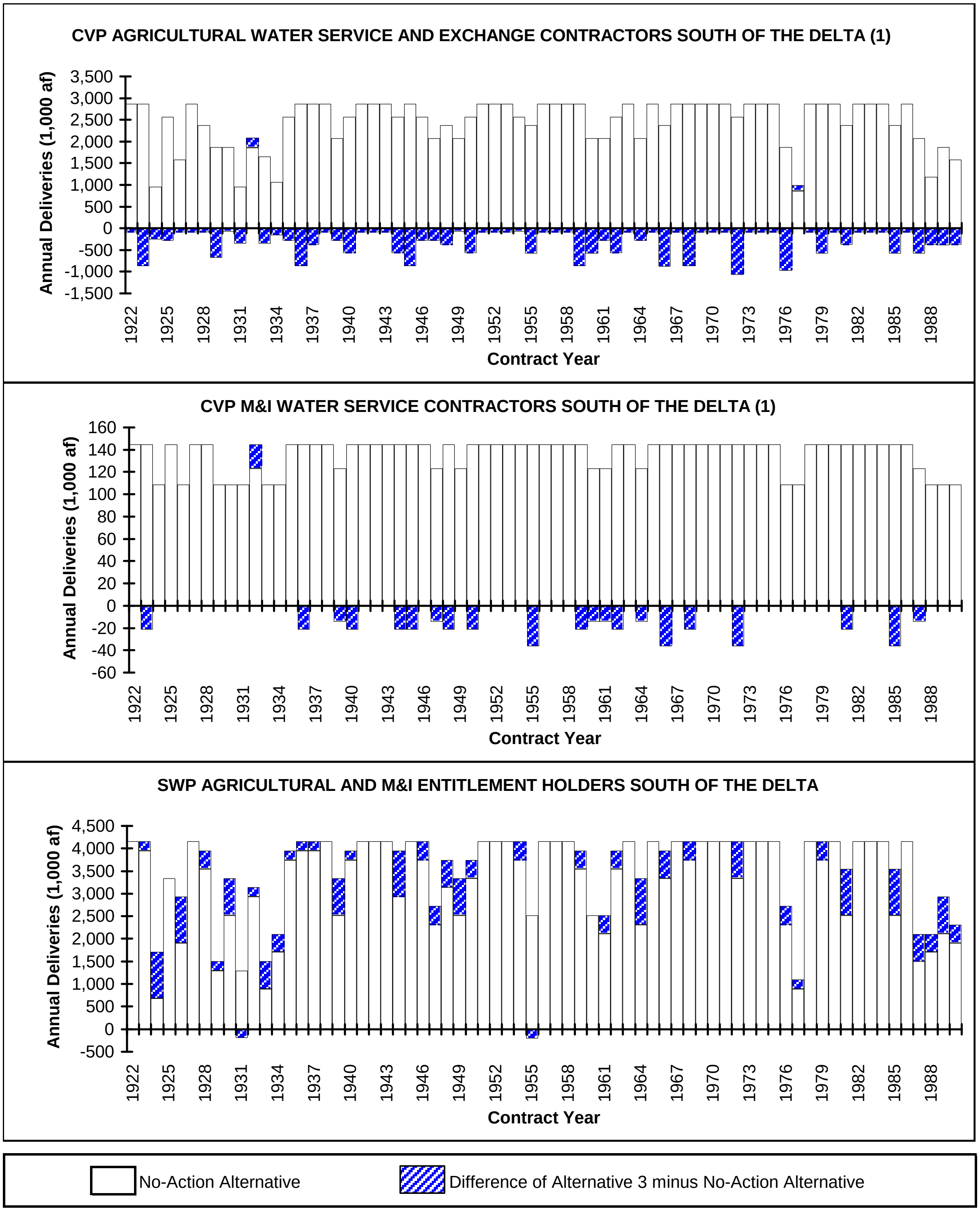
CVP Water Deliveries South of the Delta. Deliveries to CVP San Joaquin Exchange Contractors would be similar to those described in the No-Action Alternative. Figure III-22 shows the comparison of frequency distributions for CVP agricultural and M&I water service contractor deliveries as compared to the No-Action Alternative. The figure shows that water service contractors receive greater deliveries than in Alternative 1, due to the export of acquired water after it reaches the Delta. The difference in simulated annual deliveries as compared to the No-Action Alternative is shown in Figure III-59.

CVP Water Deliveries To Refuges. Alternative 3 includes annual deliveries of Level 4 water supplies to refuges as shown in Figure III-24, in comparison to the No-Action Alternative.



NOTES: (1) Includes Sacramento River and American River Divisions.
(2) Includes Sacramento River and American River Divisions plus Contra Costa exports.

FIGURE III-58
SIMULATED ALTERNATIVE 3 DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990



NOTE: (1) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE III-59
SIMULATED ALTERNATIVE 3 DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990

ALTERNATIVE 3 IMPACTS ON SWP OPERATIONS AND DELIVERIES

This section provides a comparison of Alternative 3 and No-Action Alternative SWP reservoir operations, resulting river flows, and water deliveries to SWP contractors. A comparison of deliveries to SWP contractors in the Alternative 3 simulation, as compared to deliveries in the No-Action Alternative simulation, is provided in Table III-16.

TABLE III-16
COMPARISON OF SWP DELIVERIES IN THE ALTERNATIVE 3 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual SWP Deliveries (1,000 acre-feet)		Average Annual Change in SWP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 3	
1922 - 1990	Simulation Period	3,330	3,600	+270
1928 - 1934	Dry Period	2,050	2,400	+350
1967 - 1971	Wet Period	4,140	4,200	+60

NOTES:
(1) SWP deliveries include deliveries south of the Delta to entitlement holders. SWP deliveries do not include refuge water supplies.

SWP Operations

Alternative 3 SWP operations and deliveries are affected by the ability to export acquired water through Banks Pumping Plant, when it reaches the Delta. The large capacity of Banks Pumping Plant and the SWP's flexibility to reduce Lake Oroville releases, allow the SWP to adapt operations to take advantage of the acquired water as it becomes available in the Delta.

Lake Oroville and Feather River Operations. The slight differences in Lake Oroville end-of-water year storage are shown in a comparison of frequency distributions for Alternative 3 and the No-Action Alternative, in Figure III-2. Average monthly flows in the Feather River at Nicolaus are similar to the No-Action Alternative as shown in Figure III-25.

Delta Operations. SWP Banks Pumping Plant exports increase in Alternative 3 by 270,000 acre-feet per year as compared to the No-Action Alternative. Figure III-18 shows a comparison of the frequency distributions for annual SWP exports, and also shows the change in average monthly Banks Pumping Plant exports.

San Luis Reservoir Operations. The Alternative 3 SWP average monthly storage in San Luis Reservoir is similar to the No-Action Alternative as shown in Figure III-18.

SWP Entitlement Water Deliveries

Alternative 3 average annual deliveries to SWP agricultural and M&I entitlement holders south of the Delta are 270,000 acre-feet per year greater than in the No-Action Alternative because acquired water can be exported through Banks Pumping Plant after it reaches the Delta. Figure III-22 shows a comparison of the SWP delivery frequency distributions for Alternative 3 and the No-Action Alternative. Figure III-59 shows the difference in annual SWP deliveries.

ALTERNATIVE 4

DESCRIPTION OF ALTERNATIVE

The water management provisions in Alternative 4 include all of the provisions in Alternative 3, plus additional (b)(2) Water Management actions in the Delta, and the acquisition of water from willing sellers for increased instream flow and Delta outflow. Under Alternative 4, the (b)(2) Water Management to meet target flows on CVP-controlled streams and towards 1995 Water Quality Control Plan requirements would be similar to the (b)(2) Water Management in Alternative 3. The delivery of firm Level 2 water supplies to wildlife refuges, and the revised instream fishery flow releases on the Trinity River would the same as described under Alternative 1.

Alternative 4 includes the acquisition of water from willing sellers for the delivery of Level 4 water supplies to wildlife refuges, as described under Alternative 2, and the acquisition of water for increasing stream flows toward flow targets identified in Attachment G-4 of the Draft PEIS, as described under Alternative 3. Water would be acquired to improve instream flow conditions on the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Yuba rivers. Under Alternative 4, the acquired would be used to increase both instream flow and Delta outflow, and would therefore not be available for export by the CVP or SWP.

Similar to Alternative 1, the CVP would be operated under Alternative 3 in an attempt to increase end-of-month storage in September in Shasta and Folsom lakes to provide increased river releases during the fall in the Sacramento and American rivers. As compared to the No-Action Alternative, increased reservoir releases would also be made from Whiskeytown Lake to increase Clear Creek minimum flows year round, and from New Melones Reservoir to provide higher flows on the Stanislaus River to attempt to meet target flows. Increased Clair Engle Lake releases, to meet increased Trinity River flow releases in this alternative, would result in a decrease in spring and early summer diversions to the Sacramento River. Also similar to Alternative 1, Alternative 4 includes implementation of the habitat restoration actions.

PEIS (b)(2) WATER MANAGEMENT FOR ALTERNATIVE 4

Alternative 4 includes the use of (b)(2) water to attempt to meet fishery objectives in the Delta, in addition to the (b)(2) actions on CVP-controlled streams that are included in Alternative 3. A simplified version of (b)(2) Water Management was developed that integrated nine proposed Delta (b)(2) water actions into Alternative 4. It is recognized that this simplified analysis is for the purposes of the Draft PEIS only, and that the formal WMP process, involving Reclamation and the Service, will provide detailed evaluation of the use of (b)(2) water for incorporation into CVP operating prescriptions for Reclamation's Operations and Criteria Plan.

In contrast to the proposed preliminary February 1996 Delta (b)(2) actions that were evaluated in Supplemental Analysis 1a, the Delta (b)(2) actions evaluated in Alternative 4 were developed based on preliminary information released by the Service in October 1996, which is presented in Attachment G-5 of the Draft PEIS. The Delta (b)(2) actions outlined in this attachment are a refinement of the preliminary potential actions originally proposed in February 1996, and evaluated in Supplemental Analysis 1a. The assumptions and process to develop a (b)(2) Water Management strategy for Alternative 4 are discussed in Attachment G-2 of the Draft PEIS.

The nine Delta (b)(2) actions in Alternative 4 are listed below according to priority**, as developed by the Service**. The highest priority action is assigned the number 1.

1. Limit CVP/SWP April and May exports to a percent of San Joaquin River at Vernalis flow based on water year type.

2. Head of Old River barrier in place April through May.

3. Increase level of May and June X2 requirement to 1962 level of development.

4. Provide 13,000 cfs at "I" Street Bridge and 9,000 cfs at Knights Landing on Sacramento River in May.

5. Ramp total CVP/SWP export/inflow ratio levels April 1 to April 15 and May 15 through May 31.

6. Close Delta Cross Channel Gates November 1 through January 31

7. Limit CVP/SWP exports to 35 percent of Delta inflow in July.

8. Establish conditions for a late fall run smolt survival experiment.

9. Limit CVP/SWP total exports to 35 percent of Delta inflow in November through January.

The potential impacts of all nine Delta (b)(2) actions could not be assessed in the model simulations conducted for the Draft PEIS. The simulations were programmatic in nature and did not have the capability to assess the specific changes that might occur as a result of the implementation of actions 2, 5, and 8. Although the models did not allow quantification of the potential impacts, some general assessments were made where possible.

WATER ACQUISITION IN ALTERNATIVE 4

Water acquisition quantities from willing sellers and the use of water in an attempt to meet instream flow targets in Alternative 4 would be the same as described under Alternative 3. Under Alternative 4, the difference is that water would be acquired to increase Delta outflow as well as to improve instream flows; therefore, the acquired water could not be exported by the projects as in Alternative 3. Water would be acquired for increased instream flows on the Merced, Tuolumne, Stanislaus, Calaveras, Mokelumne, and Yuba rivers. Water would also be acquired for delivery of Level 4 water supplies to wildlife refuges, in the same manner as described under Alternative 2. Results from Alternative 4 acquisition analyses are shown on figures referenced in the description of impacts associated with Alternative 3.

ALTERNATIVE 4 IMPACTS ON CVP OPERATIONS AND DELIVERIES

Alternative 4 CVP operations and water deliveries are affected by the integrated use of (b)(2) water for instream and Delta objectives, Level 2 refuge deliveries, and increased Trinity River instream flow releases. The Delta (b)(2) actions listed above would require additional reservoir releases primarily in May and June, and would further limit the amount of water that could be exported through Tracy Pumping Plant during the pulse flow period of April 15 to May 15, and during periods with an export/inflow ratio target of 35 percent.

Under Alternative 4, deliveries to CVP water service contractors would not be increased as a result of the management of acquired water. The increased flows that would result from the release of acquired water would flow through the Delta and contribute directly to increasing Delta outflow. Therefore, the acquired water could not be exported by the CVP. However, the CVP would receive some incidental benefit toward meeting Delta water quality and outflow requirements, since the increase in Delta outflow resulting from the release of acquired water would improve monthly antecedent water quality conditions in the Delta. The reduction in water deliveries to CVP contractors in Alternative 4, as compared to the No-Action Alternative, is summarized in Table III-17. A discussion of CVP operations and deliveries is provided below.

CVP Operations

In Alternative 4, CVP operations in the Trinity, Shasta, Sacramento River, and American River divisions would be similar to Alternative 1. There are minor changes in upstream CVP reservoir operations due to changes in Delta operations, but the operation of the upstream reservoirs is dominated by the need to make releases for water rights, upstream (b)(2) water objectives, and biological opinion requirements.

TABLE III-17
COMPARISON OF CVP DELIVERIES IN THE
ALTERNATIVE 4 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual CVP Deliveries (1,000 acre-feet)		Average Annual Change in CVP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 4	
1922 - 1990	Simulation Period	5,770	5,150	-620
1928 - 1934	Dry Period	4,560	3,970	-590
1967 - 1971	Wet Period	6,310	5,840	-470

NOTES:
(1) CVP deliveries include deliveries to agricultural and M&I water service contractors, Sacramento River water rights contractors, other water rights contractors, San Joaquin Exchange Contractors. CVP deliveries do not include refuge water supplies.
(2) Alternative 4 assumes purchase of up to 130,000 acre-feet of water per year for level 4 refuges from the Sacramento River Water Rights and San Joaquin River Exchange Contractors.

Friant Division operations would be similar to the No-Action Alternative. CVP operations in the Eastside Division would be similar to Alternative 3 because of the acquisition of water from willing sellers on the Stanislaus, Tuolumne, and Merced rivers. Operations in the Delta and West San Joaquin divisions would be affected due to higher Delta inflows from acquired water and the additional Delta (b)(2) actions. The operations of these divisions are discussed below.

Delta Division. As a result of upstream water acquisitions, simulated Delta inflows increase by about 400,000 acre-feet per year in Alternative 4 as compared to the No-Action Alternative. In Alternative 4, this additional inflow may not be exported by the CVP because it is acquired for instream and Delta outflow purposes. Tracy Pumping Plant exports decrease by about 300,000 acre-feet per year as compared to the No-Action Alternative, and decrease by about 40,000 acre-feet per year as compared to Alternative 1. Figure III-18 shows the frequency distributions for simulated annual Tracy Pumping Plant exports for Alternative 4 and the No-Action Alternative.

The Delta (b)(2) actions in Alternative 4 limit Tracy Pumping Plant exports primarily during April 15 through May 15, and require that additional water be released from upstream reservoirs in February through June for additional X2 requirements. Figure III-17 shows the decrease in average monthly Tracy Pumping Plant exports as compared to the No-Action Alternative.

Simulated Delta outflow increases by about 780,000 acre-feet per year as compared to the No-Action Alternative. Average monthly Delta outflows in the No-Action Alternative and Alternative 4 simulations are presented in Figure III-19. The primary increase in Delta outflow occurs in April and May due to the increase in Delta inflows from acquired water upstream releases, the reductions in Tracy and Banks Pumping Plant exports, and additional (b)(2) water releases for the increased number of X2 days at Chipps Island in May and June.

The Delta (b)(2) actions in Alternative 4 affect Delta inflows, outflows, and the ability to export water through Tracy Pumping Plant. Some of the Delta (b)(2) actions could not be implemented in all years over the 69-year simulation period due to existing operational constraints and criteria. These constraints include the need to meet water rights requirements, maintain SWP deliveries at the No-Action Alternative level, maintain Reclamation's ability to provide adequate storage in Shasta Lake to meet Winter Run Biological Opinion temperature control requirements, and the limit on the reduction in CVP deliveries due to use of (b)(2) water to no more than 800,000 acre-feet per year on an average annual basis.

Under Alternative 4, the highest priority Delta (b)(2) action, which limits CVP/SWP exports in April and May, would be met in all years over the 69-year simulation period. Action 3, the increase in the number of X2 days at Chipps Island in May and June, would also be met in all years. Action 4, which consists of increasing the flows at Knights Landing and at the "I" Street Bridge on the Sacramento River in May, was met in 22 and 59 percent of May in the 69-year simulation period. Implementation of Action 6, the closure of the Cross Channel Gates in November 1 through January 31, would be limited to wet and above normal water year types. Action 7, the limitation on CVP/SWP exports to 35 percent of Delta inflow in July, would be met in 56 percent of July in the 69-year simulation period. Action 9, which limits CVP/SWP exports to 35 percent of Delta inflow in November through January, would be met in 32, 38, and 57 percent of November, December, and January, respectively, over the simulation period.

The impacts of Delta (b)(2) actions 2, 5, and 8 were not quantitatively evaluated in the model simulations conducted for Alternative 4, but a general assessment of potential impacts may be made for actions 2 and 5. Action 8 is not assessed due to its experimental nature, and the need to establish experiment criteria and conditions. For action 2, the placement of the barrier at the head of Old River in April and May, it is generally assumed that the barrier would have minimal impact on CVP Delta operations. Action 5, the ramping of total CVP/SWP export/inflow ratio levels April 1 to April 15 and May 15 to May 31, would further reduce project exports during the ramping period. Estimates of the export/inflow ratio for the pulse period show ratios in the range of 5 to 15 percent, as compared to the 35 percent ratio that is in effect preceding and following the pulse period.

West San Joaquin Division. Operations of the CVP portion of San Luis Reservoir are similar to Alternative 1. As shown in Figure III-18, Alternative 4 simulated average monthly storage is greater in March than in the No-Action Alternative. This is caused by higher fall exports due to increased upstream CVP reservoir releases for (b)(2) Water Management. CVP San Luis Reservoir storage is reduced earlier in the spring due to reduced Tracy Pumping Plant exports in April and May.

CVP Contract Water Deliveries

In Alternative 4, upstream acquired water would not be exported through Tracy Pumping Plant when it reaches the Delta. Therefore the major effect on CVP deliveries is due to the additional (b)(2) actions in the Delta. These actions have minor effects on CVP deliveries north of the Delta, and primarily affect deliveries south of the Delta dependent on Tracy Pumping Plant exports. The resulting changes in CVP deliveries are discussed below.

CVP Water Deliveries North of the Delta. Deliveries to CVP Sacramento River Water Rights Contractors would be similar to those described in the No-Action Alternative. Deliveries to CVP agricultural and M&I water service contractors north of the Delta would be similar to those in Alternative 1. Figure III-60 shows a comparison of the Alternative 4 and No-Action Alternative deliveries.

CVP Water Deliveries Eastside Division. The deliveries to CVP agricultural water service contractors on the Stanislaus River in Alternative 4 would be similar to those described in Alternative 3.

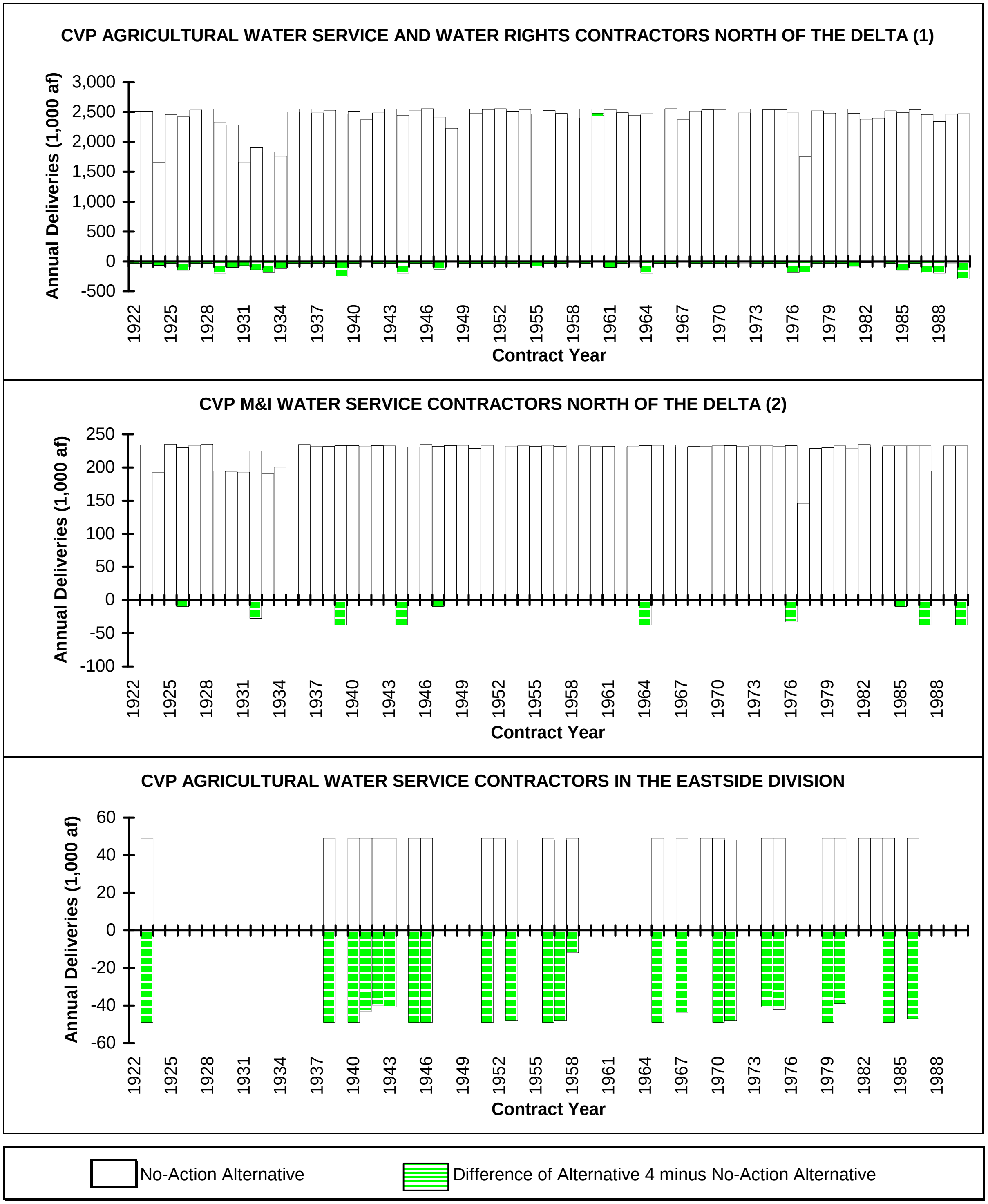
CVP Water Deliveries South of the Delta. Deliveries to CVP San Joaquin Exchange Contractors would be similar to those described in the No-Action Alternative. Figure III-22 shows the comparison of frequency distributions for CVP agricultural and M&I water service contractor deliveries as compared to the No-Action Alternative. The figure shows that CVP water service contractors south of the Delta receive lower deliveries than in the No-Action Alternative, and slightly lower than in Alternative 1. The limitations on Tracy Pumping Plant April and May exports directly affect the amount of water that can be delivered to southern water service contractors. The difference in simulated annual deliveries as compared to the No-Action Alternative is shown in Figure III-61.

CVP Water Deliveries To Refuges. Alternative 4 includes annual deliveries of Level 4 water supplies to refuges as shown in Figure III-24, in comparison to the No-Action Alternative.

ALTERNATIVE 4 IMPACTS ON SWP OPERATIONS AND DELIVERIES

For the purposes of the PEIS (b)(2) Water Management analysis, it was assumed that the SWP would cooperate with implementation of the Delta (b)(2) actions by reducing exports during specified periods and making releases to contribute to additional levels of Delta protection. It was also assumed that any negative impacts to the SWP, due to this cooperation in Alternative 4, would not exceed the benefits shown in Alternative 1. Therefore, there would be no net impact to average annual SWP deliveries as compared to the No-Action Alternative.

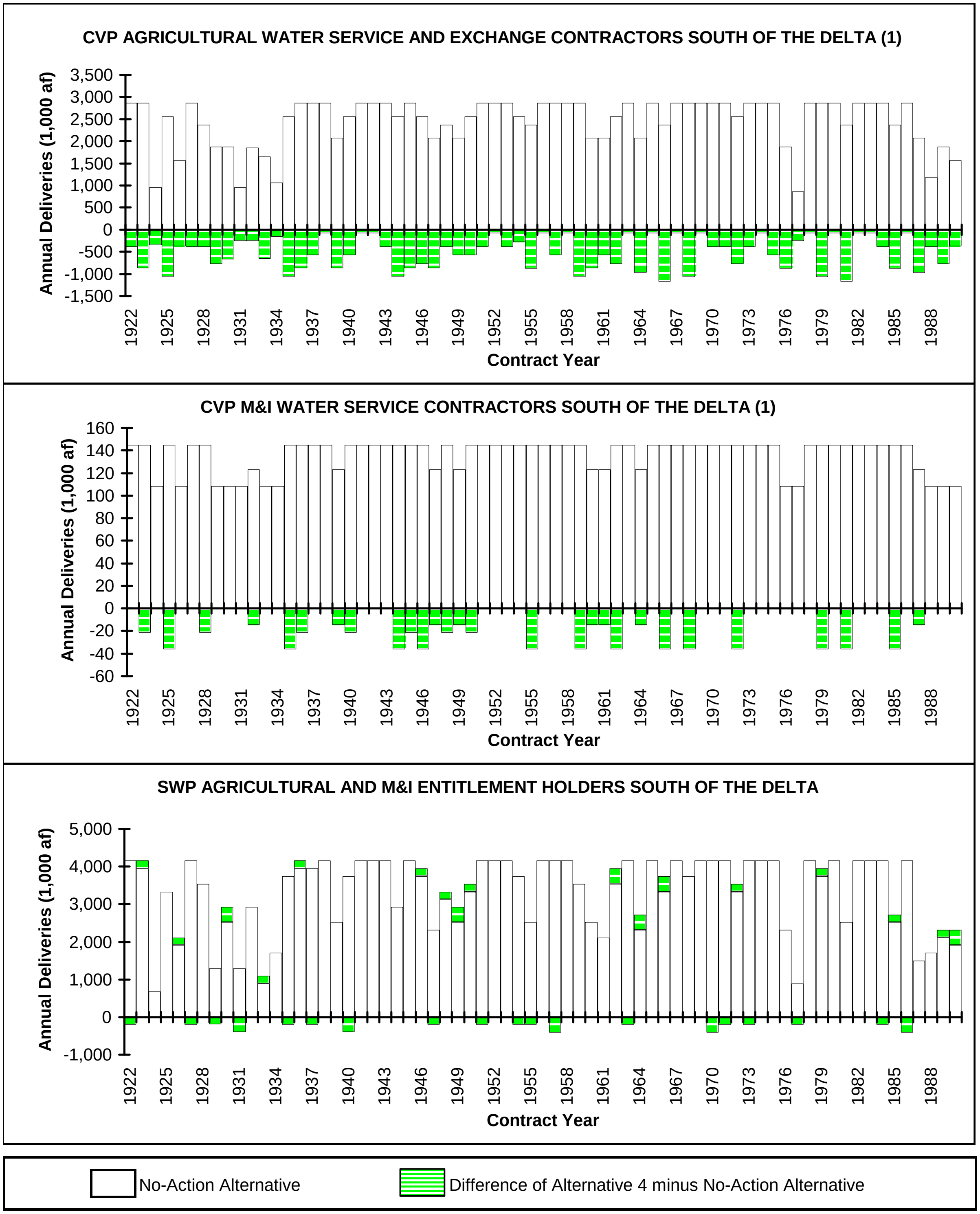
This section provides a comparison of Alternative 4 and No-Action Alternative SWP reservoir operations, resulting river flows, and water deliveries to SWP contractors. A comparison of deliveries to SWP contractors in the Alternative 4 simulation, as compared to deliveries in the No-Action Alternative simulation, is provided in Table III-18.



NOTES: (1) Includes Sacramento River and American River Divisions.

(2) Includes Sacramento River and American River Divisions plus Contra Costa exports.

FIGURE III-60
SIMULATED ALTERNATIVE 4 DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990



NOTE: (1) Includes Delta (DMC only), West San Joaquin, and San Felipe Divisions.

FIGURE III-61
SIMULATED ALTERNATIVE 4 DELIVERIES AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990

TABLE III-18
COMPARISON OF SWP DELIVERIES IN THE
ALTERNATIVE 4 AND NO-ACTION ALTERNATIVE SIMULATIONS

Contract Years	Type of Period	Simulated Average Annual SWP Deliveries (1,000 acre-feet)		Average Annual Change in SWP Deliveries (1,000 acre-feet)
		No-Action Alternative	Alternative 4	
1922 - 1990	Simulation Period	3,330	3,310	-20
1928 - 1934	Dry Period	2,050	2,050	0
1967 - 1971	Wet Period	4,140	3,990	-150

NOTES:
(1) SWP deliveries include deliveries south of the Delta to entitlement holders. SWP deliveries do not include refuge water supplies.

CHAPTER IV

BIBLIOGRAPHY

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BIBLIOGRAPHY

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