Environmental Water Account

VOLUME I
Draft Environmental Impact Statement
Environmental Impact Report

July 2003

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NOAA Fisheries
National Marine Fisheries Service

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Volume I
Chapters 1-9

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EIS/EIR Executive Summary

Purpose of Study and EIS/EIR

The Sacramento and San Joaquin Delta region provides water to the majority of California's agriculture and to urban and industrial communities. The Delta also provides habitat for numerous plant, animal, and fish species, including several endangered species. This dual role places the Delta region at the center of an ongoing conflict between environmental and water supply interests.

Within the Delta, Federal (Central Valley Project or CVP) and State (State Water Project or SWP) [1] pumping plants move water from the Delta to a system of canals and reservoirs for use by agriculture, communities, and wildlife refuges in the Central Valley, the Bay Area, along the central coast, and southern California. Pumping of water from the Delta alters normal flow patterns and can threaten the recovery of endangered and threatened fish species unless the protection of those species is employed as an operations parameter. Reduction of Delta pumping for protection and recovery of fish can, however, interrupt water supply deliveries. These interruptions reduce the reliability of California's water supply, causing conflicts.

The CALFED Bay-Delta Program (CALFED Program) [2] is a collaborative effort of 23 Federal and State agencies that seek to resolve these conflicts. The primary goals of the CALFED Program are to restore the ecological health of the Bay-Delta estuary; improve water supply reliability to farms and cities; protect drinking water quality; and protect the integrity of the Delta levees for water conveyance and ecosystem function. The CALFED Programmatic Environmental Impact Statement/ Environmental Impact Report (PEIS/EIR) Record of Decision (ROD) and Operating Principles Agreement identified an Environmental Water Account (EWA) as one element of its overall strategy for meeting the goals of the CALFED Program. The CALFED ROD identifies the EWA as a cooperative management program to protect the fish of the Bay-Delta estuary through environmentally beneficial changes in CVP/SWP operations at no uncompensated water cost to the CVP/SWP water users. This document tiers from the CALFED Bay-Delta PEIS/EIR and the CALFED ROD and as such assesses and evaluates alternatives for EWA implementation as introduced in the CALFED ROD. The EWA consists of two primary elements: (1) assisting in fish population recovery for at-risk native fish species; and (2) increasing water supply reliability by reducing uncertainty associated with fish recovery actions.

The CALFED agencies that developed the EWA recognized that to contribute effectively to the CALFED Program and to complement efforts to meet the range of

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1 The California Department of Water Resources (DWR) operates the SWP by storing available water upstream from the Delta and moving it along with unstored natural flows through the Delta to serve agricultural and urban users in the Central Valley, San Francisco Bay Area, central coast, and southern California. Reclamation operates the CVP in the same fashion, providing water to agricultural and urban users in the Central Valley and San Francisco Bay Area.

2 The California Bay-Delta Authority, created effectively January 1, 2003, will exercise oversight and coordination over the CALFED Bay-Delta Program.

CALFED ROD objectives, the EWA Program must incorporate a highly flexible, immediately implementable, and reliable water management strategy. The EWA must (1) protect the at-risk fish species affected by SWP/CVP operations and facilities, (2) contribute to the recovery of these species, (3) allow timely water-management responses to changing environmental conditions and changing fish protection needs, (4) provide reliable water supplies to water users in SWP/CVP export areas, and (5) not result in uncompensated water loss to users. This water management strategy also must comply with the general EWA guidance presented in the CALFED ROD and the EWA Operating Principles.

EWA Agencies

Five Federal and State agencies are involved in administering the EWA. The California Department of Water Resources (DWR) and the Bureau of Reclamation (Reclamation), or the "Project Agencies," are responsible for acquiring water assets and for storing and conveying the assets through use of the SWP and CVP facilities. The "Management Agencies," which include the State and Federal fishery agencies (National Marine Fishery Service [NOAA Fisheries], U.S. Fish and Wildlife Service [USFWS], and the California Department of Fish and Game [CDFG]), use the EWA to protect and restore fish. All five EWA agencies are responsible for the day-to-day program management of actions taken to protect and benefit fish (e.g., pumping reductions to protect fish) and instream flow enhancements to help facilitate fish population recovery.

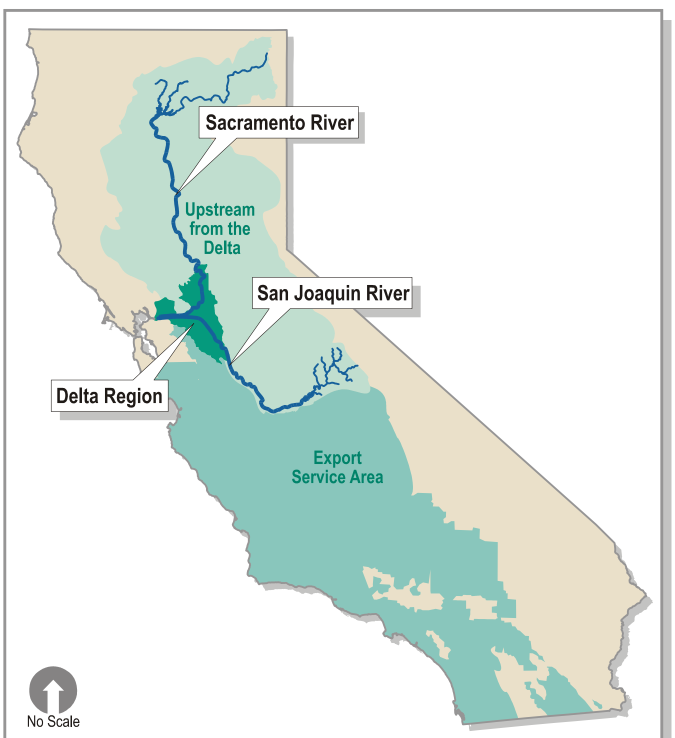

Figure ES-1
EWA Study Area

Study Area

The study area for this Environmental Impact Statement/Environmental Impact Report (EIS/EIR) encompasses the areas where the EWA agencies could acquire and manage assets as well as the areas where the assets could be used to benefit fish. Figure ES-1 shows the study area, which includes the entire Central Valley served by the SWP and CVP; the Delta region; coastal areas south of San Francisco served by the SWP; and areas of southern California served by the SWP. The study area also includes reservoirs in the foothills of the central Sierra Nevada. Rivers in the study region for this EIS/EIR include the Sacramento, Feather, Yuba, American, Merced, and San Joaquin.

Development of the EWA Alternatives

The California Environmental Quality Act (CEQA) requires that environmental documents identify and analyze a reasonable range of feasible alternatives that could meet the project purpose and need statement to varying degrees. Under CEQA, the range of potential alternatives to the proposed project shall include those that could feasibly accomplish most of the basic objectives of the project and could avoid or substantially lessen one or more of the significant effects. In addition, the National Environmental Policy Act (NEPA) requires that a reasonable range of alternatives be analyzed, including a no action alternative. The development of alternatives presented in this document was an iterative and collaborative process involving representatives from the Reclamation, DWR, USFWS, NOAA Fisheries, and CDFG. These agencies worked together to interpret the CALFED ROD definition of the EWA while considering a range of possible EWA alternatives.

To address the ability of EWA agencies in meeting the goal to provide water for the protection and recovery of fish beyond that available under the regulatory baseline, the CALFED ROD identified the EWA as a 4-year (2001-04) cooperative management program of which the purpose is to provide protection to the fish of the Bay-Delta estuary at no uncompensated water cost to the Project's water users. The approach involves acquiring alternative sources of Project water supplies to replace water supply otherwise lost through changes in Project operations. The EWA agencies may determine through written agreement to extend the EWA beyond September 30, 2004, as stated in the CALFED ROD. Because there is a possibility for extension, this EIS/EIR analyzes EWA actions that will start at the time of the signing of the EWA ROD through 2007. The EWA ROD is scheduled for signing in early 2004.

The EWA's purpose and need and project objectives formed the basis for the identification and evaluation of the range of alternatives. The selection of alternatives for detailed analysis was based on the three primary considerations related to the ongoing water conflict at the Delta pumps; alternatives selected for detailed analysis needed to be immediately implementable, flexible, and reliable.

- **Immediate.** Conflict at the pumps was an ongoing problem that required an immediate solution to meet both water supply needs and environmental protection requirements. Water agencies, water users, and resource agencies could not wait for the construction of new facilities or planned changes in water uses.

- **Flexible.** Any action taken to reduce the pumping conflict would need to take advantage of multiple means of water purchase, storage, and release, using spatial and temporal variation to provide water when it was most needed. Flexible water assets could be acquired from any entity and transferred to any entity connected to the Project systems to prevent interruption of water supplies.

- **Reliable.** Reliability is important for water users. Historic conflicts at the pump created uncertainty for users because fish presence near the export pumps could cause unexpected reductions in pumping, and these reductions could affect water supply. Alternatives must increase supply reliability for urban, agricultural, and environmental users in the Export Service Area.

The EWA Program takes advantage of the operational flexibility of the SWP and CVP facilities to manage EWA assets to the benefit of the environment and water users.

Alternatives Considered But Eliminated from Further Consideration

The alternatives development team considered a variety of means for water management, including other actions described in the ROD and other ongoing water management programs and projects. The construction of new facilities (e.g., reservoirs) to store additional water during times of pump curtailments was not considered because evaluation, design, permitting, and construction would delay the use of these facilities until after the EWA timeframe. Likewise, modifying pumping facilities to prevent fish entrainment (e.g., with Delta infiltration galleries) would require development of new designs and detailed review by all involved agencies, which could take years before permitting and construction could begin. The EWA development team also considered and rejected the following alternatives:

- **Construction of desalination plants in southern California.** Although such plants have gained acceptance as improved technologies have reduced desalination costs, it would be years before a new plant could come online to provide sufficient water quantities that could offset the water potentially lost during pump curtailments.

- **Increased use of Colorado River water.** To address conflicts regarding Colorado River apportionments, the Department of the Interior (DOI) asked California to reduce its use of Colorado River water. While California users are reducing dependence on Colorado River supplies, water users will likely need all available supplies. Increasing the use of Colorado River water would not provide reliable supplies, nor would the water be available for immediate use, so this alternative was not carried forward as an alternative.

- **Water use efficiency within the project service area.** Improved water use efficiency is a goal of the CALFED Program and is included as one of the program components. However, water efficiency alone would not be sufficient to accomplish the CALFED Program's goals for the EWA during Stage 1.

- **Additional water sources, including new or increased capacity of storage facilities, new conveyance facilities, or "water bladders" to transport water to southern California.** Development of new supplies or supply methods would delay use of these potential alternatives beyond the EWA timeframe. Development of new conveyance facilities (e.g., an isolated facility) would also be beyond the EWA timeframe.

Recognizing the need for an immediate solution to the conflicts between fish protection and water exports, the EWA agencies dismissed these and other alternatives and focused on the EWA water asset acquisition and management strategy introduced in the CALFED ROD.

EWA Description

As noted above, the EWA, as introduced in the CALFED ROD, consists of two primary elements: facilitation of fish population recovery through asset (water) acquisition and management and use of the acquired assets to replace water deliveries (or supplies) interrupted by changes in project operations. That is, the EWA helps facilitate fish population recovery by reducing pumping in the Delta when fish are most at risk. EWA agencies would also acquire water either for direct environmental use, or to repay SWP and CVP contractors whose supplies would have otherwise been interrupted by actions taken to benefit fish. Asset acquisition is the responsibility of the two Project Agencies, Reclamation and DWR. Actions taken to benefit fish are recommended by the three Management Agencies (NOAA Fisheries, USFWS, and CDFG).

EWA assets are used to replace the water that would have otherwise been delivered to export service area contractors when fish actions are taken to protect and enhance fish species recovery. As noted previously, the EWA Management Agencies are responsible for recommending the timing and location of asset use in fish actions. The fish actions recommended by the EWA Management Agencies include:

- **Pump Reductions** – Decreasing export pumping from the Delta when at risk fish species are determined to be within the vicinity of the SWP and CVP pumping stations.

- **Delta Cross Channel Gates Closure** – Closing the Delta Cross Channel Gates (above the regulatory baseline) to restore natural flow patterns and to encourage fish to migrate through the most suitable water channels away from the SWP and CVP pumping stations.

- **Instream Flow Augmentation** – Increasing the streamflow of rivers tributary to the Delta (through releases of EWA assets stored in onstream reservoirs) to improve spawning, migration, and rearing habitats.

- **Delta Outflow Augmentation** – Increasing the Delta outflow quantity to repel saline San Francisco/San Pablo Bay water from the Delta, to improve the water quality in Delta habitats, and to improve fish outmigration

The asset acquisition measures available to the EWA agencies include:

- **Stored Reservoir Water Purchase** – Purchase of surface water stored in non-Project reservoirs (not CVP or SWP reservoirs).

- **Groundwater Substitution** – Purchase of surface water supplies (typically stored in a reservoir) while the users forego their surface water supplies and pump an equivalent amount of groundwater as an alternative supply.

- **Crop Idling/Crop Shifting** – Purchase of water from agricultural users who then idle land that would otherwise have been in production or shift to less water-intensive crops.

- **Stored Groundwater Purchase** – Purchase of groundwater assets that were previously stored by the selling agency with the intent to sell a portion of those assets at a later date. This option differs from groundwater substitution in that groundwater substitution transfers would not come from water that had been previously stored.

- **Variable Assets** – Obtaining water through a regulatory or operational change in the Delta that allows water to be diverted from the Delta specifically for the EWA.

In addition to managing the acquired water, the EWA agencies may use the following asset management measures:

- **Source Shifting** – Providing water earlier or delaying water deliveries to a Project contractor. Under the earlier delivery, the EWA agencies would be essentially borrowing storage space from the contractors' facilities for a fee until the time the contractor would normally have received the water. Under the delayed delivery the EWA agencies would be essentially borrowing water for a fee and returning the water at a later date.

- **Stored Water –** purchasing stored water from the south-of-Delta sources to be used as collateral for borrowing (released only when all other assets have been expended), and to function as long-term storage space after the water has been released; and.

- **Borrowing Project Water** – Borrowing CVP or SWP water, if the water can be repaid without affecting deliveries to Project contractors. The EWA could also borrow Project storage space if the Projects do not need that space for other designated uses.

- **Exchange of EWA Assets –** If the Management Agencies decide to do so, the Project Agencies may exchange EWA assets for assets of a character, such as location, seasonality or year-type, more suitable to EWA purposes.

The Project Agencies determine the quantity of water that can be made available each year to agricultural and urban contractors within the Export Service Area. The Project Agencies then move that amount of water, either from natural flows within the Sacramento and San Joaquin River Basins or from Project reservoirs upstream from the Delta, through the Delta using the export pumping plants. EWA asset management activities also involve use of the Delta pumps when capacity is available. In wet rainfall years, the Delta pumps export water at nearly 100 percent of their capacity during the summer transfer window, leaving minimal export capacity available for moving EWA assets. Whereas, in dry rainfall years, the export pumps are not running at capacity, leaving more capacity available to move EWA assets than in wet years, during the summer transfer window. During dry years, the EWA agencies would have fewer requirements to replace water lost during pumping reductions because the pumps would not have been operating at full capacity without the EWA. Therefore the EWA Project Agencies may need to make fewer water acquisitions during dry years.

This variation in the availability of Delta pumping capacity is important to the implementation of the EWA program because it affects how assets could be acquired and managed. In general, acquiring EWA assets from areas upstream from the Delta would be less expensive than acquiring them from sellers in the Export Service Area. Assets purchased in the Export Service Area are often more expensive than other assets because potential sources in the Export Service Area are more limited; water agencies are often paying for storage and conveyance facilities; and growing conditions are more conducive to higher value crops than in the Upstream from the Delta Region.

The strategies that the EWA agencies would employ to acquire and manage assets would also vary by the hydrologic conditions posed during each water year. The approaches to acquire and manage water during hydrologically wet years (years when there is more water in the reservoirs and rivers upstream from the Delta than average) versus hydrologic dry years (less water or drought years) are described below.

- In wet years, EWA agencies would probably acquire some surface water from non-Project reservoirs upstream from the Delta because this water would be readily available and is the least expensive asset source. However, the amount of water EWA agencies would be able to export to service areas south of the Delta would be limited because the CVP/SWP export pumping facilities would be at capacity meeting contract commitments during most of the summer. During wet years, EWA agencies would need to focus on water acquisition via stored groundwater purchase or crop idling within the Export Service Area to address EWA water supply commitment goals. The EWA Project Agencies would not need to move these assets through the Delta.

- In dry years, when less water is available to meet CVP/SWP contract commitments, the Delta pumps would have greater availability to move EWA assets. EWA agencies would focus on acquisitions upstream from the Delta. The EWA would still look to purchase stored reservoir water first because of the lower price, but this water may be less available than in wet years. The EWA agencies would then focus water acquisitions on groundwater substitution and crop idling upstream from the Delta. The EWA agencies could use these upstream from the Delta water acquisitions to produce secondary benefits, such as increased instream flows and Delta outflows.

No Action/No Project Alternative

The No Action/No Project Alternative describes the reasonably foreseeable future without the EWA (if the EWA were not approved) based on legal and regulatory constraints. If the EWA were not implemented, actions to protect fish that are mandated by existing regulatory requirements would continue. For example, compliance with the biological opinions developed by USFWS and NOAA Fisheries under the Endangered Species Act would require pumping reductions, resulting in reduced deliveries. DWR and Reclamation would continue to reoperate the SWP and CVP, respectively, to avoid decreased deliveries to export users, but would not acquire and manage EWA assets that could be used to repay lost deliveries.

In response to decreased water supply reliability, some agricultural water contractors would either accept the shortage, idle or retire some crop land, substitute crops that use less water, increase the use of local water supplies through groundwater pumping, local transfers, recycling, desalination, or implement additional water use efficiency or conservation. Local entities could also pursue independent water transfers, pursue other non-local sources (e.g., the Colorado River), or turn to litigation and/or political pressure to change rules that result in the reduction of the water supply. Of these potential responses, groundwater pumping is the most likely and the most problematic. Some portions of the San Joaquin Valley groundwater basins are in overdraft, and groundwater in some areas is of lower quality than the surface water supply. Uncompensated Delta pump reductions raise concerns for diminished groundwater supplies and conditions for the San Joaquin Valley.

Urban water contractors could respond to reduced water supply by increasing their emphasis on local water conservation or by relying more heavily on local groundwater and surface water supplies, if they are available. The reduced water supply reliability caused by the pump reductions would make local planning efforts more difficult for the urban water agencies, especially in areas where local supplies are limited.

Flexible Purchase Alternative (The Proposed Action/The Proposed Project)

The Flexible Purchase Alternative uses a flexible interpretation of the CALFED ROD and Operating Principles Agreement, incorporating functionally equivalent purchases and actions within the framework of the ROD. Under the Flexible Purchase Alternative, the EWA agencies would make purchases to provide a higher level of fish protection and recovery than the Fixed Purchase Alternative. The increased level of protection would respond to differing hydrologic conditions and would take advantage of water acquisition/storage possibilities throughout the CVP/SWP service areas.

The Flexible Purchase Alternative would allow the EWA agencies to purchase up to 600,000 acre-feet of water but would not restrict acquisition of the total quantities from each region. The EWA agencies could apply the concept of functional equivalency by combining acquisition methods, water sources, and operational flexibilities to effectively respond to annual changes in hydrology and fish behavior in the Delta. Under the Flexible Purchase Alternative, the EWA agencies would acquire variable assets in the same manner as for the Fixed Purchase Alternative.

Allowing flexibility to acquire and manage EWA assets differently each year could increase the EWA agencies' capability for responding to varying hydrologic conditions. During dry years when greater export pump capacity is available, the agencies could acquire quantities up to that capacity (potentially up to 500,000 acre-feet) upstream from the Delta for storage, pre-delivery, or delayed delivery within the Export Service Area. The Flexible Purchase alternative would allow the EWA agencies to respond to changes in existing operations and allow for additional upstream fish actions, such as instream flow enhancements.

Under the Flexible Purchase Alternative, the Project Agencies would acquire water via stored reservoir water, groundwater substitution, groundwater purchase, or crop idling in a manner and in amounts that would not affect the environment or water supplies adversely. The EWA agencies would employ conservation and mitigation measures, as described in this EIS/EIR, to minimize effects of this alternative.

Fixed Purchase Alternative

The CALFED ROD established the types of EWA acquisition and management actions and included targets for the quantity of assets that the EWA agencies could acquire in each region (Table ES-1). The Fixed Purchase Alternative is based upon a strict interpretation of the ROD. Under this alternative, the Project Agencies would acquire 185,000 acre-feet of EWA assets annually. The Fixed Purchase Alternative includes a target of 35,000 acre-feet for total upstream from the Delta purchases and 150,000 acre-feet for total purchases in the Export Service Area. By dictating the selling region and the maximum purchase amounts, these targets provide for the maximum level of asset acquisitions and resulting types of actions that the Project and Management Agencies can take.

Table ES-1 lists the ROD-specified asset quantities around which the Fixed Purchase Alternative was developed. As the table shows, this alternative also allows for other actions, including source shifting and the acquisition of storage.

Table ES-1
Fixed Purchase Alternative -
EWA Tier 2 Assets in Accordance with CALFED ROD(1)

Action Description	*Water Available Annually (Average)*
SWP Pumping of (b)(2)/ ERP Upstream Releases	40,000 acre-feet
Export/Inflow Ratio Flexibility	30,000 acre-feet
Purchases – Export Service Area	150,000 acre-feet
Purchases – Upstream from the Delta	35,000 acre-feet
Storage acquisition	200,000 acre-feet of storage
Source Shifting Agreement(2)	100,000 acre-feet

(1) The water amounts in the ROD were targets for the first year; higher amounts were anticipated for subsequent years.
(2) The source shift value reflects the quantity of water that is borrowed and must be returned.

In the region upstream from the Delta under the Fixed Purchase Alternative, the Project Agencies would probably seek first to acquire stored reservoir water, which represents the least expensive asset. A number of potential surface water sources would likely be available for purchases to comprise 35,000 acre-feet. The Project Agencies would be less likely to acquire water upstream from the Delta via groundwater substitution, stored groundwater purchase, and crop idling. Stored groundwater purchase and crop idling would be the Project Agencies' likely acquisition sources in the Export Service Area.

Because the Fixed Purchase Alternative sets the maximum targets for the quantity of water that could be acquired, actions taken by the EWA agencies would be limited to the availability of carryover assets from prior years, assets available from Delta flexibility (variable assets), purchases of 185,000 acre-feet, source shifting, and the capacity to borrow water from the projects based on the availability of groundwater storage. The Fixed Purchase Alternative would provide some water management flexibility over the No Action/No Project Alternative and would address at least a portion of the water reliability concerns caused by export pump reductions.

Comparison of Alternatives

Table ES-2 presents a comparison of the EWA asset acquisition and strategies for the project alternatives. Two important interrelated considerations regarding EWA asset purchase strategies are the hydrologic-year type and the excess Delta pump capacity available to export EWA assets. The hydrologic-year type has a strong influence on the availability of Delta pumping capacity for the EWA.

As explained previously, during wet years the CVP and SWP have more water available for Project contractors and must move this water from upstream from the Delta, through the Delta pumps, and to the Project contractors in the Export Service Area. In wet years, the Delta pumps have less capacity available to move EWA assets into the Export Service Area due to the CVP and SWP necessity to meet contract commitments.

Under the Fixed Purchase Alternative, during wet years, the EWA Project Agencies would acquire 35,000 acre-feet of assets upstream from the Delta. The Flexible Purchase Alternative would not cap upstream from the Delta acquisitions, but Delta pumping capacity would likely limit the amount of acquisitions to 75,000 acre-feet. Of the 75,000 acre-feet acquired, about 15,000 acre-feet becomes Delta outflow as carriage water losses and the remaining 60,000 acre-feet would be transferred south of the Delta using the EWA's dedicated 500 cubic feet per second (cfs) transfer capacity during the July through September transfer period. The 75,000 wet year limit for the Flexible Purchase Alternative would be an amount similar to that under the Fixed Purchase Alternative for all water year types.

Table ES-2
Comparison of EWA Alternatives

EWA Water Acquisition	No Action/No Project	Flexible Purchase Alternative	Fixed Purchase Alternative
Fish Actions			
Operational Curtailments (pumping reductions to increase Delta outflow)	Actions address ESA[(3)] Biological Opinions only; no ability to repay water not delivered due to pump curtailments	Ability to provide fish protection actions at Delta pumps beyond ESA, but limited to the total volume of water acquired, variable assets, and debt without interrupting water supply. Availability of 600 TAF[(1)] of water increases opportunity for fish actions and ability to repay Projects for water not delivered during pump curtailments.	Ability to provide fish protection actions at Delta pumps beyond ESA, but limited to total volume of water acquired, variable assets, and debt without interrupting water supply. Availability of 185 TAF of water increases opportunity for fish actions and ability to repay Projects for water not delivered during pump curtailments.
Upstream Flow Enhancements for Fish Recovery/Enhancements	No potential for upstream flow enhancements beyond existing programs	The magnitude of potential benefits would vary between rivers but would be limited by the volume of upstream purchases moved during the transfer window, which could be up to 600,000 acre-feet.	The magnitude of potential benefits would vary between rivers but would be limited by the volume of upstream purchases moved during the transfer window, which could be up to 35,000 acre-feet.
Ability to Purchase Additional Water to Account for (b)(2) Changes	No ability	Acquisition of 600 TAF increases potential to acquire additional water to address the (b)(2) changes.	Acquisition of 35 TAF increases potential to acquire additional water to address the (b)(2) changes.
Asset Acquisition			
Stored Reservoir Purchase	No purchases	Purchases of up to 135 TAF in dry years; wet year purchases would be limited to the Delta[(2)] pump capacity available to EWA of up to 50 TAF	Limited to 35 TAF Upstream from the Delta
Groundwater Substitution	No purchases	Purchases of up to 315 TAF in dry years, but only up to 50 TAF in wet years; groundwater substitution would most likely be exercised in dry years but not in wet years due to pump capacity	Limited to 35 TAF Upstream from the Delta; probably would not be exercised in most years because 35 TAF can be obtained from stored water sources
Groundwater Purchase (Upstream from the Delta)	No purchases	Purchases of up to 35 TAF in dry and wet years; wet year purchase quantity would be dependent on amount acquired via other strategies.	Limited to 35 TAF Upstream from the Delta; probably would not be exercised in most years because 35 TAF can be obtained from stored water sources
Groundwater Purchase (Export Service Area)	No purchases	150 TAF maximum; stored groundwater purchase would not be available each year	Purchase of up to 150 TAF maximum; stored groundwater purchase would not be available each year
Crop Idling (rice Upstream from the Delta);	No purchases	Purchases of up to 180 TAF in dry years and 50 TAF in wet years. Crop idling would probably not be exercised in wet years.	Limited to 35 TAF Upstream from the Delta; probably would not be exercised in most years because 35 TAF can be obtained from stored water sources
Crop Idling (cotton within export service area)	No purchases	Purchases of up to 375 TAF; higher amounts would be expected for wet years when EWA has less pump capacity to export water from Delta	Purchase of up to 150 TAF maximum within export service area; higher purchases would be expected in wet years due to Delta pump capacity limitations
Variable Assets	Variable Assets defined in CALFED ROD not available for fishery actions under No Action	Variable amounts of water available to EWA each year through changes in Delta operations.	Same as Flexible Purchase Alternative
Asset Management Activities			
Groundwater Storage (banking)	No storage	Up to 200 TAF	200 TAF addressing CALFED ROD first year EWA requirement
Source Shifting	No source shifting to protect San Luis Reservoir from low-point water quality impacts	Source shifting to protect San Luis is available	Source shifting to protect San Luis is available
Project Water Borrowing	No project borrowing to repay water not delivered due to pump curtailments water	Potential for borrowing water for later repayment of up to 100 TAF	Potential for borrowing water for later repayment of up to 100 TAF
Ability to Purchase Additional Water to Account for (b)(2) Changes	No ability beyond existing program	Greater potential to acquire additional water to address the (b)(2) changes	Depending on water year and fish behavior at the pumps, there may be a potential for limited amounts of additional water being available to address the (b)(2) changes

(1) TAF = thousand acre feet
(2) Hydrologic modeling of Delta pump capacity indicates that there would be 50 TAF of excess capacity available to EWA during wet years and up to 520 TAF in dry years. Delta pump capacity is a limiting factor on the quantity of water EWA agencies can purchase and export to the CVP/SWP service areas.
(3) Federal Endangered Species Act

In the Export Service Area, the Project Agencies would focus on acquisitions of assets through crop idling (cotton) and stored groundwater purchase. The Fixed Purchase Alternative would target these purchases at 150,000 acre-feet. Under the Flexible Purchase Alternative, acquisitions would be limited by EWA funding or the amount of water offered by the willing sellers. During wet years under the Flexible Purchase Alternative, approximately 540,000 acre-feet purchased within the Export Service Area and 60,000 acre-feet upstream from the Delta are analyzed in this EIS/EIR.

Because of its wider potential range of purchases and actions, the Flexible Purchase Alternative would have a greater potential for environmental, physical, and socioeconomic effects in wet years than the Fixed Purchase Alternative. However, the Management Agencies would have greater potential for operational changes that benefit fish while keeping the Project contractors whole (provide for replacement water), plus greater opportunities for Delta outflow benefits and for upstream flow enhancements. During dry years, less water would available for the Projects to export to Project contractors, and the Delta pumps would have more pumping capacity available for EWA use than in wet years.

Upstream from the Delta, the Fixed Purchase Alternative's 35,000 acre-foot target would limit acquisitions to a quantity range likely to be available from the least expensive source – stored reservoir water. The 150,000 acre-feet purchased in the Export Service Area would likely come from crop idling, assuming that groundwater purchases would not be possible in some years. Under the Flexible Purchase Alternative, in which the acquisition limitation is effectively the Delta pump availability, asset acquisitions upstream from the Delta would focus on purchase of stored reservoir water first, followed by groundwater substitution, groundwater purchase, and finally rice cropland idling. The Project Agencies would be likely to focus acquisition efforts for the Flexible Purchase Alternative on the less expensive, upstream-from-the-Delta sources and may not need to make purchases within the Export Service Area.

Although both the Fixed Purchase and Flexible Purchase alternatives could achieve similar benefits, the Flexible Purchase Alternative would have a greater potential to achieve fishery protection, enhancement, and recovery goals than the Fixed Purchase Alternative. The behavior of fish at the Delta pumps—the timing of their arrival (typically winter and spring; December through June) and the length of their stay—varies year-to-year and cannot be predicted in advance. Years in which the fish arrive late and leave early may require fewer pump reductions than other years and the Fixed Purchase Alternative may have adequate assets to cover those reductions as a well as providing water for upstream fish enhancements.

In years in which the fish arrive early and leave later, pump reductions may occur more often, resulting in the potential for insufficient assets to address Project water commitments under the Fixed Purchase Alternative. In such years, the Flexible Purchase Alternative would have a greater potential for meeting both the Project water commitments and the fish enhancement benefits intended for EWA under the CALFED ROD.

Environmental Consequences

The environmental baseline used to establish the basis for determining effects of EWA actions is derived from the CEQA definition of existing conditions and the NEPA definition of future conditions without project. The reader is referred to the individual resource chapters in this EIS/EIR for discussions on how the baseline is being applied to each resource.

Table ES-3 presents a summary of how EWA asset acquisition and management actions could effect the natural, physical, and social environments. The table describes the effect and provides the determination of whether the effect is potentially significant or less than significant.

Table ES-4 presents the proposed mitigation measures that will reduce the potential effect to less than significant. Chapter 2 presents additional details on the mitigation measures.

Table ES-5 summarizes the benefits of EWA asset acquisition and management actions for each of the alternatives.

Compliance With Applicable Laws and Regulations

This EIS/EIR complies with NEPA and CEQA requirements. The Proposed Project, as defined herein, would comply with all Federal, State, and local laws and permitting requirements.

Major Conclusions and Findings

This EIS/EIR addresses the effects of water asset acquisition and management in relation to providing environmentally beneficial changes to CVP/SWP operations that protect at risk fish species in the Delta and increase water supply reliability to CVP/SWP water users. The environmental analyses of the proposed EWA project support the decision of the CALFED Programmatic ROD for the EWA program strategy. The analyses demonstrate that the EWA water management measures would provide benefits towards achieving population recovery for at-risk fish species in the Delta (fewer fish loses at the Delta pumps) and there will be no uncompensated water costs to Project water users.

DWR initiated acquisition of EWA assets during 2000-01, and Reclamation along with DWR purchased assets the following years. Because the ROD and EWA Operating Principles Agreement allowed for achievement of the goals through the use of functional equivalent methods for water acquisition and management, the Project and Management Agencies were able to meet the CALFED ROD goals of EWA during the first 3 years. While environmental compliance for the initial asset acquisitions was based on 1-year documents, future acquisitions will be based on the analyses and acquisition strategies provided in this EIS/EIR. This document will be supplemented if necessary to complete future acquisitions not addressed herein.

This EIS/EIR addresses the environmental effects of EWA water asset acquisition through stored reservoir water purchase, groundwater substitution, crop idling, and stored groundwater purchase, and management of those assets through reservoir releases, borrowing of Project water, groundwater storage services, exchanges, and source shifting. The following text summarizes the EWA effects by resource category.

Surface Water Supply and Management

Asset acquisition through stored reservoir water purchase could affect the water supplies of local water users. The Project Agencies would acquire stored reservoir water only from non-Project reservoirs and only when the reservoir operators have addressed refill criteria. It is anticipated that water agencies would calculate the amount of carryover storage that could be released without adverse effects, factoring the potential for a dry year and less refill into the decision-making process.

Willing sellers participating in crop idling would reduce consumptive use of the water. Farmers and other water users not participating in the EWA could receive less water because of reduced tailwater supplies. The willing seller of water from crop idling would maintain return flows in their system to a level that would not harm downstream users.

Increased Delta export pumping could reduce south Delta water levels by less than one inch, potentially affecting irrigation supplies. If EWA pumping decreases south Delta water levels, the EWA will pay its share for additional actions needed to mitigate any impacts to irrigation water supplies.

EWA-related source shift actions would change the timing of deliveries to those water contractors entering into source-shift agreements with the EWA agencies. Source shifting would only occur if the water agency has other water supplies and therefore source shifting would not adversely affect the agency’s water supply overall.

Water Quality

Stored groundwater purchase, borrowing project water, and source shifting would have the potential to reduce water quality. With groundwater purchases, the extracted groundwater released into the California Aqueduct must meet DWR’s policy for acceptance of non-Project water.

The EWA would change the timing of flows in the Delta. Delta export pump reductions from December through June would increase Delta outflows. EWA fish actions would shift exports from the spring to the summer or early fall, potentially reducing outflows during the summer and fall. The EWA agencies would incorporate carriage water as part of transfers from the Upstream from the Delta Region to maintain water quality in the Delta at pre-EWA levels. EWA actions would decrease total chloride, bromide, and organic carbon load delivered to the CVP and SWP water users.

Groundwater Resources

Groundwater substitution, stored groundwater purchase, and groundwater storage could affect groundwater resources in the Sacramento and San Joaquin Valleys. Potential effects that could be caused by an increase in groundwater extraction include decline in groundwater levels in excess of seasonal fluctuations, interaction with surface water causing reduced flows, an increase in potential for surface subsidence, and negative impacts to groundwater quality. Adherence to groundwater mitigation measures that consist of a well review, pre-purchase groundwater evaluation, and groundwater monitoring and mitigation programs would prevent or mitigate local groundwater supply effects caused by groundwater substitution and storage.

Geology, Soils, and Seismicity

Idling of cotton crops within the Export Service Area has the potential to contribute to windborne soil loss from the idled fields. Completion of a dust suppression plan as required by the San Joaquin Valley Air Pollution Control District would limit soil erosion.

Air Quality

Groundwater substitution and stored groundwater purchase would increase use of groundwater pumps. Increased pumping using diesel engines would produce NO_x and PM_{10} emissions in nonattainment areas. The addition of project-related emissions in a nonattainment area is a significant impact. Mitigation measures including use of electric pumps would reduce project-related emissions to a less-than-significant level.

Idling cotton crops within the Export Service Area has the potential to contribute to the production of windborne dust and PM_{10} in an area that is already in nonattainment for total suspended particulate matter. As a mitigation measure, farms that provide water to the EWA would be required to have a dust suppression plan. The plan would describe measures to control dust such as the growing of a cover crop (e.g., winter wheat).

Fisheries and Aquatic Ecosystems

Modeling of EWA assets exported from the Delta demonstrated that reductions in export pumping would benefit at–risk, native fish populations within the Delta. At times exporting water through the Delta could harm other fish species, but overall benefits to at-risk species outweigh the harm to non-native species.

Vegetation and Wildlife

Management of EWA assets such as holding back water in reservoirs or releasing water later than usual would change the timing and amount of river flows. Riparian vegetation is dependent upon the hydrologic and geomorphic processes that rivers provide. Alterations of these processes can affect germination, growth, and succession. The EWA agencies will implement a monitoring program to ensure that EWA actions will not exacerbate adverse effects already induced by the building of dams and levees, mining, logging, etc.

Groundwater substitution, crop idling, stored reservoir water purchase, and source shifting/pre-delivery would change water surface elevations of the various reservoirs and lakes in the EWA area of analysis, either raising or lowering lake levels depending upon the action. Altering lake levels would inundate or expose shoreline areas on a more frequent basis than without the EWA program; however, these areas are typically devoid of all but ruderal vegetation. Therefore, riparian, lacustrine, and other habitats and associated wildlife would not be affected by EWA actions.

Idling of rice crops upstream from the Delta has the potential to reduce agriculture return flows. The loss of these return flows may reduce water supplies for wetlands dependent upon agriculture return flows as a water source. The EWA agencies will require the willing seller of water for crop idling to maintain their drainage systems at a water level that would maintain existing wetlands providing habitat to covered species to ensure that effects are less than significant.

Groundwater substitution actions have the potential to affect vegetation by reducing water supplied by groundwater-surface water interactions. Effects to wetlands and other habitats potentially affected by groundwater substitution actions will be taken into account as part of the well adequacy review and monitoring program for groundwater supplies.

Idling rice crops upstream from the Delta has the potential to reduce aquatic habitat for the endangered giant garter snake. EWA Agencies would employ a water acquisition strategy that would avoid rice crop idling in areas considered as core habitat by USFWS. As part of water acquisitions from willing sellers, the Project Agencies would require the maintenance of habitat contained in agricultural ditches and the separation of idling locations into distinct units such that habitat is not fragmented and migration routes are not interrupted. Idling of rice land would reduce winter forage for some migratory bird species. Analysis of population trends for migratory birds indicates that they are not forage limited and that idling may change distribution patterns but not adversely affect the species.

Regional and Agricultural Economics

Crop idling (rice upstream from the Delta and cotton within the Export Service Area) would have the potential to affect the regional and agricultural economy in the selected counties. The Project Agencies would limit EWA water acquisitions available from crop idling to less than 20 percent of rice or cotton acreage within a county to reduce third party effects. The Project Agencies would not acquire water through idling in areas that have higher-than-normal idling rates including areas with accelerated or proposed land retirement programs. To prevent cumulative effects, EWA agencies would consider other reasonable and foreseeable crop idling transfers before idling up to 20 percent of the county crop acreage.

Agricultural Land Use

Crop idling (rice upstream from the Delta and cotton in the Export Service Area) would have the potential to change current land use patterns. EWA water acquisitions from crop idling would result in temporary changes to land use. Landowners could resume planting in the subsequent season after the water transfer. EWA water acquisition would not result in the permanent conversion of any agricultural land.

Agricultural Social Issues

The two crops identified for crop idling water acquisition actions, rice and cotton, were chosen because they provide greater amounts of water per acre of land idled and typically involve fewer farm workers than other crops. This maximized the water purchasing ability of the EWA agencies and at the same time minimized unemployment effects. These two considerations, coupled with limiting crop idling to less than 20 percent of cropland in each county, resulted in the determination that the effect on agricultural social issues would be within the labor fluctuations of each county.

Recreation Resources

The acquisition of stored reservoir water from non-Project reservoirs has the potential to decrease reservoir surface levels earlier in the recreation season compared to the Baseline Condition. However, this decrease would not significantly affect the ability of the public to access or use the reservoirs. EWA management of assets through source shifting at Lake Perris and Castaic Lake would cause reservoirs to fluctuate within recent operating parameters; however, the fluctuations could occur more often with EWA actions. This is a potentially significant impact. Implementation of mitigation measures would reduce it to less than significant.

Flood Control

Purchases and storage of EWA assets in reservoirs managed for flood control would not affect the flood control capacity of those reservoirs. Storage of EWA water has lower priority than flood control requirements, and the Project Agencies would either transfer EWA assets or lose them through spillage when reservoir operators decrease reservoir levels in anticipation of the upcoming winter rainfall season. EWA actions that decrease reservoir surface water elevation during the flood season could provide potentially beneficial effects on flood control.

Power Production and Use

Storage and releases of water from Project CVP/SWP reservoirs could affect the timing of power production from the facilities and use of power at Project CVP/SWP facilities. In accordance with the CALFED ROD, the EWA would be required to compensate the Projects for any net costs related to power caused by management of EWA assets.

Cultural Resources

Surface water acquisitions from non-Project reservoirs would have the potential to expose cultural resources that would normally be inundated by reservoir water. Project Agencies would consult with the State Historic Preservation Office and the U.S. Forest Service to address this effect should it be determined that the surface water purchase would expose cultural resources.

Visual Resources

Surface water acquisitions from non-Project reservoirs could expose the unvegetated drawdown zone surrounding the reservoir either earlier in the season or for a greater area than under non-EWA conditions. The drawdown zone visual effect is a normal phenomenon for water storage reservoirs.

Environmental Justice

Environmental justice focuses on the issue of whether an action would have a disproportional affect a minority or low-income populations. The two crops identified for crop idling water acquisition actions, rice and cotton, were chosen because they provide greater amounts of water per acre of land idled and typically involve fewer farm workers than other crops. In addition, the analysis of employment effects shows that the job losses would be spread throughout the agricultural community and not focused on any particular element of the community.

Indian Trust Assets

Groundwater extraction via groundwater substitution actions near Indian Trust Assets (ITAs) would have the potential to lower groundwater levels beneath the ITAs, potentially affecting water supplies and tribal water rights. Water transfers potentially affecting ITAs will result in the requirement for EWA agencies to consult with the associated Tribes to determine the necessity for mitigation measures.

Identification of Environmentally Preferred Alternative

Although the Fixed Purchase and Flexible Purchase alternatives involve similar water acquisition and management actions, their primary delineator is the magnitude of benefits that each alternative could provide for protecting at-risk fish species and at the same time addressing water supply commitments of the CVP and SWP. The Flexible Alternative would include higher levels of asset acquisition, which would allow the EWA agencies to take more actions to benefit fish. The Fixed Purchase Alternative would limit assets requiring the Management Agencies to prioritize their actions to address pump reductions only. The Flexible Purchase Alternative is the environmentally preferred alternative because of the increased benefits it would provide.

Table ES-3 Summary Comparison of Effects of EWA Alternatives						
			Effects Determination			
Resources	**Area of Analysis**	**Potential Effects**	**No Action/ No Project Alternative**	**Flexible Purchase Alternative**	**Fixed Purchase Alternative**	**Mitigation**
Water Supply and Management	Upstream from the Delta Region Rivers[1]	Change in the rate and timing of river flows affecting water supply of Project and non-Project users	No effect	No effect	No effect	None
	Project and Non-Project Reservoirs[2]	Reduction in carry-over storage.	No effect	LTS[6]	LTS	None
	Sacramento-San Joaquin Delta	Change in the rate and timing of Delta inflows and the amount and timing of diversions at the SWP and CVP pumps lowering South Delta water levels	No effect	PS[7], prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
		Change in available Banks pump capacity for the CVP (Joint Point of Diversion)	No effect	Lost Opportunity	No effect	None
	Export Service Area	Change in the rate and timing of Delta exports for Export Service Area water users	No effect	LTS	LTS	None
		Increase in water supply reliability to SWP and CVP contractors.	No effect	Beneficial effect	Beneficial effect	None
	Export Service Area Reservoirs[3]	Change in the pattern of reservoir level fluctuations	No effect	LTS	LTS	None
	Counties with Crop Idling[4]	Reduction in return flows from fields to agricultural and other water users not participating in EWA	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
Water Quality	Upstream from the Delta Region Rivers	Change in the rate and timing of river flows increasing concentrations of water quality constituents	No effect	LTS	LTS	None
		Increase in river water temperature degrading water quality	No effect	LTS	LTS	None
	Project and Non-Project Reservoirs	Decrease in reservoir water surface elevation increasing concentrations of constituents and degrading water quality	No effect	LTS	LTS	None
	Sacramento-San Joaquin Delta	Increase in chloride, bromide or organic carbon concentrations in the Delta during months of increased pumping	No effect	LTS	LTS	None
		Increase in annual total salt and organic carbon load delivered to CVP and SWP water users.	No effect	LTS	LTS	None

Table ES-3
Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination			Mitigation
			No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	
Water Quality (continued)	Export Service Area	Decrease in reservoir water surface elevation increasing concentrations of constituents and degrading water quality	No effect	LTS	LTS	None
	California Aqueduct	Exceedance of non-Project water acceptance criteria from release of extracted groundwater into California Aqueduct	No effect	LTS	LTS	None
	Counties with crop idling	Change in timing and quantity of water applied to cropland	No effect	LTS	LTS	None
		Increase in sediment transport via wind erosion and runoff	No effect	LTS	LTS	None
		Change in quality of surface water following mixing of groundwater and surface water	No effect	LTS	LTS	None
Groundwater Resources	Groundwater Basins	Reductions in groundwater levels in excess of seasonal variations	No effect	PS, before mitigation	PS, before mitigation	Yes, see Table ES-4
		Reductions of flows neighboring surface water channels	No effect	PS, before mitigation	PS, before mitigation	Yes, see Table ES-4
		Increased potential for land subsidence	No effect	LTS	LTS	None
		Degradation of groundwater quality	No effect	LTS	LTS	None
Geology, Soils, and Seismicity	Butte, Colusa, Glenn, Placer, Sutter and Yolo Counties	Increase in soil erosion from idled fields	No effect	LTS	LTS	None
	Fresno, Kern, Kings, and Tulare Counties	Increase in soil erosion from idled fields	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
Air Quality	Sacramento, Yolo, Sutter, Merced, Butte, Shasta, Colusa, Glenn, and Yuba Counties	Increase of emissions from use of groundwater pumps	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
	Butte, Colusa, Glenn, Placer, Sutter and Yolo Counties	Increase of fugitive dust and PM_{10} emissions from idled fields	No effect	LTS	LTS	None
	Fresno, Kern, Kings, and Tulare Counties	Increase of fugitive dust and PM_{10} emissions from idled fields	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4

Table ES-3
Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination: No Action/ No Project Alternative	Effects Determination: Flexible Purchase Alternative	Effects Determination: Fixed Purchase Alternative	Mitigation
Fisheries and Aquatic Ecosystems	Project and Non-Project Reservoirs	Reduction in acreage of littoral habitat available for spawning and rearing	No effect	LTS	LTS	None
		Increase in the frequency of potential nest-dewatering events	No effect	LTS	LTS	None
		Reduction of coldwater habitat availability	No effect	LTS	LTS	None
	Upstream from the Delta Region Rivers	Change in the rate and timing of river flows affecting spawning, rearing and migration of anadromous fish species	No effect	LTS	LTS	None
		Increase in river water temperature affecting spawning, rearing and migration of anadromous fish species	No effect	LTS	LTS	None
		Change in the rate and timing of river flows affecting spawning habitat for resident fish species	No effect	LTS	LTS	None
		Increase in river water temperature affecting spawning habitat for resident fish species	No effect	LTS	LTS	None
		Increase in salmon mortality	No effect	LTS	LTS	None
	Butte Creek	Decrease in agricultural return flows to effect spawning, rearing and migration of fish species	No effect	LTS	LTS	None
	Lake Natoma	Change in water temperature affecting long-term population of coldwater fish	No effect	LTS	LTS	None
	Nimbus Fish Hatchery	Increase in water temperature affecting hatchery production	No effect	LTS	LTS	None
	Delta	Reductions in reverse flows increasing survival of planktonic fish eggs and larvae and benefiting downstream migrating juvenile Chinook salmon smolts.	No effect	Beneficial effect	Beneficial effect	None
		Change in Delta outflow and location of X_2 affecting Delta fishery resources	No effect	LTS	LTS	None
		Exceedance of maximum Export: Import ratio identified in the SWRCB Interim Water Quality Control Plan	No effect	LTS	LTS	None
		Increase in reverse flow to delay downstream transport of planktonic eggs and larvae or effect juvenile salmonid emigration	No effect	LTS	LTS	None
		Increase in annual CVP/SWP salvage estimates for Chinook salmon, steelhead, delta smelt, and Sacramento splittail.	No effect	LTS	LTS	None
		Increase in annual CVP/SWP salvage estimates for striped bass	No effect	LTS	LTS	None
	Export Service Area	Increase in reservoir drawdown to reduce the availability of habitat for warmwater and coldwater fish species	No effect	LTS	LTS	None

Table ES-3
Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination: No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative	Mitigation
Vegetation and Wildlife	Upstream from the Delta Region Rivers	Changes in rate and timing of river flows affecting riparian, riverine and associated wetland communities	No effect	LTS	LTS	None
	Project and Non-Project Reservoirs	Decrease in surface water elevation affecting lacustrine and associated upland habitats.	No effect	LTS	LTS	None
	Counties with Crop Idling	Decrease in available seasonally flooded agriculture and associated habitats affecting wildlife and special status species	No effect	LTS[3]	LTS	None
		Decrease in seasonally flooded agriculture wastegrain forage affecting wildlife and special status species	No effect	LTS	LTS	None
		Decrease in return agricultural flows affecting wetlands	No effect	LTS	LTS	None
	Sacramento-San Joaquin Delta	Change in Delta parameters affecting riverine aquatic, riparian, and associated wetland habitats	No effect	LTS	LTS	None
	Groundwater Basins	Decrease in water table levels affecting wetlands and riparian habitats	No effect	LTS	LTS	None
	Export Service Area	Decrease in surface water elevation affecting lacustrine and associated uplands	No effect	LTS	LTS	None
Regional and Agricultural Economics	Counties with Crop Idling	Increase net revenue to farmers/land owners participating in the sale of water to EWA	No effect	Economic effect	Economic effect	None
		Decrease in net revenues to tenant farmers	No effect	Economic effect	Economic effect	None
		Temporary reduction in economic activity indicated by rice and cotton acreage, county output, value added, wages and salaries and employment	No effect	Economic effect	Economic effect	None
		Change in county revenue from sales tax, property taxes and subvention payments	No effect	Economic effect	Economic effect	None
	Groundwater Basins	Increase in groundwater extraction costs	No effect	Economic effect	Economic effect	None
	All EWA Regions	Increase in water transfers market prices	No effect	Economic effect	Economic effect	None
Agricultural Social Issues	Counties with Crop Idling	Temporary decrease in farmworker employment	No effect	Economic effect	Economic effect	None
Agricultural Land Use	Counties with Crop Idling	Temporary decrease in the amount of land categorized as prime, statewide importance or unique farmland	LTS	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
		Convert lands under the Williamson Act and other land resource protection programs to incompatible uses	LTS	LTS	LTS	None
Recreation Resources	Upstream from the Delta Region Rivers	Change in river flows affecting fishing, hunting and recreation opportunities	No effect	LTS	LTS	None

[3] Conservation measures have been developed during informal consultation with USFWS and CDFG and proposed as a part of the Action Specific Implementation Plan (Appendix J) to avoid or minimize effects on the giant garter snake, black tern, greater sandhill crane, and western pond turtle. These measures have been incorporated into the project description of the EWA EIS/EIR.

Table ES-3
Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination: No Action/ No Project Alternative	Effects Determination: Flexible Purchase Alternative	Effects Determination: Fixed Purchase Alternative	Mitigation
	Project and Non-Project Reservoirs	Change in reservoir water surface elevation affecting fishing, hunting and recreation opportunities	No effect	LTS	LTS	None
	Butte, Colusa, Glenn, Placer, Sutter and Yolo Counties	Change in location of waterfowl hunting areas	No effect	LTS	LTS	None
	Sacramento-San Joaquin Delta	Decrease in Delta Inflow affecting recreation opportunities	No effect	LTS	LTS	None
	Export Service Area	Change in reservoir water surface elevation affecting fishing and recreation opportunities	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
Flood Control	Upstream from the Delta Region Rivers	Increase in river flows affecting river channel carrying capacity	No effect	LTS	LTS	None
	Project and Non-Project Reservoirs	Change in water surface elevation affecting flood control space	No effect	LTS	LTS	None
		Increase the amount of inflow that could be captured during a flood event	No effect	Beneficial effect	Beneficial effect	None
	Sacramento-San Joaquin Delta	Increase Delta inflows during high water stages	No effect	LTS	LTS	None
	Export Service Area	Change in water surface elevation affecting flood control space	No effect	LTS	LTS	None
		Increase the amount of inflow that could be captured during a flood event	No effect	Beneficial effect	Beneficial effect	None
Power	Project and Non-Project Reservoirs	Change in water surface elevation and reservoir release patterns affecting power generation efficiency	No effect	LTS	LTS	None
		Shift in pumping times to periods of higher electricity costs	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
	Delta Pumping Facilities	Increase in electricity use at project pumps during summer months	No effect	LTS	LTS	None
		Shift in export pumping times to periods of higher electricity costs	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
	San Luis Reservoir	Change in water surface elevation and release patterns affecting power generation	No effect	LTS	LTS	None
		Shift in export pumping times to periods of higher electricity costs	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
	Export Service Area Pumping Facilities	Shift in pumping times to periods of higher electricity costs	No effect	PS, prior to mitigation	PS, prior to mitigation	Yes, see Table ES-4
Cultural Resources	Project and Non-Project Reservoirs	Change in water surface elevation exposing cultural resources to increased cycles of inundation, drawdown and erosion	No effect	Consultation will determine mitigation	Consultation will determine mitigation	Yes, see Table ES-4

Table ES-3
Summary Comparison of Effects of EWA Alternatives

Resources	Area of Analysis	Potential Effects	Effects Determination: No Action/ No Project Alternative	Effects Determination: Flexible Purchase Alternative	Effects Determination: Fixed Purchase Alternative	Mitigation
	Export Service Area Reservoirs	Change in water surface elevation exposing cultural resources to increased cycles of inundation, drawdown and erosion	No effect	LTS	LTS	None
Visual Resources	Upstream from the Delta Region Rivers	Change in river flow affecting the landscape character or overall scenic attractiveness of the area	No effect	LTS	LTS	None
	Project and Non-Project Reservoirs	Decrease in water surface elevation affecting the landscape character or overall scenic attractiveness of the area	No effect	LTS	LTS	None
	Counties with Crop Idling	Temporary conversion of rice land reducing waterfowl viewing opportunities or scenic attractiveness	No effect	LTS	LTS	None
	Sacramento-San Joaquin Delta	Reduce Delta inflows affecting existing visual landscape	No effect	LTS	LTS	None
	Export Service Area Reservoirs	Decrease in water surface elevation affecting the landscape character or overall scenic attractiveness of the area	No effect	LTS	LTS	None
Environmental Justice	Counties with Crop Idling	Disproportionate effect on low-income and minority farmworkers	No effect	No disproportionate effect	No disproportionate effect	None
Indian Trust Assets	Groundwater Basins	Increase groundwater extraction costs or dry out wells on tribes property	No effect	Consultation will determine effects	Consultation will determine effects	See Groundwater

[1]Upstream from the Delta Region Rivers include Sacramento, Feather, Yuba, American, Merced and San Joaquin Rivers
[2]Project and Non-Project Reservoirs include Shasta, Oroville, Folsom, New Bullards Bar, Sly Creek, Little Grass Valley, French Meadows, Hell Hole, and McLure
[3]Export Service Area Reservoirs include San Luis Reservoir, Castaic Lake, Anderson Reservoir, Lake Perris, Lake Mathews, and Diamond Valley Lake
[4]Counties with crop idling include Butte, Colusa, Glenn, Placer, Sutter, Yolo, Fresno, Kern, Kings, and Tulare Counties
[5]Groundwater basins include Redding, Sacramento, North San Joaquin and South San Joaquin Groundwater Basins
[6]LTS – Less than significant
[7]PS – Potentially significant
[8]SU – Significant unavoidable

Table ES-4
Summary of Mitigation Measures[1] for Potentially Significant Effects of the EWA

				Effects Determination after Mitigation		
Resources	**Area of Analysis**	**Effects Relative to the Baseline Condition**	**Mitigation Measures**	**No Action/ No Project Alternative**	**Flexible Purchase Alternative**	**Fixed Purchase Alternative**
Water Supply and Management	Sacramento-San Joaquin Delta	Change in the rate and timing of Delta inflows and the amount and timing of diversions at the SWP and CVP pumps lowering South Delta water levels	Actions such as installation of temporary pumps or dredging, would reduce effects to South Delta water users. The EWA agencies will pay its share for additional actions needed to increase South Delta water levels to the Baseline Condition.	No effect	LTS	LTS
Water Supply and Management	Sacramento Valley	Decreases in return flows due to crop idling and groundwater substitution could reduce flow of water to down drainage agriculture and other water users	Willing sellers will be required to maintain water levels in drainage systems that do not reduce supplies to downstream users.	No effect	LTS	LTS
Geology, Soils, and Seismicity	Fresno, Kern, Kings, and Tulare Counties	Increase in soil erosion from crop idling	A Dust Suppression Plan, approved by the San Joaquin Valley APCD, must be implemented. Potential elements are: Crop shift (e.g., winter wheat) and harvest between mid June and mid July. The stubble and chaff would be left on the fields to increase surface roughness, vegetative cover, and soil moisture. Increase surface roughness to reduce wind speed at the soil surface so that the wind is less able to move soil particles. Several practices include ripping clay soil, listing and furrowing fields.	No effect	LTS	LTS

Table ES-4
Summary of Mitigation Measures[1] for Potentially Significant Effects of the EWA

Resources	Area of Analysis	Effects Relative to the Baseline Condition	Mitigation Measures	Effects Determination after Mitigation: No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative
Air Quality	Fresno, Kern, Kings, and Tulare Counties	Increase of fugitive dust and PM_{10} emissions from crop idling	A Dust Suppression Plan, approved by the San Joaquin Valley APCD, must be implemented. Potential elements are crop shift (e.g., winter wheat). Harvest winter wheat between mid June and mid July. The stubble and chaff would be left on the fields to reduce the surface area exposed to wind. Increase surface roughness to reduce wind speed at the soil surface so that the wind is less able to move soil particles, which contribute to PM_{10}. Several practices include ripping clay soil, listing and furrowing fields.	No effect	LTS	LTS
Air Quality	Sacramento, Yolo, Sutter, Merced, and Yuba Counties	Increased NO_x and PM_{10} emissions from older diesel engines in non-attainment areas	EWA agencies will require the use of alternative power including electrical pumps. EWA agencies will encourage the seller to seek off-sets for project-related emissions.	No effect	LTS	LTS
Land Use	Sacramento and San Joaquin Valleys	Land use changes from prime agricultural land to non-prime agricultural land	EWA agencies will minimize the amount of consecutive years a particular parcel is idled	No effect	LTS	LTS
Power	Project and Non-Project Reservoirs	Shift in export pumping times to periods of higher electricity costs	The EWA agencies must develop a financial plan to cover additional costs incurred from implementation of the EWA, including power and ancillary costs.	No effect	LTS	LTS
	Delta Pumping Facilities	Shift in export pumping times to periods of higher electricity costs		No effect	LTS	LTS
	San Luis Reservoir	Shift in export pumping times to periods of higher electricity costs		No effect	LTS	LTS
	Export Service Area Pumping Facilities	Shift in pumping times to periods of higher electricity costs		No effect	LTS	LTS
Cultural Resources	Project and Non-Project Reservoirs	Lowering of water levels in reservoirs exposing previously inundated cultural resources	EWA agencies will consult with the Forest Service and State Historic Preservation Office to determine appropriate mitigation measure to be implemented by the willing seller.	No effect	LTS	LTS

Table ES-4
Summary of Mitigation Measures[1] for Potentially Significant Effects of the EWA

Resources	Area of Analysis	Effects Relative to the Baseline Condition	Mitigation Measures	Effects Determination after Mitigation		
				No Action/ No Project Alternative	Flexible Purchase Alternative	Fixed Purchase Alternative
Recreation	Lake Perris and Castaic Lake	Lowering of reservoir levels earlier in recreation season reducing recreational possibilities	For Lake Perris, EWA agencies with input from officials at Lake Perris will set a limitation on the amount of drawdown. For Castaic Lake, input from recreation officials will be considered.	No effect	LTS	LTS

[1]Table ES-4 presents a summary of the mitigation measures. The reader is referred to the respective resource area chapter for details regarding the specific mitigation measure.

Table ES-5 Summary of Beneficial Effects of the EWA Alternatives			
Resources	***No Action/No Project Alternative***	***Flexible Purchase Alternative***	***Fixed Purchase Alternative***
Water Supply and Management	No change from existing conditions. ESA would trigger pump reductions to protect fish, and these actions would reduce water supply reliability to Project users.	Water supply replaced due to pump reductions limited to 600 TAF. Fish actions would be taken prior to "take" thresholds. The volume of replacement water would reduce the probability of entering Tier 3 and subsequent uncompensated fish actions.	Water supply replaced due to pump reductions limited to 185 TAF and any carry-over storage. Fish actions would be taken prior to "take" thresholds. If fish actions are not enough to avoid jeopardy, Tier 3 would trigger additional fish actions where contractors may not be compensated
Fisheries and Aquatic Ecosystems	Fishery protection regulatory standards required in NOAA FIsheries and USFWS Biological Opinions, the 1995 Delta WQCP, VAMP and CVPIA would be implemented	Benefits the recovery of at-risk fish species by making available 600 TAF of EWA assets for fish actions. Fish actions could include closing DCC gates, increasing instream flows, and augmenting Delta outflows to improve spawning and rearing habitat and migration.	Contributes to the recovery of at-risk fish species by making available 35 TAF of EWA assets for fish actions. Fish actions taken would be limited by available assets and EWA agencies would need to prioritize fish actions. In most years, total assets available would be used for pumping reduction and repayments
Fisheries and Aquatic Ecosystems	No effect	Delta outflows during spring provide benefits to migratory and Delta fish populations (habitat); outflows during summer and fall benefit migratory fish.	Delta outflows during spring limited to 35 TAF acre-feet upstream purchase
Regional and Agricultural Socioeconomics	No effect	Sale of water to EWA would increase net revenues to farmers/landowners	Sale of water to EWA would increase net revenues to farmers/landowners
Flood Control	No effect	Additional space made available from release of stored water would provide space for flood control	Additional space made available from release of stored water would provide space for flood control
	No effect	Metropolitan WD use of flexible storage would provide additional storage space for inflow from the California Aqueduct or local streams	Metropolitan WD use of flexible storage would provide additional storage space for inflow from the California Aqueduct or local streams

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Acronyms and Abbreviations

ACHP	Advisory Council on Historic Preservation
AF	acre-foot/acre-feet
AFA	acre-feet annually
AFRP Plan	Anadromous Fish Restoration Program
APE	Area of potential effect
ARP	Acreage Reduction Provisions
ASIP	Action Specific Implementation Plan
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin River Delta
BA	biological assessment
BEA	Bureau of Economic Analysis
BIA	Bureau of Indian Affairs
CAA	Clean Air Act
BO	biological opinion
CALFED Ops Group	CALFED Operations Group
CASS	California Agricultural Statistics Service
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game
CDPR	California Department of Parks and Recreation
CEQ	President's Council on Environmental Quality
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
COA	Coordinated Operation Agreement
CVP	Central Valley Project
CVP/SWP	Central Valley Project/State Water Project
CVPIA	Central Valley Project Improvement Act
CVPIA(b)(2)	Central Valley Project Improvement Act Section 3406(b)(2)
CWA	Clean Water Act
CWSCP	Critical Water Storage Contingency Plan
CWSRMP	Critical Water Shortage Reduction Marketing Program
DBPs	disinfection byproducts
DCC	Delta Cross Channel
DEE	Daily Energy Expenditure
DEIM	Department of Water Resources Economic Model for Temporary Idling of Irrigation Land
DEIS/EIR	Draft Environmental Impact Statement/ Environmental Impact Report
DER	Daily Energy Required
DOE	Department of Energy
DOF	Department of Finance
DOI	Department of the Interior
DRRIP	Drought Risk Reduction Investment Program
DWR	California Department of Water Resources
EDD	Employment Development Department

EFH	Essential Fish Habitat
E/I	Export/Inflow
EIR	environmental impact report
EIS	environmental impact statement
ERP	Ecosystem Restoration Program
ESA	Federal Endangered Species Act
ESU	Evolutionary Significant Unit
ETAW	evaptranspiration of applied water
EWA	Environmental Water Account
EWA agencies	NOAA Fisheries, CDFG, USFWS, DWR, and Reclamation
EWAT	Environmental Water Account Team
EWP	Environmental Water Program
FERC	Federal Energy Regulatory Commission
FMMP	Farmland Mapping and Monitoring Program
FWCA	Fish and Wildlife Coordination Act
FPPA	Farmland Protection Policy Act
ft	foot/feet
GADPP	Governor's Advisory Drought Planning Panel
GAP	Gap Analysis Program
GGS	Giant garter snake
GIS	Geographic Information System
GWh	gigawatt hours
HCP	Habitat Conservation Plan
Hyatt-Thermalito	Hyatt Pumping-Generating Plant and Termalito Pumping Generating Plant
ID	Irrigation District
IDS	inland dune scrub
IO	input-output
ITA	Indian Trust Assets
ISI	Integrated Storage Investigation
Joint Point or JPOD	Joint Point of Diversion
KLCI	Knight's Landing catch index
KW	kilowatts
Management Agencies (MAs)	NOAA Fisheries, CDFG, USFWS
MAF	million acre-feet
Magnuson-Stevens Act	Magnuson-Stevens Fishery Conservation & Management Act
M&I	municipal and industrial
MBTA	Migratory Bird Treaty Act
MR	montane riparian
MRA	montane riverine aquatic
MSCS	Multi-Species Conservation Strategy
msl	mean sea level
MSW	managed seasonal wetland
MW	megawatt
MWF	montane woodland and forest
NAAQS	National Ambient Air Quality Act
NCCPA	Natural Community Conservation Planning Act

NCCP	Natural Community Conservation Plan
NCWA	Northern California Water Association
NDIP	North Delta Improvement Project
NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NOAA Fisheries	National Marine Fisheries Service
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOC	Notice of Completion
NOI	Notice of Intent
NOP	Notice of Preparation
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NSW	natural seasonal wetland
NWR	National Wildlife Refuge
OPR	Office of Planning and Research
PBO	Programmatic Biological Opinion
PCWA	Placer County Water Agency
PDA	public domain allotments
PEIS/EIR	Programmatic Environmental Impact Statement/ Environmental Impact Report
PG&E	Pacific Gas & Electric Company
PPIC	Public Policy Institute of California
Project Agencies	DWR and Reclamation
PSD	prevention of significant deterioration
Reclamation	Bureau of Reclamation
REIS	Regional Economic Information System
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SAFCA	Sacramento Area Flood Control Agency
SCE	Southern California Edison
SFA	Seasonally Flooded Agriculture
SGA	Sacramento Groundwater Authority
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SJRA	San Joaquin River Agreement
SMS	Scenery Management System
SMUD	Sacramento Municipal Utility District
SDIP	South Delta Improvement Project
SRA	State Recreation Area
SRFCP	Sacramento River Flood Control Project
SVWMA	Sacramento Valley Water Management Agreement
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	total acre-feet
TMDL	total maximum daily load
TOC	total organic carbons

TPA	tidal perennial aquatic
UCCE	University of California Cooperative Extension
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USDA FS	U.S. Department of Agriculture Forest Service
USFWS	U.S. Fish and Wildlife Service
USEPA	U.S. Environmental Protection Agency
VAMP	Vernalis Adaptive Management Plan
WA	Water Agency
WAP	Water Acquisition Program
WAPA	Western Area Power Administration
Water Code	California Water Code
WC	Water Company
WD	Water District
WEG	wind erodibility group
Western	Western Area Power Administration
WMAs	Wildlife Management Areas
WOMT	Water Operations Management Team
WQCPs	Water Quality Control Plans
WSD	Water Storage District

Environmental Water Account EIS/EIR

GLOSSARY OF TECHNICAL TERMS

Term	Definition
acre-foot	The volume of water that would cover 1 acre to a depth of 1 foot, or 325,851 gallons of water. On average, 1 acre-foot could supply one to two households with water for a year. A flow of 1 cubic foot per second for a day is approximately 2 acre-feet.
action	A structure, operating criteria, program, regulation, policy, or restoration activity that is intended to address a problem or resolve a conflict in the Bay-Delta system.
adequately conserved	To use, and the use of, conservation methods and procedures that are adequate to protect and perpetuate a species of fish, plant, or wildlife within the area of analysis, taking into consideration the whole of CALFED, including the direct and indirect effects of CALFED actions.
AFRP	Anadromous Fish Restoration Program (AFRP), part of the Central Valley Project Improvement Act (CVPIA). The AFRP identified instream and Delta flows needed for recovery of anadromous fish.
alternative	A collection of actions or action categories assembled to provide a comprehensive solution to problems in the Bay-Delta system.
anadromous fish	Fish that spend a part of their life cycle in the sea and return to freshwater streams to spawn.
aquifer	Underground layer of porous rock, sand, etc. that contains water.
at-risk native fish species	At-risk native fish species include: Central Valley fall and late fall-run Chinook salmon, Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Delta smelt, Sacramento splittail, and Green Sturgeon.
b(2) water	Statutory mandate to manage the water dedicated to fish and wildlife purposes pursuant to Section 3406(b)(2) of the CVPIA.

Banks Pumping Plant — The State Water Project (SWP) export pumping plant in the south Delta. The plant is located downstream of Clifton Court Forebay.

baseline level of fishery protection — Fishery protection consisting of the existing regulations and existing operational flexibility. This baseline level of fishery protection consists of the biological opinions on winter-run salmon and delta smelt, 1995 Delta Water Quality Control Plan as implemented by SWRCB Decision 1641 and Order 2001-05, and 800,000 acre-feet of CVP Yield pursuant to Section 3406(b)(2) water, combined with the assets of a fully funded Ecosystem Restoration Program (ERP).

Bay-Delta — The entire estuary system of the San Francisco Bay, Sacramento-San Joaquin Rivers, and Delta.

best management practices — A water conservation measure that the California Urban Water Conservation Council agrees to implement among member agencies. The term is also used in reference to water quality standards and watershed management activities.

biological opinion — A written statement setting forth the opinion of the USFWS or the NOAA Fisheries as to whether or not a federal action is likely to jeopardize the continued existence of a listed species or result in the destruction or adverse modification of critical habitat. See 16 USCA 1536(b).

brackish water — Water that contains more sea salts than fresh water, but less than the open sea.

CALFED Bay-Delta Program — A consortium of 15 State and Federal agencies with management or regulatory responsibilities in the Bay-Delta.

candidate species — Any species being considered by the U.S. Secretary of the Interior or Secretary of Commerce for listing as an endangered or a threatened species, but not yet the subject of a proposed rule (see 50 CFR 424.02), or any species accepted as a candidate species by the California Department of Fish and Game (CDFG)pursuant to Fish and Game Code Section 2074.2.

Central Valley Project (CVP) — A federally operated water management and conveyance system that provides water to agricultural, urban, and

	industrial users in California. The CVP was originally authorized by legislation in 1937.
Central Valley Project Improvement Act	Public Law 102-575, Title 34, 106 Stat. 4600. Federal legislation, signed into law on October 30, 1992, that Modified the operations of the Federal CVP. The CVPIA made fish and wildlife objectives equal to agricultural, municipal, industrial, and hydropower water uses.
California Endangered Species Act (CESA)	California legislation that prohibits the "take" of plant and animal species designated by the CDFG as either endangered or threatened. Take includes hunting, pursuing, catching, capturing, killing, or attempting such activity. CESA provides the CDFG with administrative responsibilities over the plant and wildlife species listed under the State act as threatened or endangered. CESA also provides CDFG with the authority to permit the take of State-listed species under certain circumstances. See Fish and Game Code Section 2050-2116.
California Environmental Quality Act (CEQA)	**California legislation that requires State, regional, and** local agencies to prepare environmental impact assessments for proposed projects that will have significant environmental effects and to circulate these documents to other agencies and the public for comment before making decisions. CEQA requires that the lead agency make findings for all significant impacts identified in the environmental impact report. The lead agency must propose mitigation to reduce environmental impacts to a less-than-significant level unless the mitigation is infeasible or unavailable and there are overriding considerations that require the project to be approved. See Public Res. Code Sections 21001.1, 21002, 21080; Guidelines 15002(c).
call dates	Dates in EWA contracts that represent the last date that the EWA agencies could decide whether or not to begin each transfer.
carriage water	Additional flows released during export periods to ensure maintenance of water quality standards and assist with maintaining natural outflow patterns in Delta channels. For instance, a portion of transfer water released from upstream of the Delta intended for export from south Delta would be used for Delta outflow.
channel islands	Natural, unleveed land masses within Delta channels that are typically good sources of wildlife habitat.

Clifton Court Forebay An SWP water body in the delta used to regulate flows to the Banks Pumping Plant.

conceptual model An explicit description of the critical cause-and-effect pathways in ecosystem function. A conceptual model includes a summary of current knowledge and hypotheses about ecosystem structure and function, and highlights key uncertainties where research might be necessary. Alternative or competing conceptual models illustrate areas of uncertainty, paving the way for suitably-scaled experimental manipulations designed both to restore and explore the ecosystem. Conceptual models also help to define monitoring needs, and the basis for quantitative modeling.

conflicts at the pumps Presence of fish at the Delta export facilities in numbers representing critical thresholds (dictated by Biological Opinions) necessitating pumping reductions that interfere with water supply reliability, resulting in conflicts between Central Valley Project and State Water Project operations and fishery management.

conjunctive use The operation of a groundwater basin in combination with a surface water storage and conveyance system. Water is stored in the ground water basin for later use in place of or to supplement surface supplies. Water is stored by intentionally recharging the basin during years of above-average surface water supply.

conserve, conserving, conservation To use, and the use of, all methods and procedures necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the Federal and California Endangered Species Acts are no longer necessary. These methods and procedures include, but are not limited to, all activities associated with scientific resources management, such as research, census, law enforcement, habitat acquisition, restoration and maintenance, propagation, live trapping, and transplantation. In the extraordinary case where population pressures within a given ecosystem cannot be otherwise relieved, the methods and procedures may include regulated taking.

conservation measures Actions to benefit or promote the recovery of listed species that are included by the Federal agency as an integral part of the proposed action. These actions will be taken by the Federal agency or applicant, and serve to minimize or

	compensate for, project effects on the species under review. These may include actions taken prior to the initiation of consultation, or actions which the Federal agency or applicant have committed to complete in a biological assessment or similar document
consumptive use	Science based evapotranspiration rate that represents the total amount of water used for vegetative growth, transpiration, or plant tissue production, plus the unavoidable evaporation of soil moisture and intercepted precipitation.
"contribute to recovery"	Also referred to as 'r', a CALFED goal assigned to evaluated species where CALFED actions affect only a limited portion of the species range and/or CALFED actions have limited effects on the species. The goal of contributing to a species' recovery means that CALFED will undertake the actions under its control and within its Multi-Species Conservation Strategy Problem Area and scope that are necessary for the species to recover.
conveyance	A pipeline, canal, natural channel, or other similar facility that transports water from one location to another.
conveyance loss	Transfer water lost to seepage and evaporation.
covered species	At a programmatic level, species selected from the evaluated species that would be adequately conserved (State requirement for State-covered species) and for which programmatic CALFED actions would not cause jeopardy and/or adversely affect designated critical habitat (Federal requirement for federally covered species).
critical habitat	Designation for federally listed species. Consists of: (1) the specific areas within the geographical area occupied by the species at the time it is listed in accordance with the provisions of Section 4 of the Federal ESA (16 USCA 1533), on which are found those physical or biological features (constituent elements) that are: (a) essential to the conservation of the species and (b) may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of Section 4 of ESA (16 USCA 1533), upon a determination by the Secretary that such areas are essential for the conservation of the species. (16 USCA 1532(5)(A).) Designated critical habitats are described in 50 CFR 17 and 50 CFR 226.

crop idling	Allowing previously irrigated agricultural land to temporarily lie idle (fallowing) for a variety of purposes for a period of time.
crop substitution	Farmers plant a crop with lower water requirements than the previous crop.
cumulative impact	The incremental impact or effect of the action together with impacts of past, present, and reasonable foreseeable future actions (regardless of the source of these other actions).
Delta	The Delta lies at the confluence of the Sacramento and San Joaquin Rivers and serves as the major hub for the operations of the SWP and CVP.
Delta Cross Channel	Existing gated structure and channel connecting the Sacramento River at Walnut Grove to Snodgrass Slough and thence to the North Fork of the Mokelumne River. The facility was constructed as part of the Central Valley Project to control movement of Sacramento River water into the central Delta and to the south-Delta export pumps. Operating criteria currently require the gates to be closed for specific periods to keep downstream-migrating fish in the Sacramento River and to prevent flooding of the central Delta.
Delta facilities	CVP and SWP facilities in the Delta that collect and convey water through the Delta.
Delta inflow	The combined water flow entering the Delta at a given time from the Sacramento River, San Joaquin River, and other tributaries.
Delta islands	Islands in the Sacramento-San Joaquin Delta protected by levees. Delta islands provide space for numerous functions including agriculture, communities, and important infrastructure such as transmission lines, pipelines, and roadways.
Delta outflow	The net amount of water (not including tidal flows) at a given time flowing out of the Delta towards the San Francisco Bay. The Delta outflow equals Delta inflow minus the water used within the Delta and the exports from the Delta.
Delta pumps	see “export pumps”

Delta pumping capacity	Delta pumping capacity is not only limited by the size of the pumps, but also by regulatory limits on exports, e.g., fish protection requirements, export/inflow (E/I) ratio, and water quality requirements.
demand limited	No contractors want any more water than they are currently receiving, and storage facilities and/or conveyance facilities are full.
direct mortality	The direct loss of fish associated with facilities (forebay, fish screens, and salvage facilities) for the south Delta export pumps. This direct mortality is a portion of the total fish mortality resulting from operation of the export pumps (see indirect morality).
diversions	The action of taking water out of a river system or changing the flow of water in a system for use in another location.
drought conditions	A time when rainfall and runoff are much less than average. One method to categorize annual rainfall is as follows, with the last two categories being drought conditions: wet, above normal, below normal, dry critical.
dual conveyance	A means of improving conveyance across the Delta by both improving through-Delta conveyance and isolating a portion of conveyance from Delta channels.
ecosystem	A recognizable, relatively homogeneous unit that includes organisms, their environment, and all the interactions among them.
ecosystem restoration	A term sometimes used to imply the process of recreating the structural and functional configurations of an ecosystem to that present at some agreed to time in the past. Because the structure and function of many elements of the Bay-Delta ecosystem have been severely disrupted and cannot be feasibly restored to a specified historic condition, within the context of CALFED, ecosystem restoration is more realistically defined as the process by which resource managers ensure that the capacity of the ecosystem to provide ecological outcomes valued by society is maintained, enhanced, or restored.
Ecosystem Restoration Program (ERP)	CALFED Program designed to restore or mimic ecological processes and to increase and improve aquatic and terrestrial habitats that support stable, self-sustaining populations. CALFED established the Environmental

	Water Program to carry out flow-related objectives within the ERP. The ERP has the potential to reduce or eliminate conflicts at the Delta pumps.
Emergent	A plant rooted in shallow water that has most of its vegetative growth above water.
endangered species (CESA)	Any species listed as endangered under the California Endangered Species Act. Endangered species are native California species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that has been determined by the CDFG to be in serious danger of becoming extinct throughout all, or a significant portion, of its range due to one or more causes, including loss of habitat, change in habitat, exploitation, predation, competition, or disease. See California Fish and Game Code Section 2062.
endangered species (ESA)	Any species listed as endangered under the Federal ESA. Endangered species are any species (including subspecies or a qualifying distinct population segment) that is in danger of extinction throughout all or a significant portion of its range. See 16 USCA 1532(6).
endemic species	A native species or subspecies confined naturally to a particular, and usually restricted, area or region.
entrainment	The process of drawing fish into diversions along with water, resulting in the loss of such fish.
environmental impact report	A detailed written report, required by the CEQA, analyzing the environmental impacts of a proposed action, adverse effects that cannot be avoided, alternative courses of action, and cumulative impacts.
environmental impact statement	A detailed written statement, required by Section 102(2)(c) of the National Environmental Policy Act (NEPA), analyzing the environmental impacts of a proposed action, adverse effects that cannot be avoided, alternative courses of action, short-term uses of the environment versus the maintenance of long-term productivity, and any irreversible and irretrievable commitment of resources.
ephemeral stream	A seasonal stream that flows only part of the year.
estuarine fish	Fish that spend a part of their life cycle in an estuary.
estuary	A water body passage where ocean water mixes with river water.

evaluated species	A species within the Multi-Species Conservation Strategy (MSCS) Focus Area that is listed under Federal law as threatened or endangered or California listed as rare, threatened, endangered, or fully protected; could become federally or California listed as threatened or endangered under California or Federal law during the term of CALFED implementation and could be adversely affected by CALFED actions; or could be adversely affected by CALFED actions within a substantial portion of the species' range or important habitat.
EWA assets	Alternative sources of project water supply which will be used to augment streamflows and Delta outflows, to modify exports that provide fishery benefits, and to replace the regular project water supply interrupted by changes in project operations. The replacement water will compensate for reductions in deliveries relative to existing facilities, project operations, and the regulatory baseline that result from EWA actions. EWA assets are managed by USFWS, NOAA Fisheries, and CDFG in coordination with the CALFED Operations Group.
EWA tools	The asset acquisition (stored reservoir water, groundwater substitution, crop idling, stored groundwater purchase) and management options (source shifting, borrowed Project water), including variable assets and functional equivalency to the CALFED ROD that are available to the EWA agencies.
export	Water diversion from the Delta for use in the Export Service Area.
Export-Inflow Ratio (E-I Ratio)	This requirement presently limits Delta exports by the State and Federal water projects to a percentage of Delta inflow.
export pumps	CVP and SWP pumping plants in the southern portion of Delta - the Tracy Pumping Plant and the Harvey O. Banks Delta Pumping Plant, respectively. These large pumps export water to urban and agricultural water users in the Export Service Area.
facultative	Not limited to a specific condition; having the ability to live under varying conditions, such as in wetland and upland habitats.
Federal Endangered Species Act (ESA)	Federal legislation that requires Federal agencies, in consultation with the USFWS and NOAA Fisheries, to

ensure that their actions do not jeopardize the continued existence of endangered or threatened species or result in the destruction or adverse modification of the critical habitat of these species. The ESA recognizes the value to the nation of species in danger of, or threatened with, extinction. The act requires Federal agencies to conserve these species and their habitats and ranges to the extent practicable. Section 4 of the ESA (16 USCA 1533) provides a listing process for species considered "endangered" (in danger of becoming extinct) or "threatened" (threatened to become endangered). The Secretary of Commerce, acting through NOAA Fisheries, is involved for projects that may affect marine or anadromous fish species listed under the ESA. All other species listed in the ESA are under USFWS jurisdiction. Section 7 of the ESA (16 USCA 1536(a)(2)) requires that all Federal agencies, in consultation with the Secretaries of the Interior and Commerce (acting through USFWS and NOAA Fisheries, respectively), ensure that their actions do not jeopardize the continued existence of species listed as endangered or threatened and protected or result in the destruction or adverse modification of the critical habitat of these species. Section 9 of the ESA (16 USCA 1538) prohibits take of a listed species. Section 9 (16 USCA 1538) compliance is applicable if the proposed action would result in the take of any listed threatened (if not subject to special rule) or endangered fish or wildlife species and such take is not authorized in a biological opinion issued by USFWS or NOAA Fisheries. Section 10 of the ESA (16 USCA 1539) authorizes the conditions for the USFWS or NOAA Fisheries to issue a permit for incidental take of a listed species when there is no other Federal agency involved. See 16 USC 153 1 et seq. federally covered species.

fish actions

Operational tools available to the biologists to protect threatened and endangered fish near the Delta Pumps. Tools include closing the Delta Cross Channel gates, reducing pumping, shifting pumping between the SWP and the CVP, and increasing inflows to the Delta.

fish entrainment

The incidental capture and loss of fish during water diversion.

fish group

Federally listed and proposed species identified by the USFWS and NOAA Fisheries in the programmatic biological opinions for which programmatic CALFED actions would not cause jeopardy and/or adversely affect designated critical habitat. A classification that is based on ecological behavior of the included fish species. Two fish groups are evaluated in the MSCS: anadromous fish and estuarine fish.

fish salvage — The process of screening fish at the south Delta export facilities and physically transporting them by truck to release in other parts of the Delta. This generally results in higher fish mortality than a more conventional fish screen where screened fish simply return to the river and continue downstream. Fish salvage is required at the existing export facilities since there is no flow continuing downstream to carry the fish away.

fish screens — Physical structures placed at water diversion facilities to keep fish from getting pulled into the facility and dying there.

fixed assets — The annual acquisition of 150,000 acre-feet (AF) of water from willing sellers in the Export Service Area and at least 35,000 AF of water from willing sources upstream from the Delta (or their functional equivalents), as required by the CALFED ROD. Both the Flexible Alternative and the Fixed Alternative include "fixed assets".

flexible operations — Operation of the CVP/SWP Delta export pumps that would allow reducing export pumping at times critical to fish and increasing export pumping at other times. Flexible operations would allow higher or lower export rates and export-inflow ratios than prescribed by the 1995 Water Quality Control Plan. Pumping could deviate from currently permitted rates seasonally and on a real-time basis in response to Delta flows and fish distributions.

fry — Small adult fish, especially when in large groups.

functional equivalence — The volume of water needed to replace a like quantity of exports forgone as a result of a SWP or CVP Delta export pumping reduction. The concept provides EWA greater purchase strategy flexibility that is responsive to varying hydrologic conditions, fish needs, fluctuating Delta capacity, water sources, and ultimately asset maximization.

habitat conservation plan — A comprehensive planning document pursuant to Section 10 of the Federal ESA (16 USCA 1539(a)(2)(A)) that is a mandatory component of an incidental take permit issued pursuant to Section 10 (16 USCA 1539(a)(l)(B)).

habitat enhancement, enhance	To improve degraded habitat. Management actions that enhance habitat do not result in increasing the extent of habitat area.
habitat protection, protect habitat	To maintain the existing extent and quality of habitat.
habitat restoration, restore habitat	To create habitat. Management actions that restore habitat result in increasing the extent of habitat area.
hold-back period	Generally occurs April through June during which time normally released irrigation water would remain in reservoirs. Surface elevations in reservoirs would be higher than the existing conditions during hold-back periods. Rivers would convey less water, yet comply with temperature and flow requirements.
hydrograph	A chart or graph showing the change in flow over time for a particular stream or river.
impingement	Occurs when fish are trapped against the outer surface of a fish screen.
incidental take	"Take" that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.
incidental take permit	Federal exception to Section 9 of the Federal ESA (16 USCA 1538); a permit issued pursuant to Section 10 of ESA (16 USCA 1539(a)(l)(B)).
In-Delta Storage	Water storage within the Delta by converting an existing island to a reservoir. The storage can help facilitate flexible operations of the export pumps by allowing export of stored water when critical fish species are present in the south Delta.
indirect mortality	The indirect fish losses from operating the Delta Cross Channel and south Delta export pumps. For example, fish diverted from the Sacramento River into the central and south Delta experience higher mortality through increased stress, small agricultural water diversions, poor water quality, predation, reduced shallow water habitat for fry, higher water temperatures, and higher residence times. This indirect mortality is a portion of the total fish mortality resulting from operation of the export pumps (see direct morality).
instream flows	Year-round flows in rivers and streams.

invertebrate An animal that lacks a backbone or spinal column.

jeopardy Situation in which an action is likely to threaten the continued existence of a species listed as endangered or threatened under Federal or State ESAs.

Joint Point of Diversion SWRCB Water Rights Decision 1641 refers to the ability of the SWP and CVP to utilize each other's point of diversion. Allows the SWP and CVP to pump water for each other during times of restriction for one set of pumps.

Level 4 Refuge Supplies The Central Valley Habitat Joint Venture defined four levels of refuge water supplies: existing firm water supply (Level 1), current average annual water deliveries (Level 2), full use of existing development (Level 3), and to permit full habitat development (Level 4). CVPIA Section 3406(d) committed to providing a firm water supply through long-term contractual agreements for Level 2 refuges.

listed species (CESA) Species or subspecies declared as threatened or endangered by the CDFG in 14 CCR Section 670.5.

listed species (ESA) Species, including subspecies, of fish, wildlife, or plants federally listed at 50 CFR 17.11 and 50 CFR 17.12 as either endangered or threatened, or listed at 14 CCR Section 670.2 and 14 CCR Section 670.5 as threatened or endangered.

"maintain" Also known as "m", a CALFED goal assigned to species expected to be minimally affected by CALFED actions. The MSCS requires that CALFED actions' adverse effects on species in this category be avoided, minimized, or compensated for. The avoidance, minimization, and compensation measures for these species may not contribute to their recovery, but would ensure that CALFED actions do not degrade the status of the species or contribute to the need to list the species. CALFED is also expected, where practicable, to take advantage of opportunities to improve conditions for these species.

Management Agencies USFWS, NOAA Fisheries, and the CDFG.

mitigation To moderate, reduce, or alleviate the impacts of a proposed activity; including: (a) avoiding the impact by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) compensating for the impact by replacing or providing substitute resources or environments.

Monterey Agreement Amendment made to contracts for State water as a result of the Monterey principles. This amendment established a number of water management tools including: 1) the turn-back pool, 2) transfer of water amounts in Table A, 3) storage of water outside of the Export Service Area, and 4) flexible management of SWP terminal reservoirs.

Multi-Species Conservation Strategy Identifies a list of species for which the CALFED Program and the ERP have responsibilities related to: (1) recovery of the species, (2) contributing to their recovery, or (3) maintaining existing populations. Serves as the platform for compliance with the Federal ESA, the California Endangered Species Act (CESA), and the State's Natural Community Conservation Planning Act (NCCPA).

National Environmental Policy Act Federal legislation establishing the national policy that environmental impacts will be evaluated as an integral part of any major federal action. Requires the preparation of an environmental impact statement (EIS) for all major federal actions significantly affecting the quality of the human environment.

Natural Community Conservation Plan (NCCP) A plan prepared pursuant to the NCPPA that identifies and provides for the regional or areawide protection and perpetuation of natural wildlife diversity, while allowing compatible and appropriate development and growth.

NCCPA The Natural Community Conservation Acts, a California law providing for regional or areawide planning for natural wildlife diversity and compatible and appropriate development and growth. (See Fish and Game Code Section 2800 et seq.)

NCCP community Refers to both habitats and fish groups addressed in the MSCS. The MSCS provides the information for a programmatic NCCP for 20 natural communities, encompassing 18 habitat types and two ecologically based fish groups.

NCCP community goals CALFED goals developed by the MSCS team and ERP staff for NCCP communities.

NCCP community prescriptions — MSCS targets that describe the future expected changes in extent and condition of MSCS NCCP communities with full implementation of CALFED. If NCCP community prescriptions are achieved, CALFED goals for NCCP communities will have been met.

NCCP habitat — Broad habitat categories, each of which includes a number of habitat or vegetation types recognized in frequently used classification systems. The MSCS includes an evaluation of 18 NCCP habitats.

non-native species — Also called introduced species or exotic species; refers to plants and animals that originate elsewhere and are brought into a new area, where they may dominate the local species or in some way negatively impact the native species environment.

obligate species — A species limited to a restricted environment, such as a wetland.

Operating Principles Agreement — EWA agencies' specific methods for asset acquisition and management.

operational flexibility — Central Valley Project and State Water Project operational measures dedicated to the EWA that include: 50 percent of the SWP export pumping of (b)(2) water and ERP water from upstream releases; 50 percent of SWP excess capacity subsequent to Joint Point of Diversion provisions; Export/Inflow relaxation; and exclusive use of 500 cfs increase in authorized Banks Pumping Plant capacity (between 6,680 and 7,180 cfs) July through September. These measures increase the ability to store and carry over assets.

overdraft — The condition, over the long-term, when more water is withdrawn from a groundwater basin than is recharged.

perennial plant — A plant that grows for more than one season; it over-winters in a dormant condition and resumes growth the following season.

Phase I — First phase of CALFED. During Phase I, begun in May 1995, the problems of the Bay-Delta were defined and work began on developing a range of alternatives to solve them. Phase I was completed by CALFED in August 1996.

Phase II — Second phase of CALFED. This is CALFED's current phase, that will end at the time of the Final Programmatic

	Environmental Impact Statement/ Environmental Impact Report (PEIS/EIR). In Phase II, CALFED is developing a Preferred Program Alternative, conducting comprehensive programmatic environmental review, and developing the implementation plan focusing on the first 7 years (Stage 1) following the Record of Decision (ROD).
Phase III	Third and final phase of CALFED. During Phase III, implementation of the Preferred Program Alternative will begin. Implementation will continue in stages over many years. This phase will include any necessary studies and site-specific environmental review and permitting.
practicable	Capable of being put into practice, done, or accomplished using reasonable means and costs.
prescriptive measures	Water quality standards and operational criteria that protect various beneficial uses of water, e.g., instream flow recommendations, temperature requirements, pumping thresholds based on the ration of exports to inflow, salinity standards, and Delta outflow requirements.
Project Agencies	Bureau of Reclamation (Reclamation) and the Department of Water Resources (DWR).
Projects	Combination of State Water Project and Federal Central Valley Project.
program area	The area where EWA assets are acquired and managed.
pumping reductions	Operational changes at the Delta CVP/SWP facilities that cause a reduction in Project south-of-Delta water exports beyond the baseline level of fisheries protection established in the CALFED ROD.
raptor	A bird species in the order Falconiformes such as hawks, eagles, kites, and falcons, and in the order Strigiformes (owls).
"recovery" (CALFED goal)	Also referred to as "R", a CALFED goal assigned to evaluated species whose recovery is dependent on restoration of the Delta and Suisun Bay/Marsh ecosystems and for which CALFED could reasonably be expected to undertake all or most of the actions necessary to recover the species. The term "recover" means that the decline of a species is arrested or reversed and threats to the species are neutralized and that the species' long-term survival in nature is therefore assured.

recovery (ESA) — The process by which the decline of an endangered or threatened species is arrested or reversed, and threats to survival are neutralized, so that long-term survival in nature can be ensured.

riparian — The strip of land adjacent to a natural watercourse such as a river or stream. Often supports vegetation that provides important wildlife habitat values when a complex forest structure is present and important fish habitat values when vegetation grows large enough to overhang the bank.

riverine habitat — Habitat within or alongside a river or channel.

San Luis low point — The low point is the summertime seasonal lowest level of San Luis Reservoir. The low point problem occurs when the volume of water in the reservoir drops to approximately 300,000 acre-feet, the point at which algal blooms can cause water quality problems for urban water users that receive supplies, especially Santa Clara Valley Water District.

secondary benefits — Implementation of EWA indirectly augments instream flows and enhances Delta outflows.

Section 7 — Section 7 of the Federal ESA (16 USCA 1536) deals with the requirement that Federal agencies consult with the USFWS or National Marine Fisheries Service to ensure that any action authorized, funded, or carried out by a Federal agency is not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of designated critical habitat of such species.

Section 9 — Section 9 of the Federal ESA (16 USCA 1538) defines prohibited acts, including the "take" of any listed species without specific authorization of the USFWS or NOAA Fisheries.

Section 10 — Section 10 of the Federal ESA (ESA) (16 USCA 1539) defines exceptions to acts prohibited by Section 9 of ESA (16 USCA 1538) for nonfederal entities (e.g., states, local governments, private individuals).

sensitive species — Listed species, species that are candidates for listing, and other species that have been designated as species of special concern by Federal or State agencies or scientific organizations (see "special-status species").

service area All of the areas that receive water from SWP or CVP projects.

Smelt A young salmon that has assumed the silvery color of the adult and is ready to migrate to the sea.

source shifting Tool for EWA to borrow scheduled water from project contractors for a fee, returning the water at a later date.

special-status species Species that are in at least one of the following categories: listed as threatened or endangered under the Federal ESA; proposed for Federal listing under the ESA; Federal candidates under ESA; listed as threatened or endangered under the CESA; candidates under CESA; plants listed as rare under the California Native Plant Protection Act; California fully protected species or specified birds under various sections of the California Fish and Game Codes; California species of special concern; California Native Plant Society List 1A, lB, 2, or 3 species; or other native species of concern to CALFED.

species Species of fish, wildlife, or plants, any subspecies of fish, wildlife, or plants, and any distinct population segment of vertebrate fish or wildlife that interbreeds when mature. The CESA also includes any native species or subspecies of bird, mammal, fish, amphibian, reptile, or plant.

species goal CALFED goals developed by the MSCS Team and the ERP staff for the evaluated species, termed “recovery”, “contribute to recovery”, and “maintain”.

species of concern Species evaluated in the MSCS that could be affected by actions and are not listed as threatened or endangered under the Federal ESA; proposed for listing under ESA; candidates under ESA; listed as threatened or endangered under the CESA; candidates under CESA; plants listed as rare under the California Native Plant Protection Act; California fully protected species or specified birds under various sections of the California Fish and Game Codes; California species of special concern; or California Native Plant Society List lA, lB, 2, or 3 species.

species prescriptions MSCS targets that describe the future expected changes in evaluated species’ habitats and populations with full implementation of CALFED. If evaluated species prescriptions are achieved, CALFED goals for evaluated species will have been met.

Stage	The height of the water surface above an arbitrarily established elevation.
Stage 1	The first 7 years of CALFED implementation following the ROD on the CALFED PEIS/EIR.
State-covered species	Evaluated species identified by CDFG in the programmatic NCCP determination that would be adequately conserved with the implementation of programmatic CALFED actions and conservation measures.
State Water Project (SWP)	A California State water conveyance system that pumps water from the Delta for agricultural, urban domestic, and industrial purposes. The SWP was authorized by legislation in 1951.
study area	The EWA EIS/EIR study area includes those areas of California that could be potentially affected by the EWA.
subsidence	The reduction in land elevation due to the compaction of soil, oxidation of organic soils, removal of underground fluids, or other mechanisms.
Table A	A tool for apportioning available water supply and cost obligations under the SWP contract. When the SWP was being planned, the amount of water projected to be available for delivery to the contractors was 4.2 million acre-feet (maf) per year. Table A lists by year and acre-feet the portion of the 4.2 maf deliverable to each contractor. The Table A amounts are not an indication of the SWP water delivery reliability, nor should these amounts be used to support an expectation that a certain amount of water will be delivered to a contractor in any particular time span.
take	Under the ESA, "To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" in regard to federally listed, endangered species of wildlife (16 USCA 1532[19]). "Harm" is further defined as an act "which actually kills or take threatened species injures". Harm may include "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter" (50 CFR 17.3). Under the California Fish and Game Code, take is defined as "to hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture, or kill" (California Fish and Game Code Section 86).

terrestrial species — Types of species of animals and plants that live on or grow from the land.

threatened species (CESA) — Any species listed as threatened under the CESA. Threatened species are native California species or subspecies of a bird, mammal, fish, amphibian, reptile, or plant that have been determined by the CDFG, although not presently threatened with extinction, to be likely to become an endangered species in the foreseeable future in the absence of special protection and management efforts. See California Fish and Game Code Section 2067.

threatened species (ESA) — Any species listed as threatened under the ESA. Threatened species are any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range (see 16 USCA 1532[19]).

Tier 1 — Governed by regulatory commitments in Section VIII-B of the MSCS Conservation Agreement that defines the baseline amount of water required under the biological opinions, 1995 WQCP, and 800,000 AF of CVP Yield pursuant to the CVPIA Section 3406(b)(2).

Tier 2 — EWA assets combined with benefits of a fully funded ERP. Serves as an insurance mechanism that would allow fish protection when needed without reducing deliveries to water users.

Tier 3 — EWA assets beyond Tiers 1 and 2 that would be based upon commitment and ability of CALFED agencies to make additional water available, if needed.

Tracy Pumping Plant — The CVP export pumping plant in the south Delta.

turbidity — A cloudy appearance that results when excessive silt or other substances are in the water.

turn back pool — SWP contractors may sell unwanted SWP Table A amounts to other contractors through the "turn back pool". Contractors not storing water in a given year can elect to participate in the annual turn-back pool of allocated but unneeded water. SWP contracts do not allow contractors to sell water for use outside their service area except through the turn-back pool.

turnout	Connection from CVP/SWP conveyance systems that distributes untreated water from the central delivery system to various entitlement holders
upstream storage	Any water storage upstream of the Delta supplied by the Sacramento or San Joaquin Rivers or their tributaries.
variable assets	Water made available each year through changes in Delta operations, i.e., Joint Point of Diversion, Export/Inflow Ratio Flexibility, 500 cfs SWP pumping increase. Water obtained by methods other than active acquisitions. The Flexible Purchase Alternative provides up to 195,000 AF of water through variable assets. The Fixed Purchase Alternative does not include variable assets.
vernal pool	Seasonally ponded landscape depressions in which water accumulates because of limitations to subsurface drainage and that support a distinct association of plants and animals.
Vernalis Adaptive Management Program	Science based management plan designed to determine and protect the survival and transport of salmon smolts through the Delta in relation to the flow of the San Joaquin River, SWP/CVP exports, and the operation of a fish barrier at the head of the Old River.
water managers	Any entity, Federal, State, or local, involved in decision making related to water supply, storage, release, sale, and use.
water transfers	Voluntary water transactions conducted under State law and in keeping with Federal regulations.
watershed	An area that drains to a particular channel or river, usually bounded peripherally by a natural divide of some kind such as a hill, ridge, or mountain.
watershed program area	The area that encompasses the watersheds of the CALFED Solution Area, but focuses on the watersheds of the San Joaquin and Sacramento Rivers, primarily those areas above major dams, and a portion of the upper Trinity River watershed.
wheeling	Use of Project facilities to pump and convey non-project water.
X2	The location (measured in kilometers upstream from the Golden Gate Bridge) of 2 parts per thousand total

dissolved solids. The length of time X2 must be positioned at set locations in the estuary in each month is determined by a formula that considers the previous month's inflow to the Delta and a "Level of Development" factor, denoted by a particular year. X2 is currently used as the primary indicator in managing Delta outflows. The X2 indicator is also used to reflect a variety of biological consequences related to the magnitude of fresh water flowing downstream through the estuary and the upstream flow of salt water in the lower portion of the estuary. The outflow that determines the location of X2 also affects both the downstream transport of some organisms and the upstream movement of others and affects the overall water operations of the CVP and SWP.

DRAFT
ENVIRONMENTAL IMPACT STATEMENT (EIS)/
ENVIRONMENTAL IMPACT REPORT (EIR)
ENVIRONMENTAL WATER ACCOUNT

State Clearinghouse # 1996032083
State of California

Co-Lead Agencies:
Lead Agency for the EIS: U.S. Department of the Interior, Bureau of Reclamation
Lead Agency for the EIR: California Department of Water Resources

Cooperating Agencies:
U.S. Fish and Wildlife Service
National Marine Fisheries Service
California Department of Fish and Game

ABSTRACT

This Draft EIS/EIR addresses implementation of an Environmental Water Account (EWA) as provided in the CALFED Programmatic EIS/EIR Record of Decision (ROD). The EWA consists of two primary elements: (1) assisting in fish population recovery for at-risk native fish species; and (2) increasing water supply reliability by reducing uncertainty associated with fish recovery actions. This Draft EIS/EIR analyzes three alternatives, including two action alternatives that involve the acquisition of EWA assets via stored surface water, stored groundwater, groundwater substitution, and crop idling purchases; with EWA asset management through source shifting, groundwater storage, and borrowing of Project water. The alternatives differ primarily in actions taken to protect fish and the quantities of assets acquired under each. The Draft EIS/EIR analyzes the direct, indirect, and cumulative impacts to the physical, socioeconomic, and the natural environment that result from the purchase, storage, and conveyance of EWA assets, and the actions taken to benefit fish populations. EWA agencies have incorporated conservation and mitigation measures for asset purchase and management to minimize impacts. Impacts presented include the timing of release of stored reservoir water on power production and fish; socioeconomic, air quality, and terrestrial wildlife effects due to crop idling; and Delta fish and water quality effects due to the pumping of EWA assets. The cumulative effects of other water acquisition and land management programs are also assessed.

This Draft EIS/EIR is prepared in compliance with the National Environmental Policy Act (NEPA), Bureau of Reclamation (Reclamation) NEPA procedures, and the California Environmental Quality Act (CEQA) and CEQA Guidelines.

Comments on this document must be submitted by September 9, 2003.

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Chapter 1
Introduction

This Environmental Impact Statement/Environmental Impact Report (EIS/EIR) addresses alternative methods for implementing the Environmental Water Account (EWA).

The August 28, 2000, CALFED Programmatic Record of Decision (CALFED ROD; CALFED 2000b) for the CALFED Bay-Delta Program Programmatic Environmental Impact Statement/Environmental Impact Report (CALFED PEIS/EIR; CALFED 2000a) described an EWA as a 4-year program that could be extended by written agreement of the participating agencies. The CALFED ROD (Appendix A to this document) identifies the EWA as a cooperative water management program, the purpose of which is to provide protection to at-risk native fish species of the San Francisco Bay/Sacramento-San Joaquin River Delta estuary, while improving water supply reliability for water users. The CALFED ROD described the EWA actions involving the development and management of alternative sources of water supply, called "EWA assets," to address the CALFED agencies' water supply reliability and ecosystem quality objectives.

The EWA program makes environmentally beneficial changes in the operations of the State Water Project (SWP) and the Federal Central Valley Project (CVP), at no uncompensated water loss to the CVP and SWP (jointly referred to as the "Projects") water users. Protective actions for at-risk native fish species would range from reducing Delta export pumping to augmenting instream flows and Delta outflows. Beneficial changes in SWP and CVP operations could include changing the timing of some flow releases from storage and the timing of water exports from the Delta pumping plants to coincide with periods of greater or lesser vulnerability of various fish species to environmental conditions in the Delta. For example, the EWA might alter the timing of water diversions from the Delta and carry out water transfers in order to reduce fish entrainment at the pumps and provide migratory cues for specific anadromous fish species. The CALFED ROD states that an EWA program would replace any regular water supply interrupted by the environmentally beneficial changes to SWP and CVP operations. The timing of the protective actions and operational changes would vary from year to year, depending on many factors such as hydrology and real-time monitoring that indicates fish presence at the pumps.

The EWA program (CALFED 2000c; Appendix C) obtains its water assets by acquiring, banking, transferring, or borrowing water and then arranging for its conveyance. Water would be acquired substantially through voluntary purchases in the water transfer market or by developing additional assets over time. The EWA program also obtains water through operational flexibility of Delta facilities. Figure 1-1 illustrates the statewide area that could participate in, or be affected by, the EWA.

No Scale

Figure 1-1
EWA Area

The CALFED ROD (CALFED 2000b; Appendix A) and the EWA Operating Principles Agreement (CALFED 2000c; Appendix C) gave five Federal and State agencies the responsibility for implementing an EWA. All five "EWA agencies" cooperate in day-to-day operational management of EWA assets to best benefit fish at no uncompensated water costs to the water users. Of these five agencies, the three "Management Agencies," —the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NOAA Fisheries), and the California Department of Fish and Game (CDFG) —have primary responsibility for exercising biological judgment to recommend which SWP/CVP operational changes would be beneficial to the Bay-Delta ecosystem or the long-term survival of fish species, including those fish species listed under the State and Federal Endangered Species Acts (CESA and ESA, respectively). The Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR), the two "Project Agencies," cooperate with the Management Agencies in administering the EWA by acquiring, transferring, selling, borrowing, banking, and conveying EWA water assets and by implementing the recommended SWP/CVP operational changes proposed by the Management Agencies. All five EWA agencies manage the EWA "assets" and make day-to-day operational decisions on a real-time basis rather than by using a purely prescriptive approach. The EWA is based on the concept that flexible management of water will achieve fishery and ecosystem benefits more efficiently and to a greater degree than a completely prescriptive regulatory approach. EWA is dependent on monitoring and real-time water diversion management.

1.1 History of the CALFED Bay-Delta Program

The CALFED Bay-Delta Program is a collaborative effort of 23 Federal and State agencies to improve water supplies in California and the health of the Bay-Delta watershed, shown on Figure 1-2[1]. The CALFED Program was established in 1994 as a collaborative effort involving

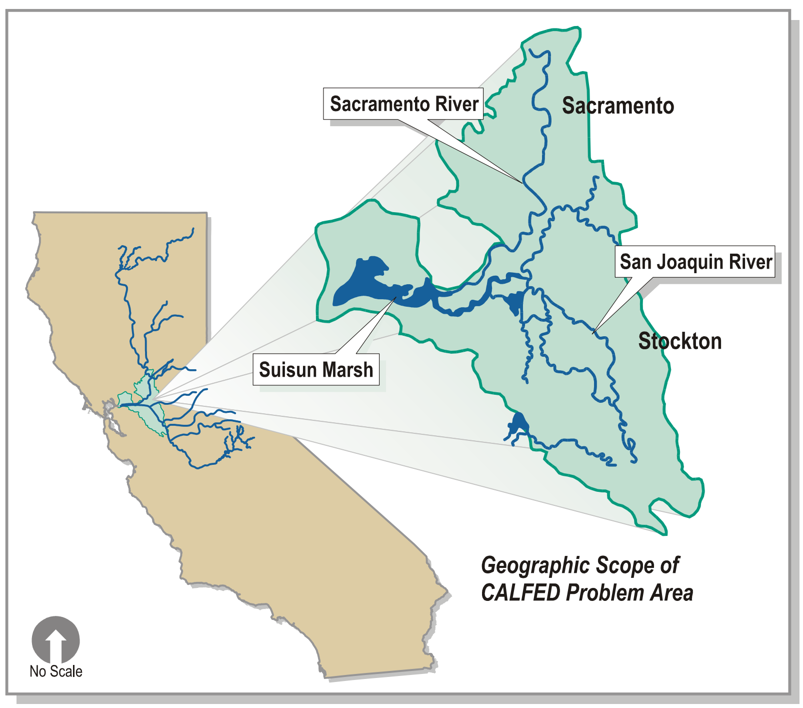

Figure 1-2
CALFED Problem Area

[1] The CALFED solution area includes the broader Bay-Delta watershed and areas that receive Bay-Delta supplies. The solution area is discussed in more detail in Chapter 3.

Federal and State agencies focused on restoring the ecological health of the Bay-Delta estuary while ensuring water quality improvements and water supply reliability to all users of Bay-Delta water resources.

The CALFED Program began with the Framework Agreement, which was signed in June 1994. This agreement stated that agencies with management and regulatory responsibility for the Bay-Delta estuary would work together to address three areas of Bay-Delta management:

- Water quality standards formulation;
- Coordination of SWP and CVP operations with existing ESA and Clean Water Act (CWA) regulatory requirements; and
- Long-term solutions to problems in the Bay-Delta estuary.

The CALFED Program is charged with responsibility for the third issue identified in the Framework Agreement. The CALFED Program long-term planning effort that was conducted by the many agencies comprising the program, included intensive stakeholder involvement to develop a comprehensive and balanced plan to address problems in four interrelated resource areas: ecosystem quality, water quality, levee system integrity, and water supply reliability. The CALFED agencies and the public developed four primary objectives for the CALFED plan:

- **Ecosystem Quality** – Improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species.
- **Water Supply** – Reduce the mismatch between Bay-Delta water supplies and the current and projected beneficial uses dependent on the Bay-Delta system.
- **Water Quality** – Provide good water quality for all beneficial uses.
- **Vulnerability of Delta Functions** – Reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of levees (CALFED 2002a).

Six solution principles guided development of the comprehensive plan and the refinement of programmatic alternatives (CALFED 2002a). These solution principles state that any CALFED Program solution must be affordable, equitable, implementable, durable, reduce conflicts in the system, and have no significant redirected impacts.

To practicably achieve its mission, the CALFED plan will concurrently and comprehensively address problems of the Bay-Delta system within each of four resource categories: ecosystem quality, water quality, water supply reliability, and levee system integrity. Important physical, ecological, and socioeconomic links exist between the problems and possible solutions in each of these categories. Accordingly, a solution to problems in one resource category cannot be pursued without addressing problems in other resource categories. The CALFED plan includes a range of balanced actions that can be taken forward to a comprehensive, multi-agency approach to managing Bay-Delta resources. The plan has established eight program elements; the goals of each element are listed below.

- **Ecosystem Restoration Program (ERP)** – improve and increase aquatic and terrestrial habitats and improve the ecological functions in the Bay-Delta system to support sustainable populations of diverse and valuable plant and animal species.
- **Water Quality Program** – achieve continuous improvement in the quality of the waters of the Bay-Delta system to minimize ecological, drinking water, and other water quality problems.
- **Levee System Integrity Program** – improve levee stability to benefit all users of Delta water and land.
- **Water Use Efficiency Program** – assure efficient use of existing and any new water supplies developed by the Program.
- **Water Transfer Program** – facilitate water transfers and further develop a statewide water transfer market.
- **Watershed Program** – provide financial and technical assistance to local watershed programs that benefit the Bay-Delta system.
- **Storage** – use groundwater and surface water storage to improve water supply reliability, provide water for the environment at times when it is needed most, provide flows timed to maintain water quality, and protect levees through coordinated operation with existing flood control structures.
- **Conveyance** – improve through-Delta conveyance to improve water supply reliability, protect and improve Delta water quality, improve ecosystem health, and reduce risk of supply disruption due to catastrophic breaching of levees.

Several program elements are discussed in greater detail in Section 1.3.

The CALFED Program has a phased planning and implementation approach:

- **Phase I** – CALFED agencies and stakeholders considered hundreds of potential actions and combined these actions into alternatives to meet the objectives and solution principles of the program. Phase I concluded in September 1996, with the development of a range of alternatives for achieving long-term solutions to the problems of the Bay-Delta estuary.

- **Phase II** – CALFED agencies performed a programmatic environmental review of the alternatives and released a draft CALFED PEIS/EIR and interim Phase II Report identifying three draft alternatives and program plans on March 16, 1998. Phase II culminated in the August 28, 2000, final CALFED PEIS/EIR and CALFED ROD. (See Section 1.5.1).

- **Phase III** – the CALFED Program is currently in Phase III, in which the CALFED agencies are implementing the preferred alternative defined in the CALFED PEIS/EIR and CALFED ROD. The EWA will be implemented as one of these Phase III actions.

The first 7 years of the Phase III implementation phase are referred to as Stage 1, which is intended to set forth the direction and build the foundation for long-term Phase III actions. Much of the analysis in this EWA EIS/EIR focuses on Stage 1 because potential subsequent EWA actions will likely adapt with the benefit of information learned during initial implementation of the EWA, and the EWA could change form as other CALFED Program projects are implemented.

The CALFED Bay-Delta Program is not an agency and does not implement projects such as the EWA. Although the term "CALFED" is often used as shorthand for the CALFED agencies, individually or collectively, the CALFED Program should not be confused with the agencies themselves. The program is a forum in which the agencies coordinate their activities, resolve disputes, plan, and monitor their collective progress toward resolving the Delta's problems. No Federal or State CALFED agency has delegated its authority or discretion to any other agency or to the CALFED agencies collectively. The agencies retain their discretion to make final decisions to implement elements of the CALFED Program plan according to their own independent legal authority. The fundamental notion of the CALFED Program is that the agencies can best meet their individual responsibilities by sharing information and cooperating with each other.

Senate Bill 1653 established the California Bay-Delta Authority to oversee and ensure balanced implementation of the CALFED Bay-Delta Program. The bill specifies that the Authority's governing board include six Federal agency representatives, six State agency representatives, seven public members, one member of the Bay-Delta Public Advisory Committee, and four ex officio members, namely the chairs and vice-chairs of the Senate and Assembly water committees (CALFED 2003).

1.2 EWA Program Purpose and Need and Project Objectives

The San Francisco Bay/Sacramento-San Joaquin River Delta estuary is one of the most important aquatic ecosystems in the United States, providing habitat for hundreds of plant, animal, and fish species. It also provides drinking water for two-thirds of California's populace and irrigation water for over 7 million acres of prime farmland. These competing interests – economic and ecologic, and urban and agricultural –

place a demand on the water of the Bay-Delta system that exceeds the available water supply. As water use has increased during the past several decades, conflicts have increased among the multiple users of Bay-Delta water. Heightened competition for the water during certain seasons or during low-rainfall years has magnified the conflicts.

The increasing demand for water has degraded the quality of Bay-Delta water resources for both the human and natural environments. Water demand for urban and agricultural uses has reduced water availability for ecological functions and/or has reduced the quality of aquatic habitat in the Bay-Delta system. Upstream water development, depletion of natural flows by local diverters, and the export of water from the Bay-Delta system have changed seasonal patterns of the inflow, reduced the outflow, and diminished natural variability of flows into and through the Bay-Delta system. Several Bay-Delta fish and wildlife species, some with critical life history stages that depend on adequate fresh-water flows, have been listed as endangered or threatened under the ESA and the CESA. All alternative methods for implementing the EWA need to improve the quality of the Bay-Delta aquatic ecosystem and contribute to the recovery of threatened or endangered fish species and fish species of special concern. The EWA plan should include specific actions that can quickly benefit the in-Delta, upstream, and downstream movement of larval, juvenile, and adult life stages of Bay-Delta aquatic species.

The SWP and CVP are operated by DWR and by Reclamation, respectively. The CVP delivers water primarily to agricultural and urban contractors within the Central Valley and the San Francisco Bay area. The SWP delivers water to agricultural and urban contractors in the Central Valley, the San Francisco Bay area, the central coast, and southern California. The SWP and CVP systems are both large, complex networks of water storage and conveyance facilities. (Described in more detail in Section 1.3.) DWR and Reclamation have sophisticated operation systems that move water from areas in which it is available to areas of California with more limited water resources. Both the SWP and CVP store water upstream from the Delta and move the water south of the Delta to urban and agricultural water users in the Export Service Area via large pumps in the south Delta. Water supplies pumped from the Delta are referred to as "Delta exports," or "exports." Exporting water at the Delta pumps creates another significant conflict between Bay-Delta water uses. Because exporting water from the Delta at certain times of the year (typically winter, early spring, late spring, or early summer) can entrain and kill fish, DWR and Reclamation may reduce exports at times to protect listed fish species. (Section 2.4.1 includes additional detail on export pumping and fish.) These pumping reductions protect endangered and threatened fish species, but reductions significantly decrease the reliability of the water supply to urban and agricultural users in the Export Service Area. Any alternative method for implementing the EWA program would be required to substantially reduce or eliminate the conflict at the pumps between fish protection needs and water supply reliability needs.

The conflicts between competing beneficial uses of Bay-Delta water are adversely affecting urban water users, agricultural water users, water quality, environmental quality, and harming threatened and endangered Delta-dependent species. Consequently, an effective statewide water-management program is needed almost immediately to reduce water-use conflicts. The immediate need for a solution requires all EWA alternatives to operate within existing facilities and infrastructure and comply with current laws and regulatory requirements. All stakeholders (Project Agencies, Management Agencies, and water users) agree that solutions requiring the construction of new facilities, extensive modification of existing facilities, changes in State water use, or legislative changes to existing laws or programs would require many years to authorize, plan, and implement. Any solution must be able to be implemented in the next water year.

Successful implementation of the EWA requires the flexibility to move water through the complex networks of CVP and SWP water storage and conveyance facilities in response to annual and seasonal hydrologic variation, water user needs, and the behavior of endangered species, which varies from season-to-season and year to year. The EWA must have the flexibility to respond quickly to real-time changes in fish needs and the environment, including changes in fish presence at the pumps, fish migration patterns, or water needs in area waterways for fish spawning and rearing. Similarly, the acquisition and management of water "assets" to increase water supply reliability and benefit the environment also require flexibility to be effective. The availability of supplies and willingness to sell will likely vary each year, dependent on local needs and hydrology. EWA flexibility is also needed to acquire assets when and where they are available and to maximize the amount of water that the EWA can acquire for a set budget.

1.2.1 Statement of Purpose and Need

The purpose and need for the proposed action is to: 1) provide a highly flexible, immediately implementable, water management strategy that protects the at-risk native Delta-dependent fish species affected by SWP/CVP operations and facilities, 2) contributes to the recovery of these fish species, 3) allows timely water management responses to changing environmental conditions and changing fish protection needs, 4) improves water supply reliability for water users downstream from the Delta, and 5) does not result in uncompensated water cost to the Projects' water users. This water management strategy must also be consistent with the preferred program alternative selected by the CALFED agencies in the CALFED ROD.

1.2.2 Project Objectives

The objectives for the EWA Program can be summarized as:

1. Provide protection for at-risk native fish species dependent on the Bay-Delta estuary affected by SWP/CVP operations and facilities, and to contribute to recovery of these species;

2. Allow for timely water management responses to changing environmental conditions and changing fish protection needs;

3. Improve the water supply reliability for water users in the Export Service Area by reducing conflicts at the Delta export pumps without resulting in uncompensated water costs to the Projects' water users;

4. Implement actions to accomplish the first three objectives immediately; and

5. Maximize the flexibility in operations of the SWP and CVP to most efficiently accomplish the objectives above.

1.3 The CVP and SWP

The CVP was initially authorized in the 1935 Rivers and Harbors Act, and construction began in the 1930s. Designs for the CVP were motivated by a fear of floods and drought, and a desire to transport water from the northern end of the Central Valley to the drier southern end. Today the CVP supplies irrigation water to the Sacramento and San Joaquin valleys, water to cities and industries in Sacramento and the east and south Bay Areas, and to fish hatcheries and wildlife refuges throughout the Central Valley. The CVP is operated and maintained by Reclamation and delivers approximately 7 million acre-feet of water. CVP facilities include 20 dams and reservoirs, 39 pumping plants, 2 pumping-generating plants, and 11 power plants (Reclamation 2001). Figure 1-3 shows the primary CVP facilities within the area affected by the EWA.

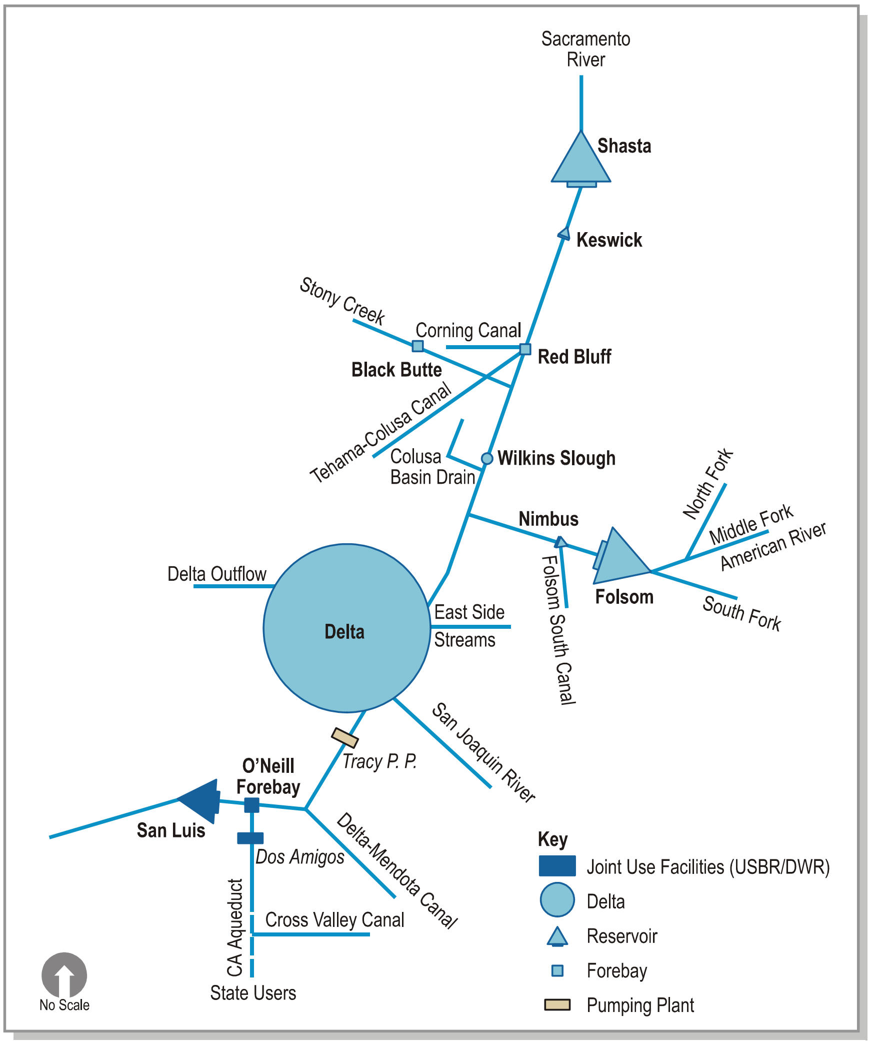

Figure 1-3
CVP Facilities Within the EWA Area

The SWP was developed to respond to an increased water need as a result of a growing population and an increase in agricultural production following World War II. The CVP could not supply enough water to meet the increasing needs, consequently the State Legislature requested that the DWR (then the Division of Water Resources) to update existing water studies. DWR produced "The California Water Plan", published in 1957, that outlined plans for water resource development including transferring water from areas of surplus in the north to areas lacking water in the south.

Today, the SWP delivers water from northern California to users in the San Francisco Bay area (North and South bay), San Joaquin Valley, and beyond to southern California. The SWP conveys an annual average of 2.5 million acre-feet of water through 17 pumping plants, 8 hydroelectric power plants, 32 storage facilities, and over 660 miles of aqueducts and pipelines. Of the contracted water supply, urban users have received 53 percent of the total water delivered over the last 20 years (DWR 2001a); the remainder is supplied for agricultural use. A total of 29 contracting agencies receive water from the SWP. Contracts specify the schedule and amount of delivery; however, the actual amount received depends on hydrologic conditions, pumping capacity in the Delta, and operational constraints such as fish protection, water quality, and legal and regulatory restrictions. Although the SWP was built primarily for water supply, it also serves Californians with recreation, flood control, fish and wildlife enhancement, power, and salinity control in the Delta. Figure 1-4 identifies SWP facilities that are within the regions affected by the EWA.

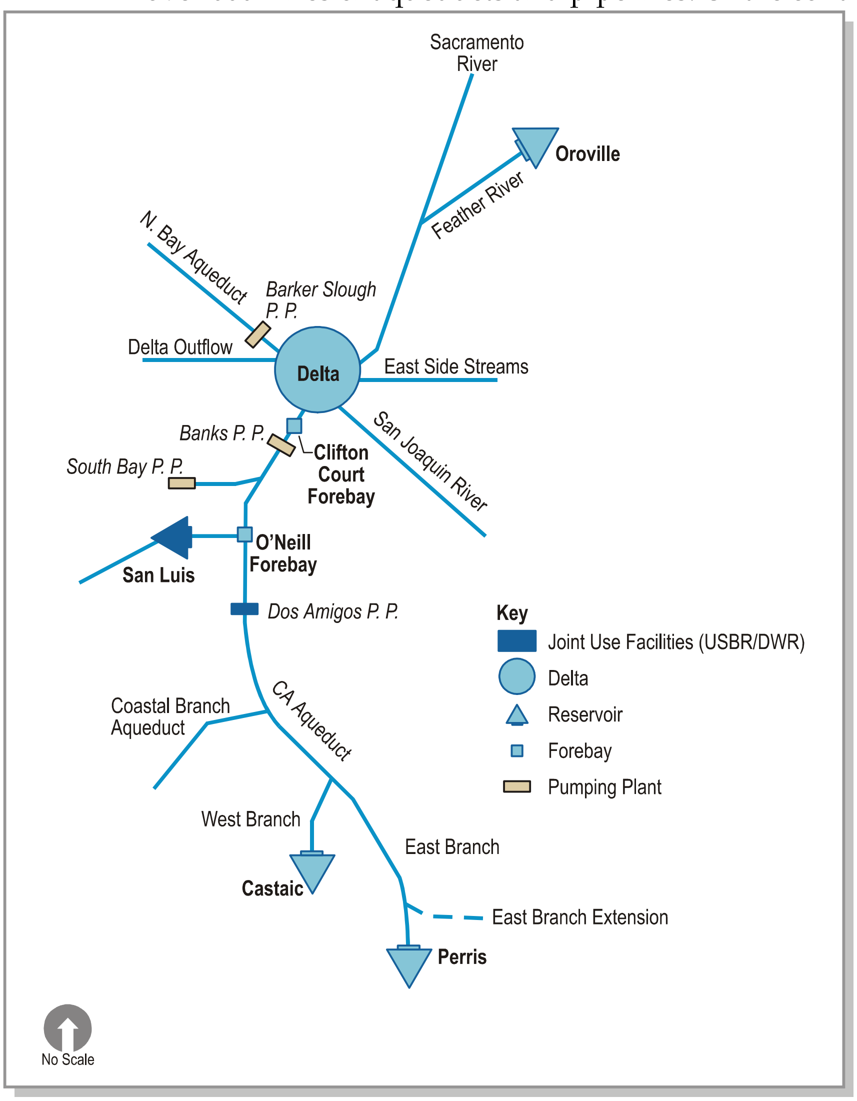

Figure 1-4
SWP Facilities Within the EWA Area

The Coordinated Operation Agreement (COA), concerning operations of the CVP and SWP, coordinates operations and establishes an accounting system to ensure that the Projects meet requirements. This agreement is discussed in more detail in Section 1.6.3.

1.4 Overview of the EWA Within the Larger CALFED Program

The EWA is just one component of the CALFED plan developed to reduce water-use conflicts in the Bay-Delta region. The CALFED PEIS/EIR and CALFED ROD (CALFED 2000b) explain all elements of the CALFED plan. The CALFED Plan elements work together as part of four broad resource management strategies that address the plan's four objectives: the Ecosystem Restoration Strategy, Levee System Improvement Strategy, Water Quality Strategy, and Water Management Strategy (CALFED 2000b). In addition, the CALFED plan incorporates a Multi-species Conservation Strategy (MSCS) for compliance with State and Federal endangered species laws, which resulted in programmatic biological opinions and Natural Community Conservation Plan (NCCP) determinations by the wildlife agencies on the overall CALFED plan. The sections below describe relevant portions of the CALFED plan and the opinions and determinations related to the plan.

The EWA is one of the water management tools in the CALFED plan that is part of the overall Water Management Strategy (CALFED 2000b). The EWA combines portions of several of the CALFED plan elements, such as water transfers, water use efficiency, conjunctive use, access to storage, access to conveyance, and flexible operations of the CVP and SWP.

The EWA Operating Principles Agreement, Attachment 2 of the CALFED ROD (CALFED 2000c), defined the EWA as a 4-year program, unless the five agencies agree in writing to extend the program. This EIS/EIR analyzes the EWA program actions through 2007, the end of Phase 1 of the CALFED Program.

1.4.1 CALFED Ecosystem Restoration Program

The CALFED Program ecosystem quality objective is to improve and increase aquatic and terrestrial habitats and improve ecological function in the Bay-Delta system to support sustainable populations of diverse and valuable plant and animal species. All CALFED plan elements will contribute in varying degrees to this objective, with the ERP being the principal plan element directed at the objective (CALFED 2000a). The ERP identifies programmatic actions throughout the Bay-Delta watershed designed to restore, rehabilitate, or maintain important ecological processes, habitats, and species within 14 ecological management zones. Prioritization and implementation of programmatic actions will be guided by the ERP Strategic Plan for Ecosystem Restoration (Strategic Plan), which includes an adaptive management approach.

The ERP will also help fulfill the mission of improving water management for beneficial uses of the Bay-Delta system. Current regulatory protections for endangered and threatened fish species require that exports of Bay-Delta water be reduced when they pose a risk to the fish species. By helping to recover currently endangered and threatened species and by maintaining viable populations of non-listed species, the ERP can help ease current diversion restrictions and avoid the need for more stringent export restrictions in the future, thereby improving the reliability of Bay-Delta water supplies.

A scientific review panel was convened in 1997 to review the three-volume ERP plan. According to the review panel, the ERP plan did not include an approach for implementation. The Strategic Plan was developed to "provide the conceptual framework and process that will guide the refinement, evaluation, prioritization, implementation, monitoring, and revision of ERP actions" (CALFED 2000[c]). The goals and objectives outlined in the Strategic Plan reflect the CALFED Ecosystem Restoration goals. ERP Strategic Goal 1 focuses on the recovery of endangered and other at-risk native species and native biotic communities. Based on this and five other goals and their associated objectives, the Strategic Plan presents a process for implementing the ERP.

The CALFED agencies have established the Environmental Water Program (EWP) to carry out the flow-related objectives within the ERP. The EWP would acquire water from willing sellers to meet these objectives. The EWP is discussed in more detail in Chapter 22, Cumulative Effects.

As the ERP moves forward to meet its goals, it will increase fish populations in area waterways. While reducing conflicts at the Delta pumps is not a primary goal of the ERP, the conflicts at the Delta export pumps would be reduced as fish recover. In the interim, the EWA would reduce water conflicts by allowing environmentally beneficial changes in the operations of the SWP and the CVP, at no uncompensated water loss to the Projects' water users.

1.4.2 CALFED Water Management Strategy

The CALFED Program objective for water supply reliability is to reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system. As with the Ecosystem Restoration Program, all CALFED plan elements will contribute to meeting the water supply reliability objective to varying degrees. The CALFED agencies integrated all available water management tools into a Water Management Strategy with three basic purposes:

- Develop a menu of water management tools that can be used to attain the CALFED agencies' water supply reliability goals;
- Identify specific water management tools from this menu that will be implemented in Stage 1 of the CALFED Bay-Delta Program; and

- Provide a long-term decision-making framework for evaluating the success of implementation efforts and for selecting additional tools needed to achieve the objectives of the CALFED plan.

An objective of the EWA is to ensure that fish actions do not result in uncompensated loss to water users, which increases water supply reliability for these users. The EWA would therefore be one of several water management tools used to meet the water supply reliability objective. Transferring water consistent with the Water Transfer Program plan is another tool. Other tools include increasing water use efficiency, increasing water storage opportunities (both surface water and groundwater storage), and improving through-Delta conveyance. Each of these tools will also contribute to the objectives of ecosystem quality, water quality, and levee system integrity.

The CALFED Water Transfer Program Plan (The Program) presents: 1) a framework of actions, policies, and processes that collectively facilitate water transfers and 2) further develops the statewide water transfer market. The purpose of the water transfer framework is to act as a water management tool. The Program consists of solution options that protect third parties (those not directly involved in a water transfer transaction) from socioeconomic impacts; protects groundwater and surface water resources; and propose technical, operational, and administrative rules. Recommendations pertain to CALFED agencies that affect the structure and operation of the water market.

1.4.3 Multi-Species Conservation Strategy (MSCS)

The CALFED MSCS builds on the ERP to provide a framework for compliance with the ESA, CESA, and Natural Community Conservation Planning Act (NCCPA), which also concerns listed species (CALFED 2000d).

The MSCS framework identifies the habitats and species that could be affected by CALFED plan actions, analyzes how the CALFED plan actions would affect them, and proposes conservation measures that would provide for compliance with the laws covering protected species and their habitats at a programmatic level. The MSCS conservation measures build on the programmatic actions presented in the ERP.

The MSCS provides a programmatic level of species and habitat information to accompany the CALFED PEIS/EIR. This EWA-specific EIS/EIR tiers off the CALFED PEIS/EIR (see Section 1.5.1), and requires an EWA-specific level of detail for the biological analysis. The ESA Section 7 consultation (see Section 1.5.1.2 below) for the EWA program will use the CALFED MSCS to identify special status species and natural communities that might be affected by EWA actions. Because the EWA program area is larger than the MSCS focus area, the Management Agencies (USFWS, NOAA Fisheries, and CDFG) will help identify additional special status species and natural communities that may be affected specifically by the EWA program. Chapters 9 (Fisheries and Aquatic Ecosystems) and 10 (Vegetation and Wildlife) discuss ESA compliance for the EWA.

1.4.4 CALFED Programmatic Biological Opinions

Through consultations, the USFWS, NOAA Fisheries and CDFG, in coordination with the agencies taking an action (in this case the five EWA agencies), determine the effects of the proposed project on threatened and endangered species and natural communities and identify the conservation measures necessary to avoid, minimize, or mitigate these effects. The results of these processes vary depending upon the potential effects of the action. If the action agency determines in its biological assessment that its action is not likely to adversely affect a species or result in adverse modification of critical habitat, and the relevant Service concurs, consultation will be concluded. However, if the agency action is likely to adversely affect a listed species or result in adverse modification of critical habitat, a biological opinion will be prepared. A biological opinion often includes conservation measures not already proposed by the Action Agency/or Agencies. Section 1.5 describes several Federal and State consultation requirements applicable to the EWA.

The CALFED agencies used the MSCS to initiate an ESA/NCCPA[2] consultation between the CALFED agencies and the USFWS, NOAA Fisheries, and CDFG. The CALFED ROD includes the USFWS and NOAA Fisheries programmatic biological opinions that were written on the entire CALFED Program, which included an EWA. The CALFED Biological Opinions anticipated an EWA as an integral component of the entire CALFED plan that is designed to help meet ESA requirements.

The CALFED Biological Opinions included in the CALFED ROD were made at the programmatic level for the 30-year, programmatic plan referred to here as the CALFED Program. Additional Biological Opinions are required on a project-specific basis for the EWA. The EWA Action Specific Implementation Plan (ASIP, Section 1.5.1.2), tiers off the MSCS, provides more detail and will be used to initiate consultation between the EWA agencies and USFWS, NOAA Fisheries, and CDFG on the EWA. If required, the EWA ROD will include Biological Opinions written by the USFWS and NOAA Fisheries.

1.4.5 CALFED NCCPA Compliance

The NCCPA requires the preparation of a NCCP. (Section 1.5.2.3 describes the elements in an NCCP.) Consultation with CDFG results in an NCCP Determination, which makes conclusions regarding the adequacy of the proposed NCCP are presented. The CALFED ROD includes the Determination written by CDFG for the CALFED plan; CDFG concluded that the MSCS is an adequate NCCP for the CALFED plan.

The CALFED NCCP Determination included in the CALFED ROD was made at the programmatic level for the 30-year, programmatic plan referred to here as the CALFED Program. A new NCCP Determination is required on a project-specific basis for the EWA. The EWA Action Specific Implementation Plan (ASIP, Section 1.5.1.2) tiers off the MSCS, provides more detail and will be used to initiate consultation

[2] Section 1.5.1.2 and 1.5.2.3 describe ESA and NCCPA requirements.

between the EWA agencies and CDFG on the EWA. If required, the EWA ROD will include an EWA NCCP Determination written by CDFG.

1.4.6 Preliminary EWA Activities in Water Years 2000 and 2001

The CALFED ROD proposed an EWA for the first 4 years of Stage 1, requiring further approval to extend it beyond September 30, 2004. The EWA program began as one of the early implementation activities undertaken by the CALFED agencies. DWR began acquiring water supplies for use in EWA actions in 2000. In 2000, the EWA was implemented as a State-only project.

The first 2 years of the EWA interim operations were completed in 2001 and 2002 under a series of agreements executed by the Project Agencies to provide the required water for the EWA. Each of these agreements was consistent with applicable State and Federal laws, policies, and procedures. All of these actions facilitated by these agreements or taken by the Project Agencies for the EWA had independent utility. A National Environmental Policy Act (NEPA) and/or California Environmental Quality Act (CEQA) document was prepared for each water acquisition by the acquiring agency unless the action was categorically excluded from NEPA or categorically exempt from CEQA. Documentation of the agreements and EWA activities in the first 2 years can be found on the CALFED website at:
http://wwwoco.water.ca.gov/calfedops/2001ops.html and
http://wwwoco.water.ca.gov/calfedops/2002ops.html.

1.5 Federal and State Legal Requirements

The EWA program must fulfill or comply with the Federal, State, regional, and local environmental requirements described below.

1.5.1 Federal Requirements

1.5.1.1 National Environmental Policy Act

NEPA (42 USC 4321; 40 CFR 1500.1) applies to all Federal agencies and to most of the activities they manage, regulate, or fund that affect the environment. It requires all agencies to disclose and consider the environmental implications of their proposed actions. NEPA establishes environmental policies, provides an interdisciplinary framework for preventing environmental damage, and contains "action-forcing" procedures to ensure that Federal agency decision-makers take environmental factors into account.

NEPA requires the preparation of an appropriate document to ensure that Federal agencies accomplish the law's purposes. The President's Council on Environmental Quality (CEQ) has adopted regulations and other guidance, including detailed procedures that Federal agencies must follow to implement NEPA. CEQ regulations Section 1506.6 includes provisions for public involvement. Agency pursuit of public involvement may include:

- Providing public notice of NEPA-related hearings, public meetings, and the availability of environmental documents;
- Holding or sponsoring public hearings or public meetings;
- Soliciting appropriate information from the public;
- Explaining in its procedures where interested persons can get information or status reports on EIS' and other elements of the NEPA process; and
- Making EIS', the comments received, and any underlying documents available to the public pursuant to the provisions of the Freedom of Information Act (5 U.S.C. 552).

Reclamation and associated Cooperating Agencies will use this EIS/EIR to comply with CEQ regulations and document NEPA compliance.

1.5.1.2 Federal Endangered Species Act

The ESA requires that both USFWS and NOAA Fisheries maintain lists of threatened species and endangered species. "Endangered species" are defined as "any species which is in danger of extinction throughout all or a significant portion of its range"; "threatened species" are defined as "any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C.A. §1532). Section 9 of the ESA makes it illegal to "take" (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect or attempt to engage in such conduct) any endangered species of fish or wildlife and most threatened species of fish or wildlife (16 U.S.C.A. §1538). Section 7 of the ESA requires that Federal agencies consult with the USFWS on any actions that may destroy or adversely modify critical habitat. Critical habitat is defined as the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species at the time it is listed in accordance with the provisions of section 4 of the Act, upon a determination by the Secretary that such areas are essential for the conservation of the species (16 U.S.C.A. §1532). NOAA Fisheries's jurisdiction under the ESA is limited to the protection of marine mammals and fishes and anadromous fishes; all other species are within the USFWS' jurisdiction.

Section 7 of the ESA requires that all Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of habitat critical to such species' survival. To ensure against jeopardy, each Federal agency must consult with the USFWS or NOAA Fisheries, or both, regarding Federal agency actions. The consultation is initiated when the Federal agency determines that its action may affect a listed species and submits a written request for initiation to the USFWS or NOAA Fisheries, along with the agency's biological assessment of its proposed action. If the USFWS or NOAA Fisheries concurs with the action agency that the action is not likely to adversely affect a listed species, the action may be carried forward without further review under the ESA. Otherwise, the USFWS or NOAA Fisheries, or both, must prepare a written biological opinion describing how the agency action will affect the listed species and its critical habitat.

The MSCS served as the program-level biological assessment of the CALFED Bay-Delta Program's Preferred Program Alternative in the PEIS/EIR for purposes of initiating consultations with the USFWS and NOAA Fisheries under Section 7 of ESA. Based on the MSCS, the PEIS/EIR and other CALFED program-level documents, the USFWS prepared the "Programmatic Biological Opinion on the CALFED Bay-Delta Program (the USFWS PBO)[3]," dated August 28, 2000 and NOAA Fisheries prepared the "CALFED Bay-Delta Program Programmatic Biological Opinion (the NOAA Fisheries PBO)[4]," dated August 28, 2000. In the USFWS PBO and NOAA Fisheries PBO, each agency concluded that the Preferred Program Alternative will not jeopardize the continued existence of any listed species and will not adversely modify the critical habitat of any listed species. In other words, the USFWS and NOAA Fisheries concluded that at the program-level, the Preferred Program Alternative complies with Section 7 of the ESA.

The USFWS PBO and the NOAA Fisheries PBO do not authorize incidental take of any species, nor do they authorize any specific CALFED Program action. However, once specific CALFED actions have been proposed, Section 7 consultations may be initiated for the actions under the simplified regulatory compliance process established in the MSCS through the use of ASIPs.

The ASIPs will serve as the biological assessment of the EWA for purposes of compliance with Section 7 of the ESA and will discuss any endangered or threatened species that may be affected by the project.

1.5.1.3 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) establishes a management system for national marine and estuarine fishery resources. This legislation requires that all Federal agencies consult with NOAA Fisheries regarding all actions or Proposed Actions permitted, funded, or undertaken that may adversely affect "essential fish habitat." Essential fish habitat is defined as "waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." The legislation states that migratory routes to and from anadromous fish spawning grounds are considered essential fish habitat. The phrase "adversely affect" refers to the creation of any impact that reduces the quality or quantity of essential fish habitat. Federal activities that occur outside of an essential

[3] Attachment 6a to the Record of Decision.
[4] Attachment 6b to the Record of Decision.

fish habitat but that may, nonetheless, have an impact on essential fish habitat waters and substrate must also be considered in the consultation process. Under the Magnuson-Stevens Act, effects on habitat managed under the Pacific Salmon Fishery Management Plan must also be considered.

The Magnuson-Stevens Act states that consultation regarding essential fish habitat should be consolidated, where appropriate, with the interagency consultation, coordination, and environmental review procedures required by other Federal statutes, such as NEPA, the Fish and Wildlife Coordination Act (FWCA), the CWA, and the ESA. Essential fish habitat consultation requirements can be satisfied through concurrent environmental compliance if the lead agency provides NOAA Fisheries with timely notification of actions that may adversely affect essential fish habitat and if the notification meets requirements for essential fish habitat assessments. Reclamation and associated Cooperating Agencies will use the EIS/EIR and ASIP to comply with Magnuson-Stevens Act regulations.

1.5.1.4 Fish and Wildlife Coordination Act

The FWCA (16 USC 661 et seq.) requires Federal agencies to consult with USFWS, or, in some instances, with NOAA Fisheries and with State fish and wildlife resource agencies before undertaking or approving water projects that control or modify surface water. The purpose of this consultation is to ensure that wildlife concerns receive equal consideration water resource development projects and are coordinated with the features of these projects. The consultation is intended to promote the conservation of fish and wildlife resources by preventing their loss or damage and to provide for the development and improvement of fish and wildlife resources in connection with water projects. Federal agencies undertaking water projects are required to fully consider recommendations made by USFWS, NOAA Fisheries, and State fish and wildlife resource agencies in project reports and to include measures to reduce impacts on fish and wildlife in project plans.

The EWA agencies formed a team that met weekly or bi-weekly during the preparation of this EIS/EIR. Through USFWS, NOAA Fisheries, and CDFG participation, wildlife conservation needs were fully considered during every phase of development of the program description. When the draft EIS/EIR is issued, USFWS will provide a report for Coordination Act compliance (Appendix B) in accordance with the FWCA.

1.5.1.5 Farmland Protection Policy Act and Memoranda on Farmland Preservation

Federal agencies are required to assess the potential effects of proposed Federal actions on prime and unique farmland under the Farmland Protection Policy Act (FPPA) of 1981 and the Memoranda on Farmland Preservation, dated August 30, 1976, and August 11, 1980, respectively. Federal agencies must examine potential effects before taking any action that could result in converting designated prime or unique farmland for nonagricultural purposes. If there are potentially adverse effects on farmland preservation, the Federal agencies may consider alternative actions to lessen those effects. To the extent practicable, Federal agencies may create programs that are compatible with State, local, and private programs to protect farmland. The Natural Resource Conservation Service is responsible for identifying prime or unique farmland that might be affected.

Implementation of the EWA would not result in the permanent conversion of any farmland; therefore, the EWA is not subject to the FPPA or the Memoranda on Farmland Preservation.

1.5.1.6 National Historic Preservation Act

The National Historic Preservation Act (NHPA) of 1966, as amended, is the principal legislation that guides cultural resource management for Federal agencies. Section 106 of NHPA requires that Federal agencies take into account the effects of an undertaking on historic properties listed or eligible for listing on the National Register of Historic Places (NRHP).

The Section 106 review process is described in 36CFR800. The five steps in this process include: 1) initiation of the Section 106 process by identifying interested parties and an area of potential effect; 2) identification and evaluation of historic properties; 3) assessments of the effects of the undertaking on historic properties; 4) preparation of an agreement document to address adverse effects on historic properties; and 5) receipt from the Advisory Council on Historic Preservation (ACHP) of comments on the agreement or results of consultation. The Section 106 process requires consultation throughout each phase with the State Historic Preservation Officer, Indian tribes, and interested parties.

1.5.1.7 Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 regulates alteration of (and prohibits unauthorized obstruction of) any navigable waters of the United States. If renewed, Section 10 of the Rivers and Harbors Act[5] limits SWP Delta operations, which influences the ability of the Project Agencies to move EWA assets from the Delta to the Export Service Area. Section 10 limits SWP diversion of water into Clifton Court Forebay to a 3-day average rate of 13,250 acre-feet per day, or an average 24-hour diversion rate of 6,680 cubic feet per second (cfs). From December 15 to March 15, when San Joaquin River flows at Vernalis are above 1,000 cfs, the permit allows a greater diversion, equal to the 3-day average of 13,250 acre-feet per day plus an additional amount equal to one-third of the total flow at Vernalis.

The U.S. Army Corps of Engineers increased the allowable 24-hour diversion rate to 7,125 cfs for the months of July, August, and September, through 2002. If renewed, this additional 500 cfs capacity provides capacity that will be available to the Project Agencies for pumping EWA assets for storage in San Luis Reservoir or for use by the

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5 U.S. Army Corps of Engineers Public Notice 5820-A permit.

Projects (CALFED 2000b). The EWA alternatives (Chapter 2) include this increased pumping capacity.

1.5.1.8 Clean Air Act

The Federal Clean Air Act (CAA) established national ambient air quality standards (NAAQS) in 1970 for six pollutants: carbon monoxide, ozone, particulate matter, nitrogen dioxide, sulfur dioxide, and lead. Areas that do not meet the ambient air quality standards are called nonattainment areas. The CAA requires states to submit a State Implementation Plan (SIP) for nonattainment areas. The U.S. Environmental Protection Agency (USEPA) reviews the SIP and must delineate how the Federal standards will be met. States that fail to submit a plan or to secure approval may be denied Federal funding and/or required to increase emission offsets for industrial expansion. The 1990 Amendments to the CAA established categories of air pollution severity for nonattainment areas, ranging from “marginal” to “extreme.” SIP requirements vary, depending on the degree of severity.

The conformity provisions of the CAA are designed to ensure that Federal agencies contribute to efforts to achieve the NAAQS. USEPA has issued two regulations implementing these provisions. The general conformity regulation addresses actions of Federal agencies other than the Federal Highway Administration and the Federal Transit Administration. General conformity applies to a wide range of actions or approvals by Federal agencies. Projects are subject to general conformity if they exceed emissions thresholds set in the rule and are not specifically exempted by the regulation. Such projects are required to fully offset or mitigate the emissions caused by the action, including both direct emissions and indirect emissions over which the Federal agency has some control. The development and evaluation of the proposed action and alternatives (Chapter 2) considered CAA and SIPs.

1.5.1.9 Executive Order 12898 – Environmental Justice

Executive Order 12898, “Federal Actions to Address Environmental Justice in Minority and Low-Income Populations,” requires that Federal agencies identify and address any disproportionately high and adverse human health or environmental effects of Federal actions on minority and low-income populations and assure that Federal actions do not result directly or indirectly in discrimination on the basis of race, color, or national origin. Federal agencies must provide opportunities for input by affected communities into the NEPA process and must evaluate the potentially significant and adverse environmental effects of proposed actions on minority and low-income communities during environmental document preparation. Even if a proposed Federal project would not result in significant adverse impacts on minority and low-income populations, the environmental document must describe how the NEPA process addressed Executive Order 12898.

The alternative scoping process for the EWA program included affected communities. (See Section 1.7 and Chapter 19, Environmental Justice.) The EWA agencies designed the EWA alternative plans (Chapter 2) to minimize potential effects of the EWA on minority and low-income populations. The alternatives' effects on minority and low-income populations are analyzed in Chapter 19, Environmental Justice.

1.5.1.10 Migratory Bird Treaty Act

The Migratory Bird Treaty Act of 1918 (MBTA) is the domestic law that implements four international treaties and conventions between the U.S. and Canada, Japan, Mexico, and Russia, providing protection of migratory birds. Each of the conventions protects selected species of migratory birds that are common to both the U.S. and one or more of the other involved countries. This act makes it unlawful for any person to hunt, kill, capture, collect, possess, buy, sell, purchase, import, export, or barter any migratory bird, including the feathers, parts, nests, eggs, or migratory bird products. The MBTA does not protect the habitat of migratory birds. No EWA actions would directly or indirectly result in collection or sale of migratory birds, bird parts, or bird products; therefore, the EWA would not violate the MBTA.

1.5.1.11 Farm Security and Rural Investment Act of 2002

The Farm Security and Rural Investment Act of 2002, also known as the 2002 Farm Bill, became law in April 2002. Title II of the act includes conservation provisions designed to provide landowners with incentives and technical assistance for incorporating sound conservation practices into farming, grazing, and livestock operations. The Conservation Reserve Program is an element of this act that subsidizes farmers for idling crops. All California farmland participating in this program is included in the DWR land use surveys that were used to develop the Baseline Condition for the EWA EIS/EIR. EWA water acquisitions resulting in crop idling within the alternatives would result in an increase of total idled lands in excess of the Baseline Condition.

1.5.2 State Requirements

1.5.2.1 California Environmental Quality Act

CEQA (Public Resource Code 21000 et seq.) is regarded as the foundation of environmental law and policy in California. CEQA's primary objectives are to:

- Disclose to decision-makers and the public the significant environmental effects of proposed activities;
- Identify ways to avoid or reduce environmental damage;
- Prevent environmental damage by requiring implementation of feasible alternatives or mitigation measures;
- Disclose to the public the reasons for agency approval of projects with significant environmental effects;
- Foster interagency coordination in the review of projects; and

- Enhance public participation in the planning process.

CEQA applies to all discretionary activities that are proposed or approved by California public agencies, including State, regional, county, and local agencies, unless an exemption applies. CEQA requires that public agencies comply with both procedural and substantive requirements. Procedural requirements include the preparation of the appropriate environmental documents, mitigation measures, alternatives, mitigation monitoring, findings, statements of overriding considerations, public notices, scoping, responses to comments, legal enforcement procedures, citizen access to the courts, notice of preparation, agency consultation, and State Clearinghouse review.

CEQA's substantive provisions require that agencies address environmental impacts, disclosed in an appropriate document. When avoiding or minimizing environmental damage is not feasible, CEQA requires that agencies prepare a written statement of the overriding considerations that resulted in approval of a project that will cause one or more significant effects on the environment. CEQA establishes a series of action-forcing procedures to ensure that agencies accomplish the purposes of the law. In addition, under the direction of CEQA, the California Resources Agency has adopted regulations, known as the State CEQA Guidelines, which provide detailed procedures that agencies must follow to implement the law.

This EIS/EIR document is intended to document EWA compliance with all relevant CEQA guidelines and CEQA requirements.

1.5.2.2 California Endangered Species Act

The CESA (Fish and Game Code Sections 2050 to 2097) is similar to the ESA. California's Fish and Game Commission is responsible for maintaining lists of threatened and endangered species under the CESA. CESA prohibits the "take" of listed and candidate (petitioned to be listed) species. "Take" under California law means to "hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch capture, or kill." (See California Fish and Game Code, Section 86.) Because CDFG may authorize incidental take of listed species pursuant to a CDFG approved NCCP, the EWA agencies will not require a separate incidental take permit pursuant to CESA for covered species if EWA actions adhere to MSCS goals and CDFG's NCCP Approval. (See section 1.5.2.3 below for a description of the NCCPA.)

1.5.2.3 Natural Community Conservation Planning Act

The NCCPA, California Fish and Game Code, Section 2800, et seq., was enacted to form a basis for broad-based planning to provide for effective protection and conservation of the State's wildlife heritage, while continuing to allow appropriate development and growth. The purpose of natural community conservation planning is to sustain and restore those species and their habitat identified by CDFG that are necessary to maintain the continued viability of biological communities impacted by human changes to the landscape. A NCCP identifies and provides for those measures necessary to conserve and manage natural biological diversity within the plan area while allowing compatible use of the land. CDFG may authorize the take of any identified species, including listed and non-listed species, pursuant to Section 2835 of the NCCPA, if the conservation and management of such species is provided for in an NCCP approved by CDFG.

The MSCS was approved by CDFG as a program-level NCCP. The MSCS' project-level compliance process centers on a multi-purpose project-level environmental document called an "ASIP," which is intended to provide one format for all information necessary to initiate project-level compliance with the ESA and the NCCPA. The EWA will comply with the NCCPA through the ASIP, which contains all the necessary components of a project-level NCCP for the EWA study area.

On February 2, 2002, Governor Davis signed SB 107, which completely repealed and replaced the NCCPA with a new NCCPA. SB 107 became effective on January 1, 2003. However, in accordance with Section 2830 (c) of SB 107, the MSCS will remain in place as an approved NCCP, and CDFG may authorize take of covered species pursuant to the MSCS and CDFG's NCCP Approval.

1.5.2.4 Porter-Cologne Water Quality Control Act of 1970

In 1967, the Porter-Cologne Act established the California State Water Resources Control Board (SWRCB) and nine regional water quality control boards (RWQCBs) as the primary State agencies with regulatory authority over California water quality and appropriative surface water rights allocations. The SWRCB administers the Porter-Cologne Act, which provides the authority to establish Water Quality Control Plans (WQCPs) that are reviewed and revised periodically; the Porter-Cologne Act also provides the SWRCB with authority to establish statewide plans.

The nine RWQCBs carry out SWRCB policies and procedures throughout the State. The SWRCB and the RWQCBs also carry out sections of the Federal CWA - administered by USEPA, including the National Pollutant Discharge Elimination System permitting process for point source discharges and the CWA Section 303 water quality standards program.

WQCPs, also known as basin plans, designate beneficial uses for specific surface water and groundwater resources and establish water quality objectives to protect those uses. These plans can be developed at the SWRCB or the RWQCB level. RWQCBs issue waste discharge requirements for the major point-source waste dischargers, such as municipal wastewater treatment plants and industrial facilities. In acting on water rights applications, the SWRCB may establish terms and conditions in a permit to carry out WQCPs.

The EWA program has the potential to affect water quality in surface water or groundwater in the Central Valley region and the San Francisco Bay region, which are governed by the Central Valley RWQCB and the San Francisco Bay RWQCB, respectively. Three WQCPs (including respective amendments) developed by the

RWQCBs apply in these two regions: *WQCP for the Sacramento and San Joaquin River Basins (1998 – 4th edition); San Francisco Bay Basin WQCP (1995)*; and the *WQCP for the Tulare Lake Basin (1995 – 2nd edition)*. The basin plans are subject to a triennial review and may be amended under a structured process involving full public participation and State environmental review.

Each EWA alternative considered in this EIS/EIR complies with the water quality objectives set forth in these three basin plans. Chapter 5 of this document describes EWA water quality compliance specific to these basin plans.

1.5.2.5 Requirements of the 1995 Bay/Delta Plan Water Quality Control Plan (1995 Delta WQCP) and Decision 1641

The SWRCB adopted its WQCP for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary in May 1995 and incorporated several elements of USEPA, NOAA Fisheries, and USFWS regulatory objectives for water salinity and endangered species protection. The WQCP identifies the beneficial uses of the Bay-Delta that are to be protected and includes water quality objectives that are intended to protect the beneficial uses. The plan also includes an implementation program for achieving the water quality objectives. Under the CWA, the water quality standards comprise the uses and the quality objectives established to protect them.

Features of the current WQCP affect the EWA by requiring certain Delta outflows and by regulating actions that may be used to protect fish and benefit the environment (Section 2.4.1). Features of the WQCP that were taken into consideration during the formulation of the EWA are:

- Water-year classifications that affect outflow requirements and, consequently, export limitations.
- The Delta outflow requirements that are requirements for flow from the Delta to the San Francisco Bay. (See “Augmenting Delta Outflows” in Section 2.4.1.4.)
- Limitations on combined SWP and CVP Delta exports. Sufficient Delta outflow is provided based upon available water. Exports (that divert water from its natural course to San Francisco Bay) are limited to a percentage of the Delta inflow (that does not include rainfall). These percentages range from 35 to 45 percent from February through June, depending on the Delta inflow, and 65 percent during the remainder of the year.

The SWRCB has fully implemented the 1995 Delta WQCP objectives with new water right decisions. Decision 1641 is the water rights decision implementing the water quality standards on the San Joaquin and Mokelumne Rivers and Cache and Putah Creeks. (See discussion below.) The SWRCB issued Decision 1641 (D-1641) on December 29, 1999, revised March 15, 2000 (SWRCB 1999). D-1641 also approved a petition to change points of diversion of the CVP and SWP in the southern Delta[6], and approved a petition to change places and purposes of use of the CVP.

The final phase of implementation focused on how water right holders in the Sacramento Valley should contribute to meeting the 1995 Delta WQCP objectives. A negotiated settlement resolved this issue by creating the Sacramento Valley Water Management Agreement (SVWMA), which is described in more detail in Chapter 23, Cumulative Effects.

1.5.2.6 Environmental Justice

State law defines environmental justice in Government Code Section 65040.12(e) as the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies. Government Code Section 65040.12(a) designates the Governor's Office of Planning and Research (OPR) as the coordinating agency in State government for environmental justice programs, and requires OPR to develop guidelines for incorporating environmental justice into general plans.

1.5.3 State and Federal Laws and Regulations Governing Water Transfers and Water Acquisitions

Both State and Federal laws contain provisions that authorize, acknowledge, or support water transfers. This section includes a description of pertinent laws that helped shape the EWA alternatives. This section describes the water rights and regulations that govern water transfers and are applicable to the EWA. Sections 1.5.3.3 and 1.5.3.4 discuss the duration and sources of potential water transfers.

1.5.3.1 Water Rights

1.5.3.1.1 Riparian Rights

Property owners with land abutting a stream, lake, or defined underground channel have a right to the use of water adjacent to or flowing by that land. These rights are known as riparian rights. Riparian rights extend only to the natural flow of the stream and allow riparian landowners to take as much water as they can reasonably and beneficially use on riparian land in the watershed of the stream. During times of water shortage, riparian right holders are obligated to share the natural flow of the stream equally with other riparian rights holders. These rights holders are also prohibited from storing water from times of water surplus for use in times of water shortage.

There is no permit requirement for riparian rights; however, riparian rights holders (with some exceptions) must file statements of water diversion and use (California Water Code [Water Code] 5100) with the State documenting their water use. This

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6 D-1641 conditionally authorized the SWP and CVP to change their diversion points by allowing each Project to use the others' facilities, known as the Joint Point of Diversion. (See Section 2.3.2.1.)

allows the State to inform the riparian rights holders when applications for upstream water use are received.

Because riparian rights are attached to land, water that may be diverted under a riparian right cannot be transferred to others. Others can, however, appropriate water not taken under riparian rights.

The alternatives described in Chapter 2 were developed to comply with all laws regarding riparian rights.

1.5.3.1.2 Appropriative Rights to Surface Water

Appropriative water rights are based on beneficial use. Appropriative rights allow use of the flow of a stream on land that does not directly abut the waterway. Appropriative rights may be used both for storage and directly applied, beneficial use. Unlike riparian right holders, who share in the natural flow of the system, priority among appropriative right holders is based upon the "first in time, first in right" doctrine. During periods of reduced flows on a waterway, senior water rights have priority, and junior right holders must reduce or cease water use if necessary.

Appropriative rights are divided into two categories: Pre-1914 and Post-1914 (or Modern) appropriative rights. Pre-1914 appropriative rights are not under any statewide permitting authority, and right holders need not give notice or request permission to change the purpose of use, place of use, or points of diversion. If such change could be construed as initiation of a new right; however, a new appropriative right would be required for the diversion and use of the water. Such changes must also not injure any users of water. (See upcoming discussion on Water Code Section 1706.) In contrast, Modern appropriative rights are subject to an administrative process that issues water right permits and licenses. Water users obtain Modern appropriative rights by applying to the SWRCB. Any changes to Modern appropriative rights must first go through a public notification and petition and approval process.

The alternatives described in Chapter 2 were developed to comply with all laws regarding appropriative rights.

1.5.3.1.3 Other Rights and Protections

Many water users such as the SWP and CVP contractors have a right to use water through contract with the holder of a water right.

Several other types of water rights exist, including Federal reserved rights and Pueblo rights. These rights typically attach to the land from which they are derived and are not a major factor in water transfers in California.

Water Code sections 1010, 1011, 1011.5, 1244, 1440, 1731, 1737, and 1745.07 provide protection to water rights holders who transfer water. Water rights can be lost through non-use for a stated period of time, subject to notice and opportunity for hearing requirements; however, if the non-use of water is due to water conservation, use of recycled water, or participation in a conjunctive groundwater use program, the rights can be protected under Water Code sections 1010 and 1011.

The alternatives presented in Chapter 2 were developed to comply with these rights and protections.

1.5.3.2 Related Concepts in the Water Code

Both State and Federal law contain provisions that authorize, acknowledge, or support water transfers. The Water Code protects legal users of water and fish and wildlife during water transfers through the "no injury rule," analyses of impacts to fish and wildlife, evaluation of third-party impacts, and the 1707 process. The sections below discuss these protections.

1.5.3.2.1 No Injury Rule

A change in a water right may not cause injury to any legal user of the water involved. This condition applies to Modern water rights through Section 1702 of the Water Code and applies to pre-1914 water rights through Section 1706 of the Water Code. The SWRCB supervises changes to post-1914 water rights, and the courts have jurisdiction over potential violations of Section 1706. Actions included in the alternatives presented in Chapter 2 comply with the No-Injury Rule.

1.5.3.2.2 Effects on Fish and Wildlife

Water Code Sections 1435, 1725, and 1736 require that the SWRCB make a finding that certain proposed transfers not result in unreasonable effects on fish and wildlife or other instream beneficial uses. These Code Sections apply to specific types of water transfers (urgent, temporary, and long-term transfers) related to post-1914 water rights. Pre-1914 water rights are not subject to the permit system, although a change in use for instream flow may be permitted under Section 1707 on petition to the SWRCB. The alternatives presented in Chapter 2 were developed in compliance with these codes.

1.5.3.2.3 Third-Party Impacts

"Third parties" in the context of the EWA are any persons and resources other than the entities transferring or receiving water. Although the Water Code does not define "third party impacts," they traditionally include impacts related to downstream water rights; adjacent groundwater users; fish and wildlife; and recreation, economic, and social impacts. Most third-party impacts are evaluated under Water Code Sections that protect prior rights and fish and wildlife as discussed above. However, Water Code Sections 386 and 1810 require evaluation of other third-party impacts for some specific transfers and prohibit such transfers from affecting the overall economy of the area or county from which the water is being transferred. Water Code Section 1810 states that transferors can utilize public water conveyance facilities as long as "this use of a water conveyance facility is to be made without injuring any legal user of water and without unreasonably affecting fish, wildlife, or other instream beneficial uses and without unreasonably affecting the overall economy or the environment of the county from which the water is being transferred."

Chapter 11, Regional and Agricultural Economics, discusses economic third party impacts of the Proposed Action and the alternative plans.

1.5.3.2.4 Section 1707

Section 1707 of the Water Code allows water rights holders, including riparian rights holders, to dedicate their rights to instream uses "for the purpose of preserving or enhancing wetlands, fish and wildlife resources, or recreation in, or on, the water." These transfers, from a consumptive use to a non-consumptive use with an identified need, may be temporary or permanent. The transfer must meet the following requirements for the SWRCB to consider approving the change in use:

- Will not increase the amount of water the person is entitled to use;
- Will not unreasonably affect any legal user of water; and
- Otherwise meets the requirements of Division 2 of the Water Code.

The petitioner can request that the water subject to transfer approval be in addition to water required for "Federal, State, or local regulatory requirements governing water quantity, water quality, instream flows, fish and wildlife, wetlands, recreation and other instream beneficial uses." If the petitioner does not submit this request to the SWRCB, then the water shall be used to meet any of the above requirements.

1.5.3.3 Duration of Transfer

Transfers may occur with short- or long-term durations.

1.5.3.3.1 Short Term

Short-term transfers are those that take place over a period of 1 year or less. Water Code Section 1725 allows expedited processing of short-term transfers of post-1914 appropriative rights. Short-term transfers under Section 1725 are limited to water that would have been used consumptively or stored absent the water transfer. Short-term transfers qualify for this expedited process because the effects are limited to 1 year, minimizing the risk of potential impacts. Transfers qualified under Section 1725 are exempt from CEQA; the Water Code relies on notice to the affected parties and findings made by the SWRCB rather than the development of environmental documents under CEQA. EWA acquisitions may include some short-term transfers that are exempt from CEQA.

Short-term transfers must not injure any legal user or unreasonably affect fish, wildlife, or instream uses. Petitioners for transfers must provide the SWRCB notification in writing of the proposed change, providing information outlining the buyer's consumptive use and other requested permit or license information, including documentation that no unreasonable effects to fish and wildlife would occur. The petition is publicly noticed, and parties can file objections to the transfer. The SWRCB must evaluate and respond to the notification within 55 days if objections are filed.

Short-term EWA transfers proposed in Chapter 2 would comply with Water Code Section 1725.

1.5.3.3.2 Long Term

Long-term transfers are those that take place over a period of more than 1 year. Long-term transfers of water under post-1914 water rights are governed under Section 1735 of the Water Code. Long-term transfers are not limited to stored or consumptively used water. Because of the long-term nature of these transfers and their potential effects, the Water Code does not allow the expedited processing that is provided for short-term transfers. Long-term transfers under Section 1735 are subject to the requirements of CEQA and must also comply with the standard SWRCB public noticing and protest process. If valid protests to the proposed change cannot be resolved through negotiation between the parties, a hearing must be held prior to the SWRCB's decision on the requested transfer.

Long-term transfers for the EWA may have CEQA coverage through this EIS/EIR. Long-term transfers under post-1914 water rights will comply with Water Code Section 1735.

1.5.3.4 Source of Water for Transfer

The EWA would make use of transfers that could originate from surface water or stored water, the SWP, the CVP, groundwater, or conjunctive use.

1.5.3.4.1 Surface Water or Stored Water

Water Code Section 1725 allows a permittee or licensee to temporarily change a point of diversion, place of use, or purpose of use of water. The transfer must involve water that would have been used consumptively or stored in the absence of the transfer. Section 1725 defines consumptively used water as "the amount of water which has been consumed through use by evapotranspiration, has percolated underground, or has been otherwise removed from use in the downstream water supply as a result of direct diversion." Return flows (water that returns to a stream or a useable underground aquifer after being applied to land) are typically used by other users; therefore, they are generally not available for transfer because the transfer of this water could injure these downstream users. The most common ways to reduce consumptive use are to idle land, shift to less water-intensive crops, or substitute diversions to a source other than surface water (like groundwater sources). The two EWA action alternatives described in Chapter 2 include crop idling and groundwater substitution transfers. The amount of stored water dedicated to the transfer is equal to the amount of water that would have been stored in the absence of the transfer, subject to approval by the SWRCB.

Long-term transfers of surface water or stored water held under post-1914 water rights are authorized under Water Code Section 1735, and transfers of pre-1914 surface water or stored water are subject to the "no injury" rule.

1.5.3.4.2 SWP

The SWP long-term water supply contractors may sell unwanted portions of their allocated Table A amounts[7] to other SWP contractors or DWR if certain conditions are met. All annual SWP-to-SWP sales must be conducted through the turn-back water pool, which is available to contractors that have signed the Monterey Amendment to their SWP contract. Contractors can sell to the turnback pool or purchase water from this pool. Pool water that is not purchased by other contractors may be purchased by DWR (or by non-contractors if DWR does not want the water). DWR is operating the SWP according to the Monterey Amendments pending completion of the new EIR for the Monterey Amendments and termination of litigation related to the earlier EIR.

The two EWA action alternatives described in Chapter 2 include the option of purchasing stored groundwater or crop idling water from Kern County Water Agency, which is a SWP contractor. SWP contractors must comply with their SWP contracts when selling water to the EWA. Chapter 2 (Program Description) and Chapter 6 (Groundwater) present additional information on these constraints. Prior to entering into purchase contracts with SWP contractors for EWA purchases, DWR will require that contractors specify the year-acquired and origin of water offered for sale.

1.5.3.4.3 CVP

The Central Valley Project Improvement Act (CVPIA) granted the right to all individuals who receive CVP water (through contracts for water service, repayment contracts, water rights settlements, or exchange contracts) to sell this water to other parties for reasonable and beneficial purposes.

The Secretary of the DOI must approve each transfer and may not approve a transfer if it will impair the CVP's ability to meet its obligations to CVP users or to fish and wildlife. Transfers of more than 20 percent of the amount of water under contract within any controlling district require mandatory public review and the approval of the district. Transfers of CVP water must be authorized within 90 days from the date a complete transfer proposal is received by Reclamation, the reviewing agency. If Reclamation fails to make a decision within the time allotted, the transfer is deemed approved.

Reclamation issues its decision regarding potential CVP transfers in coordination with the USFWS, contingent upon the evaluation of impacts on fish and wildlife. A CVP transfer approval must be accompanied by appropriate documentation under NEPA and must be in compliance with other applicable State and Federal laws.

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7 Table A is a component of all SWP Water Supply contracts between DWR and the SWP contractors. It specifies the amount of water that the State will make available for delivery. Under certain conditions, the State may deliver a lesser amount.

The SWRCB generally considers transfers of water under CVP water service or repayment contracts, water rights settlement contracts, or exchange contracts within the CVP place of use to be internal actions and not subject to SWRCB review. Where a water right limits the place of use to a specific watershed; however, it is anticipated that transfers of water outside the watershed would require SWRCB approval. Transfers of CVP water outside of the CVP service area require SWRCB review and approval. Transfers to non-CVP parties are allowed, although Reclamation levies an additional fee on these transfers. Transfers to CVP users for lands outside the CVP service area are limited to the average quantity of contract water delivered to the contracting district or agency during the last 3 years of normal water deliveries prior to the date of enactment of the CVPIA.

The EWA agencies considered these CVP transfer requirements during development of the EWA.

1.5.3.4.4 Groundwater

Groundwater users may drill a well and pump groundwater without a State water rights permit; however, local ordinances govern use of groundwater in some locations. Some groundwater basins, mostly in southern California, have been adjudicated, and many groundwater basins have local groundwater management plans adopted under Water Code 10750 (also known as AB 3030 for the Assembly Bill that enacted these statutes) or local ordinances that govern groundwater transfers.

The three types of transfers that involve groundwater are groundwater substitution, stored groundwater, and direct transfer. The direct transfer of groundwater out of an unmanaged groundwater basin,[8] in which groundwater is pumped directly to a user that does not overlie the groundwater basin, will not be an option under the EWA and is not discussed further.

Groundwater substitution transfers occur when users pump groundwater to meet their needs and transfer their surface water rights to a downstream user. Groundwater management plans, local ordinances, or Section 1745.10 of the Water Code may govern the replacement of surface water with groundwater. Groundwater substitution transfers are included in the EWA alternatives described in Chapter 2.

Stored groundwater is water stored underground for later use. Most commonly, the water suppliers are part of an overall groundwater management plan; however, underground storage can be a localized practice of a small set of water users. The amount of transferable water from a stored groundwater transfer is equal to the amount of banked groundwater that is taken from storage for the purpose of the transfer. Stored groundwater purchases are included in the EWA alternatives described in Chapter 2.

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[8] In this instance an unmanaged groundwater basin is a groundwater basin where water is not previously stored for the purpose of sale.

From a water right perspective, the storage of surface water in a groundwater basin is equivalent to surface water stored in an aboveground reservoir. The original water rights holder stores the water and controls the eventual beneficial use of that water for which the appropriation to storage was made. Water rights of stored water are covered in permits, and the terms of groundwater storage must comply with local groundwater management plans. Purchases of stored groundwater and purchasing groundwater storage space are included in the EWA alternatives described in Chapter 2.

1.6 Other Pertinent Programs, Documents, Laws, and Agreements

1.6.1 CALFED Bay-Delta Program Programmatic EIS/EIR and ROD

This document tiers from the CALFED Bay-Delta PEIS/EIR and the CALFED ROD issued August 28, 2000 (including CEQA certification). “Tiering” of environmental documents means addressing a broad, general program in an initial programmatic environmental document, then analyzing the complete details of related “second-tier” projects in subsequent documents. The environmental documents for individual or “second-tier “ projects may incorporate by reference analyses already completed in the first-tier document to address many large-scale, non-site-specific resources and issues, while focusing the second-tier analysis on new effects not previously considered. Tiering of environmental documents avoids repetitive evaluations when a first-tier analysis is sufficiently detailed.

The CALFED PEIS/EIR provides a very broad, programmatic analysis of the general effects of implementing the CALFED plan over a 30-year period, across two-thirds of the State. Because of the broad nature of the programmatic analysis in the PEIS/EIR, and the fact that the programmatic analysis was not intended to address any environmental effects for site-specific projects, the PEIS/EIR is being incorporated by reference solely for purposes of background information, to explain the context of the screening of the programmatic alternatives, and to demonstrate consistency with the overall CALFED plan. This document contains all necessary analysis of impacts of the EWA Program through 2007, including alternatives, direct and indirect impacts, cumulative impacts, secondary effects, and mitigation measures.

Specific links between this EWA EIS/EIR and the first-tier CALFED PEIS/EIR include:

- CALFED Final PEIS/EIR, main text Chapters 1, 2, and 4;
- CALFED Final PEIS/EIR, Responses to Comments Volume 1, Common Responses 1, 5, and 21;
- CALFED Final PEIS/EIR, Technical Appendices (Phase II Report, Implementation Plan, Water Transfer Program Plan, and Multi-Species Conservation Strategy);

Specific links between the EWA EIS/EIR and the CALFED ROD include:

- CALFED ROD, Chapter 2 (the Decision on pages 11-30 and the Plan for Action on pages 31-76 for background and content);
- CALFED ROD Attachment 2 (Environmental Water Account Operating Principles Agreement) (Appendix C);
- CALFED ROD Attachment 3 (Implementation Memorandum of Understanding);
- CALFED ROD Attachment 5 (Conservation Agreement Regarding Multi-Species Conservation Strategy);
- CALFED ROD Attachment 6A (Programmatic Endangered Species Act Section 7 Biological Opinions of the U.S. Fish and Wildlife Service);
- CALFED ROD Attachment 6B (Programmatic Endangered Species Act Section 7 Biological Opinion of the National Marine Fisheries Service);
- CALFED ROD Attachment 7 (Natural Community Conservation Plan Determination);
- CALFED ROD Attachment 9 (Coastal Zone Management Act Programmatic Consistency Determination).

This EWA EIS/EIR incorporates by reference the information, analyses, conclusions, and agreements contained in the aforementioned first-tier document sections in their entirety. Tiering of this EWA document fully complies with NEPA (CEQ) Regulation 1502.20 and CEQA Guidelines Section 15152, as well as the Guide to Regulatory Compliance for Implementing CALFED Actions (CALFED 2001).

The CALFED PEIS/EIR and ROD are available for review at the CALFED Bay-Delta Program, 650 Capitol Mall, 5th Floor, Sacramento, CA; the CALFED Program website - http://calwater.ca.gov/; and through the California State Library system.

1.6.1.1 EWA Operating Principles Agreement

The EWA Operating Principles Agreement (Attachment 2 of the CALFED ROD) is signed by the five participating agencies and defines the operations for the EWA. The agreement includes asset acquisition and management methods, accounting methods, fishery protection tools, clauses to prevent reductions in Project deliveries, and requirements for Science Panel review. Appendix C contains the text of this agreement. As needed, protocols have been developed to clarify the meaning of the

EWA Operating Principles Agreement and to further describe aspects of how the EWA will be managed[9].

1.6.2 CVPIA

CVPIA[10] is a Federal statute passed in 1992 with the following purposes:

> "To protect, restore, and enhance fish, wildlife, and associated habitats in the Central Valley and Trinity River basins of California; To address impacts of the Central Valley Project on fish, wildlife and associated habitats; To improve the operational flexibility of the Central Valley Project; 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; To contribute to the State of California's interim and long-term efforts to protect the San Francisco Bay/Sacramento-San Joaquin Delta Estuary; 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."

The CVPIA changed the relative priorities of the various project purposes of the CVP by making fish and wildlife protection, as a project purpose, equal to water supply for agricultural and urban uses.

CVPIA Section 3406 (b)(2) (CVPIA[b][2]) authorized and directed the Secretary to dedicate and manage 800,000 acre-feet of CVP yield annually for the primary purpose of implementing the fish, wildlife, and habitat restoration purposes and measures authorized in CVPIA, to assist the State of California in its efforts to protect the waters of the Bay-Delta Estuary, and to help meet obligations legally imposed on the CVP under State or Federal law following the date of enactment of the CVPIA. This dedicated 800,000 acre-feet of water, known as (b)(2) water, was included as a component of the CALFED PEIS/EIR existing regulatory baseline for fishery protection conditions for environmental and fisheries protection measures. (See Section 1.5.1.2.) The CALFED ROD added an EWA program to augment the existing fisheries protection baseline measures by providing additional water for the long-term survival of fish species in the Bay-Delta system.

In 1999, the Department of Interior (DOI) established an accounting methodology for (b)(2) water that, among other things, 1) limited the quantity of (b)(2) water that would be accounted toward Federal obligations of the May 1995 Delta WQCP adopted by the SWRCB to 450,000 acre-feet; 2) allowed (b)(2) water released from

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9 The EWA Team revises these protocols each year to incorporate lessons learned. The protocols from 2001, 2002, and 2003 are available online:
http://wwwoco.water.ca.gov/calfedops/2001ops.html
http://wwwoco.water.ca.gov/calfedops/2002ops.html and
http://wwwoco.water.ca.gov/calfedops/2003ops.html

10 Title 34 of Public Law 102-575, the Reclamation Projects Authorization and Adjustment Act of 1992, signed October 30, 1992.

upstream reservoirs from October through January to be "reset" if hydrology refilled the reservoir by the end of January; and 3) allowed export pump reductions and upstream releases that would be accounted as (b)(2) costs to be "offset."[11]

1.6.2.1 Recent Decisions Affecting CVPIA (b)(2) Water

DOI's October 1999 policy regarding (b)(2) water in use at the time the CALFED ROD was signed was included in the CALFED ROD as part of the fisheries protection baseline assumptions. (See Section 1.5.1.2.)

The implementation of DOI's 1999 decision regarding use of (b)(2) water changed in 2001 and 2002 as a result of legal challenges of DOI's interpretation and implementation of (b)(2) use. In a series of judgments in *San Luis & Delta Mendota Water Authority, et al v. United States*, the Federal District Court for the Eastern District of California ruled that the 450,000 acre-foot cap, "offset," and "reset" were improper interpretations of Subsection 3406(b)(2). The 450,000 acre-foot cap was found to be an arbitrary limitation, and "offset" and "reset" could result in more than 800,000 acre-feet of water being used for fish and wildlife purposes. DOI has revised its decision on implementation of (b)(2), which was released to the public on May 9, 2003, and will be implemented in the 2004 water year. This revised decision is consistent with the Federal District Court's rulings[12]. Changes in implementation of (b)(2) have resulted in a change to Tier 1 as described in the CALFED ROD and may reduce the amount of variable assets available under the EWA Operating Principles.

1.6.3 CVP and SWP COA

The COA for the operations of the CVP and SWP was signed in 1986 (Reclamation and DWR 1986). The COA replaced earlier similar agreements between the United States and the State of California. The COA agreement specified how the SWP and CVP would operate to meet all Project requirements and objectives without adversely affecting the rights of other parties. The COA specifies two basic conditions for operational purposes: balanced conditions and excess conditions. Balanced water conditions occur when releases from upstream reservoirs plus unregulated flow equal the water supply needed to meet Sacramento Valley in-basin uses plus exports. During balanced water conditions, storage releases required to meet the Sacramento in-basin uses are made 75 percent from the CVP and 25 percent from the SWP. If there is unstored water available during balanced conditions, then this water is allocated 55 percent to the CVP and 45 percent to the SWP.

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[11] "Reset" and "offset" are defined in greater detail on Page 56 of the CALFED ROD (CALFED, 2000b).

[12] On June 3, 2003, the Ninth Circuit issued a Memorandum affirming in part and reversing in part the Federal District Court's decisions. The Ninth Circuit affirmed the Federal District Court on the issues of calculation of yield, the prohibition on using offset and reset, and the reuse of water released for (b)(2) purposes. The Ninth Circuit ruled that the District Court erred in concluding that DOI lacks discretion to allocate the 800,000 acre-feet among the three purposes of the statute. DOI believes that the Decision on Implementation of (b)(2) issued May 9, 2003 is consistent with the Ninth Circuit ruling.

Excess water conditions occur when the Delta inflows (combined releases from upstream reservoirs and unregulated flow) are greater than needed to meet the in-basin uses plus export. Under this condition, flow through the Delta is adequate to meet all needs and no coordinated operation between the CVP and SWP is required.

The COA does not cover all circumstances that occur in Delta operations (including water quality requirements from the 1995 Delta WQCP, biological opinions, the EWA, and others). The CVP and SWP are making accommodations for these circumstances now, but the COA will likely be renegotiated. The requirements of the COA agreement were fully considered during the development of EWA alternatives for this EIS/EIR.

1.7 Summary of Scoping Actions and the Issues of Known Controversy

Federal, State, and local agencies, and other parties have participated in the NEPA and CEQA process leading to the development of the EWA alternatives presented in this EIS/EIR. Many agencies[13] have been involved.

During July 2001, public scoping sessions on the EWA Program were held in six cities[14] across California: Sacramento, Chico, Oakland, Tracy, Bakersfield, and Los Angeles. Concerns are documented in the CALFED Environmental Water Account NEPA/CEQA Public Scoping Meeting Summary, 2001. Key issues raised during the public scoping process include:

- Tradeoffs between adverse and beneficial effects that may occur to those not directly involved in the water transfer process. Specific concerns included:
  - *Power*. Power concerns centered on potential effects of water transfers on: 1) the cost of power, 2) on-and off-peak hydropower production, 3) coordinating transfers with hydropower requirements, and 4) the effect of divestiture on the availability of water. The Western Area Power Administration (WAPA) requested to be included in the management of the EWA.
  - *Water Supply and Water Management*. Water supply concerns include: 1) the availability of water during droughts, 2) repayment of water debt during droughts, 3) potential effects of groundwater extraction on users within

[13] Agencies involved in scoping include California Resource Agencies: Department of Water Resources, Department of Fish & Game, The Reclamation Board, Delta Protection Commission, Department of Conservation, San Francisco Bay Conservation and Development Commission, California Environmental Protection Agency, State Water Resources Control Board, Department of Health Services, Department of Food and Agriculture. Department of Interior agencies include Bureau of Reclamation, Fish and Wildlife Service, Geological Survey, Bureau of Land Management, Environmental Protection Agency, Department of Agriculture Natural Resources Conservation Service and U.S. Forest Service, Department of Commerce National Marine Fisheries Service, Western Area Power Administration.

[14] Public Scoping Meetings were held in Sacramento on July 19, 2001; Chico on July 19, 2001; Oakland on July 23, 2001; Tracy on July 24, 2001; Bakersfield on July 25, 2001, and Los Angeles on July 26, 2001.

groundwater basins, 4) incorporation of water conservation into EWA, 5) potential long-term groundwater overdraft south of the Delta, and 6) municipal water supply vs. fishery needs. The South Delta Water Agency had concerns about protecting water supplies for non-Project water users in the south Delta.

- *Agricultural Land Use*. Members of the public expressed concern about California's food supply and decreased agricultural production that could result from water transfers involving crop idling.

- *Fisheries*. The public expressed concerns over protecting fisheries at the expense of agricultural production and/or municipal water supplies. Of additional concern were potential impacts on upstream fisheries due to Delta fishery protection.

- **Delta Issues.** Community members and the South Delta Water Agency expressed concern that water transfers could result in increasing seawater intrusion into fresh water aquifers and diminish the Delta's fresh water supply. Increased pumping could also cause increased Delta salinity from interaction with the Bay, resulting in adverse impacts on Delta fisheries and fishery habitat. Communities were concerned that EWA actions could increase export pumping without increasing the level of protection for water levels and quality in the south Delta. Delta agriculture also depends upon maintaining the fresh water supply and sustaining levels that allow existing irrigation systems to divert water from the levee system.

- **Groundwater.** Community members expressed concern about the interface between surface water and groundwater and the relationship with fish and wildlife. Increased groundwater pumping could draw water in from surface water bodies, which could affect fish and wildlife within those streams.

- **Lack of information to determine actual benefits and impacts of EWA.** Members of the public were concerned that baseline fishery data are not extensive; therefore, the EWA's effects on fisheries cannot be fully measured.

During public meetings and via written comments, public groups also expressed concerns regarding:

- **Project definition** – the EWA does not apply to CVP contractors other than export contractors;

- **Acquisition of assets** – additional asset acquisition strategies should be considered;

- **Management of assets** – the program definition was unclear about procedures that elevate the EWA Tier 3;

- **Integration of the EWA with CVPIA (b)(2) water** – additional explanation is needed of how these two programs would work together and how the Wanger decisions (Section 1.5.1.2) would affect the EWA;
- **Project alternatives** – desalination should be considered as an alternative;
- **Cumulative effects** – EIS/EIR should address cumulative effects of all water acquisition programs; and
- **Cost and funding – the EWA costs should be compared to benefits.**

1.8 Scope of This EIS/EIR

The CALFED ROD and the EWA Operating Principles Agreement describe the term of an EWA program as the first 4 years of Stage 1 of the CALFED Bay-Delta Program, but the program could be extended by written agreement of the participating agencies. Because it is expected that a written agreement will be reached, the impact analysis in this EIS/EIR includes all potential EWA actions that may occur from the time that the EWA ROD is signed (February 2004) through the end of the CALFED Stage 1 period, or until December 31, 2007.

The EWA Operating Principles Agreement (Appendix C) sets general operating principles for an EWA program and describes the tools available for use by an EWA program. The CALFED ROD and Operating Principles provide overall direction regarding EWA operation and establish water-asset acquisition targets, but do not identify specific willing sellers, water asset acquisition locations, consider the quantities of water that would likely be available by the sellers, or contemplate how EWA assets would be most efficiently conveyed and managed to protect and benefit fisheries. Moreover, the CALFED PEIS/EIR did not attempt to analyze any specific project at a detailed, site-specific level of review. Because these details about the EWA program were not known, and because the CALFED PEIS/EIR was not intended to analyze proposed projects at a site-specific level, the CALFED PEIS/EIR did not analyze all the potential site-specific impacts of the proposed EWA program on the natural and human environment, particularly project-specific impacts.

In addition to the No Action/No Project alternative, this EWA EIS/EIR presents two action alternatives for implementing the EWA Program, termed the Fixed Purchase Alternative and Flexible Purchase Alternative. The Fixed Purchase Alternative is based on the initial water acquisition quantities of 185,000 acre-feet specified in the CALFED ROD. The Flexible Purchase Alternative allows the EWA agencies to acquire up to 600,000 acre-feet to respond to differences in hydrology and fish behavior. Both alternatives include details on EWA asset acquisitions; potential willing sellers; water quantities available from willing sellers; conveyance, transfer, and storage; and management actions that protect and benefit fish. This EIS/EIR analyzes the direct, indirect, and cumulative effects of each EWA alternative. Within each alternative, the impacts of each type of EWA action (see Section 2.1) are analyzed separately.

1.8.1 Scope of Effects Analysis

This EIS/EIR cannot present a definitive list of all EWA acquisitions that may occur each year. The quantity of water available each year depends on the water supply conditions and the amount of water that water right holders and contract holders are willing to make available for transfer. Because this document cannot discuss all potential EWA acquisitions, it examines the acquisitions that are more likely to occur in the next several years because the sellers have indicated that they may be interested in transferring water. The program description in Chapter 2 describes likely maximum quantities of water that would be made available from these specific water agencies. The resource area analyses (Chapters 4-21) present the environmental effects of these transfers to the level of detail possible with the current information, recognizing that the EWA does not know the exact locations of some transfers (e.g., the farm fields for groundwater substitution or crop idling transfers). Within each alternative, the effects of each type of water acquisition are analyzed separately.

1.8.2 Scope of Study Area

The EIS/EIR study area includes those areas of California that could be potentially affected by the EWA because they serve as a site for EWA water asset acquisition, EWA asset conveyance, or storage. (See Figure 1-1.) The study area roughly coincides with the CALFED PEIS/EIR study area. (See Figure 3-5.) However, the EWA program study area is divided into three subareas, based on the subarea's relation to the Delta. Conveyance through the Delta is a significant constraint to EWA operation, influencing both the acquisition of assets and the effects evaluation. The effects analysis of each alternative was conducted under this regional framework because of the similarity of effects within each of the three subareas. The three subareas are defined as the land and tributaries Upstream from the Delta, the Delta, and the CVP/SWP Export Service Area. The CVP/SWP Export Service Area is defined as those lands that receive SWP and CVP water via the south Delta pumping plants, as well as reservoirs south of the Delta that are used for EWA asset management. Within the resource areas, these three subareas are further subdivided into river reaches, counties, or groundwater basins.

The actions evaluated in this EIS/EIR include two project alternatives, the Fixed Purchase Alternative and the Flexible Purchase Alternative, as well as the alternative of not implementing EWA, the No Project /No Action Alternative. Direct and indirect effects and cumulative impacts are evaluated, as appropriate, for each resource area.

1.9 Decision to be Made

Reclamation, DWR, USFWS, NOAA Fisheries, and CDFG decision-makers will use this EIS/EIR to decide on the best method for implementing the EWA based on a full understanding of the environmental consequences of each EWA alternative. Possible decision outcomes are:

- Take no action;
- Approve the EWA Fixed Purchase Alternative, which fixes purchases to the amounts described in the EWA Operating Principles Agreement without the use of functional equivalents of some actions; or
- Approve the EWA Flexible Purchase Alternative, which allows the EWA agencies to purchase the functional equivalent of the purchases described in the EWA Operating Principles Agreement and has a higher upper limit of EWA purchases (600,000 acre-feet) than the amount identified in the CALFED ROD.

1.10 Uses of the Document

In addition to the decision highlighted above, Reclamation, DWR, USFWS, NOAA Fisheries, and CDFG will use this document, in conjunction with the ASIP, as the environmental analysis for a decision on whether to continue the selected EWA alternative through 2007. The ASIP is an integral component of the EIS/EIR that provides additional information to meet the requirements of the Federal ESA, State ESA and NCCPA as described in the MSCS, and it analyzes the effects of program actions on covered species.

The Project Agencies and the Management Agencies are also expected to use this document as the environmental analysis for individual actions to implement the selected EWA alternative, including:

- Contracts for water acquisition, source shifting, or access to storage capacity (also local agencies);
- Issuance of Biological Opinions on the selected alternative;
- Issuance of NCCPA Determination on the selected alternative;
- Real-time decisions to increase upstream flows, Delta outflows, reductions/increases in pumping, consistent with existing operations rules;
- Approvals of water transfers and/or change petitions; and
- Approval of county groundwater permits for purposes of transfers (counties, where applicable).

When approving a specific water acquisition, the acquiring agency will consider whether it was analyzed on a site-specific basis in this document. If so, the agency may make a finding to that effect and rely on this document, unless there have been significant changes that would trigger the need for a supplemental document. In either case, the agency would be able to tier from the analyses provided in this EIS/EIR. If the action was not analyzed on a site-specific basis, the agency would determine whether the action is categorically exempt from CEQA categorically excluded from NEPA, or whether additional CEQA/NEPA documents are required.

It is anticipated that local agencies that must approve their own participation in an EWA transaction will use this document in the same manner. Responsible agencies and cooperating agencies, such as the SWRCB, are also expected to use this document in a similar manner for approvals they must issue for projects to implement the EWA.

1.11 Report Organization

The remaining chapters of this document are organized as follows:

- **Chapter 2 – Alternatives, Including the Proposed Action** – Chapter 2 describes two alternatives of the EWA program, plus the No Action/No Project Alternative, and explains how the EWA agencies would acquire, manage, and use assets to complete fish actions to meet the EWA's objectives.

- **Chapter 3 – Introduction to the Environmental Setting, Impacts, and Mitigation Measures** – This chapter describes the approach for describing the environmental setting and assessing environmental consequences and mitigation measures.

- **Chapter 4 – Water Supply and Water Management** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on water supply and water management.

- **Chapter 5 – Water Quality** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on water quality.

- **Chapter 6 – Groundwater Resources** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on groundwater resources.

- **Chapter 7 – Geology, Soils, and Seismicity** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on geology, soils, and seismicity.

- **Chapter 8 – Air Quality** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on air quality.

- **Chapter 9 – Fisheries and Aquatic Ecosystems** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on fisheries and aquatic ecosystems.

- **Chapter 10 – Vegetation and Wildlife** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on vegetation and wildlife.

- **Chapter 11 – Regional and Agricultural Economics** – This chapter includes the affected environment/environmental setting, environmental effects, measures to reduce effects, and cumulative effects of the EWA program on regional and agricultural Economics.

- **Chapter 12 – Agricultural Social Issues** – This chapter includes the affected environment/environmental setting, environmental effects, measures to reduce effects, and cumulative effects of the EWA program on agricultural social issues.

- **Chapter 13 – Agricultural Land Use** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on agricultural land use.

- **Chapter 14 – Recreation Resources** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on recreation resources.

- **Chapter 15 – Flood Control** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on flood control.

- **Chapter 16 – Power Production and Energy** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on power production and energy.

- **Chapter 17 – Cultural Resources** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on cultural resources.

- **Chapter 18 – Visual Resources** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on visual resources.

- **Chapter 19 – Environmental Justice** – This chapter includes the affected environment/environmental setting, environmental effects, measures to reduce effects, and cumulative effects of the EWA program on environmental justice.
- **Chapter 20 – Indian Trust Assets** – This chapter includes the affected environment/environmental setting, environmental consequences/environmental impacts, mitigation measures, and cumulative effects of the EWA program on Indian Trust Assets.
- **Chapter 21 – Growth Inducing Impacts** – Chapter 21 provides an overall evaluation of the potential for regional growth inducement resulting from implementation of the EWA.
- **Chapter 22 – Cumulative Impacts** – Chapter 22 discusses the programs and projects that are included in the cumulative impacts analyses. The analysis of the cumulative impacts occurs within each resource area in Chapters 4 - 20.
- **Chapter 23 – Consultation and Coordination** – Chapter 23 describes the consultation and outreach activities that have occurred during the document preparation process.
- **Chapter 24 – List of Preparers**.

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Chapter 2
Alternatives, Including the Proposed Action/Proposed Project

This chapter includes an overview of the Environmental Water Account (EWA) program, a description of the alternatives formulation process, and detailed descriptions of the three alternatives. For purposes of CEQA, the technical characteristics of the proposed project are described in Sections 2.1 and 2.4.

2.1 EWA Program Overview

The EWA is a cooperative management program; the purpose of the EWA program is to provide protection to at-risk native fish species of the Bay-Delta estuary through environmentally beneficial changes in State Water Project (SWP)/Central Valley Project (CVP) operations at no uncompensated water cost to the Projects' water users. This approach to fish protection involves changing Project operations to benefit fish and the acquisition of alternative sources of project water supply, called the "EWA assets," which the EWA agencies use to replace the regular Project water supply lost by pumping reductions. The following EWA program overview is excerpted from the CALFED Programmatic Record of Decision (CALFED ROD; provided in Appendix A of this EIS/EIR).

The EWA program consists of two primary elements: implementing fish actions that protect species of concern and increasing water supply reliability by acquiring and managing assets to compensate for the effects of these actions. Actions that protect fish species include reduction of pumping at the SWP and CVP export pumping plants in the Delta. Project export pumping varies by season and hydrologic year and can adversely affect fish at times when fish are near the pumps or moving through the Delta. Pumping reductions can reduce water supply reliability for the SWP and CVP Export Service Area, causing conflicts between fishery and water supply interests. A key feature of the EWA is use of water assets to replace supplies that are interrupted during pumping reductions. The EWA assets can also provide other benefits such as augmenting instream flows and Delta outflows.

The CALFED agencies established an EWA to provide water for the protection and recovery of fish beyond that which would be available through the existing baseline of regulatory protection. The EWA involves neither new sources of water nor new construction.

2.1.1 EWA Actions to Protect and Enhance Fish

The SWP and CVP export Project water through the Delta pumping plants. This pumping can change flow patterns within the Delta, and the pumps can entrain and kill fish at the intakes to the SWP and CVP pumping facilities when fish are moving through the Delta. The EWA agencies take actions to protect and restore Delta at-risk native fish species and provide additional benefits upstream. EWA actions in the Delta to protect fish can involve temporary pumping reductions at the Delta or closure of the Delta Cross Channel gates (see Section 2.1.4.2). Closing the gates at the Delta Cross Channel, a channel constructed to increase Sacramento River flow into the Central Delta, improves the survival of anadromous fish migrating through the Sacramento River because it helps fish migrate out to the Bay instead of traveling into the central Delta. Agency biologists use real-time data on fish abundance, flow, and fish salvage at the Delta pump intakes to develop recommendations for fish protection. Actions to provide secondary benefits include increasing instream flows in rivers upstream from the Delta or augmenting Delta outflows.

The EWA seeks to benefit fish species that spend some portion of their life cycle in the Delta. The fish species of concern, their life stages, and location in the Delta are described in Chapter 9 and the ASIP.

2.1.2 Asset Development

The EWA agencies take actions to protect fish and the environment while compensating for the supply effects of these actions by acquiring EWA assets and then storing and moving the assets to where they are needed to compensate for fish actions. The CALFED ROD (CALFED 2000b) and Operating Principles Agreement (CALFED 2000c) stated that the Project Agencies would acquire and manage EWA assets in several ways:

- **Delta Operations:** altering Delta Project operations, when environmental conditions allow, to export additional water (also called variable assets);
- **Water Purchases:** purchasing water from willing sellers both upstream from the Delta and within the Export Service Area;
- **Stored Water:** purchasing stored water from the Export Service Area sources to be used as collateral for borrowing (released only when all other assets have been expended), and to function as long-term storage space after the water has been released;
- **Source Shifting:** delaying delivery of water to a Project contractor, who would use water from an alternative source until the water is paid back; and
- **Exchanges:** The Project Agencies may exchange EWA assets for assets of character, such as location, seasonality, or year-type, more suitable to EWA purposes.

2.1.3 Regulatory Commitments

The CALFED Multi-Species Conservation Strategy (MSCS) Conservation Agreement (CALFED 2000d) and the CALFED Biological Opinions included commitment by several CALFED agencies (USFWS, NOAA Fisheries, U.S. Bureau of Reclamation, Bureau of Land Management, U.S. Environmental Protection Agency, U.S. Army

Corps of Engineers, Natural Resources Conservation Service, the Resources Agency of California, California Department of Fish and Game, and the Department of Water Resources) that there would be no additional CVP or SWP export reductions from actions conducted to protect fish under the federal Endangered Species Act (ESA), California Endangered Species Act (CESA), or Natural Community Conservation Planning Act (NCCPA) beyond the regulatory baseline of fishery protection. This commitment was subject to specified conditions and legal requirements and extended for the first 4 years of CALFED Stage 1 implementation. This commitment is based on the conditions in Section VIII-B of the MSCS Conservation Agreement and the availability of three tiers of EWA assets:

- Tier 1 is baseline water, provided by existing regulations and existing operational flexibility. This baseline level of fishery protection consists of the biological opinions on winter-run salmon and delta smelt, 1995 Delta Water Quality Control Plan as implemented by SWRCB Decision 1641 and Order 2001-05, and 800,000 acre-feet of CVP Yield pursuant to the Central Valley Project Improvement Act (CVPIA) Section 3406(b)(2).

- Tier 2 consists of the assets in the EWA combined with the benefits of a fully funded Ecosystem Restoration Program (ERP) and would be an insurance mechanism that would allow water to be provided for fish when needed without reducing deliveries to water users. Tier 1 and Tier 2 would be, in effect, a water budget for the environment and would be used to avoid the need for Tier 3 assets.

- Tier 3 consists of assets beyond Tiers 1 and 2 and would be based upon the commitment and ability of the CALFED agencies to make additional water available should it be needed. It would be unlikely that assets beyond those in Tier 1 and Tier 2 would be needed to meet ESA requirements. If further assets were needed, however, the third tier would be provided in specific circumstances. To determine the need for Tier 3 assets, the fishery agencies would consider the views of an independent science panel. Tier 3 measures would be used only when Tier 1 and Tier 2 measures are insufficient to avoid jeopardy, as determined by the USFWS or NOAA Fisheries. The USFWS and NOAA Fisheries define jeopardy as a situation in which an action is likely to jeopardize the continued existence of a species listed as endangered or threatened under the ESA. If USFWS and NOAA Fisheries trigger Tier 3, measures could include increased EWA acquisitions or uncompensated fish actions (CALFED 2002b).

2.2 Alternative Formulation

The California Environmental Quality Act (CEQA) and the National Environmental Policy Act (NEPA) require that environmental documents identify and analyze a reasonable range of feasible alternatives that could meet the project objectives to varying degrees. Under CEQA and NEPA, the range of potential alternatives to the proposed project shall include those that could feasibly accomplish most of the basic purpose and need, and objectives of the project. In addition, CEQA requires an alternative that could avoid or substantially lessen one or more of the significant effects. NEPA and CEQA require that a reasonable range of alternatives, including a no-project/no-action alternative be analyzed.

The development of alternatives presented in this document was an iterative and collaborative process involving representatives from Reclamation, DWR, USFWS, NOAA Fisheries, and CDFG. These agencies worked together to interpret the CALFED ROD definition of the EWA while considering a range of possible EWA alternatives. The agencies also held public scoping meetings to solicit additional EWA alternatives. The purpose and need statement (Section 1.2.1) formed the basis for the determination and evaluation of alternatives under NEPA. The project objectives (Section 1.2.2) formed the basis for determination and evaluation under CEQA. Section 2.2.1 presents the alternatives considered and eliminated from detailed analysis, along with the reasons why the alternatives would not address the EWA purpose and need and project objectives. Section 2.2.2 summarizes the process used by the agencies to define the alternatives subject to detailed analysis in this EIS/EIR.

The CALFED ROD for the PEIS/EIR identified an EWA as a part of the CALFED program. The CALFED agencies used a six-step public process to develop potential Bay-Delta solution options for the that were evaluated in the CALFED PEIS/EIR: identify problems; define objectives; identify actions; develop solution strategies; assemble alternatives; and refine alternatives. The process identified 50 categories of actions that would resolve Bay-Delta problems and achieve the four basic plan objectives to varying degrees. The action categories became the building blocks for the preferred alternative, which included programmatic actions grouped into eight basic plan elements: ecosystem restoration, water quality, water transfers, water use efficiency, watersheds, levee system integrity, storage, and conveyance. In addition, an innovative combination of plan elements, an EWA, was included in the CALFED ROD as one of the anticipated projects to implement the CALFED plan. Additional information about the alternatives development process for the CALFED PEIS/EIR can be found in the Final CALFED PEIS/EIR (CALFED 2000a), Chapter 2 and the CALFED PEIS/EIR, Responses to Comments, Volume 1, Common Response 5 (July 2000).

Because the CALFED PEIS/EIR did not address EWA actions at a project-specific level, this project-specific EIS/EIR evaluating all projected EWA actions through 2007, is required. The preparation of the EWA EIS/EIR allows for further, more detailed evaluation of the actions described in the CALFED PEIS/EIR ROD.

2.2.1 Alternatives Not Carried Forward for Further Analysis

2.2.1.1 Screening Criteria for Alternatives

The selection of alternatives for detailed analysis was based on the ability of potential alternatives to meet the project purpose and need/CEQA project objectives, as is discussed in Section 1.2. An emphasis in screening the alternatives was also placed on the three primary considerations related to the ongoing water conflict at the Delta pumps: timeliness, flexibility, and reliability. That is, alternatives selected for detailed analysis needed to be immediate, flexible, and reliable, as described below.

- **Immediate.** Conflict at the pumps was an ongoing problem that required an immediate solution to meet both water supply needs and environmental protection requirements. Water agencies, water users, and resource agencies could not wait for the construction of new facilities or planned changes in water uses.

- **Flexible.** Any action taken to reduce the pumping conflict would need to take advantage of multiple means of water purchase, storage, and release, using spatial and temporal variation to provide water when it was most needed. Flexible water assets could be acquired from any entity and transferred to any entity connected to the Project systems to prevent interruption of water supplies.

- **Reliable.** Reliability is important for water users. Historic conflicts at the pumps created uncertainty for users because fish presence near the export pumps could cause unexpected reductions in pumping, and these reductions could affect water supply. Alternatives must increase supply reliability for urban, agricultural, and environmental users in the Export Service Area.

2.2.1.2 Alternatives Eliminated from Detailed Evaluation

This section describes alternatives considered but eliminated from detailed analysis based on the purpose and need consideration for timeliness, flexibility, and reliability.

EWA scoping sessions identified a number of methods that could reduce the conflicts at the Delta export pumps. The EWA agencies developed additional suggestions and formulated the following set of alternatives to the EWA:

- Desalination in Southern California;

- Increased use of Colorado River water;

- Water use efficiency within the Project service area;

- Additional water sources, including new or increased capacity of storage facilities, new conveyance facilities, or "water bladders" to transport water to southern California;

- Isolated facility; and

- Delta infiltration galleries to eliminate surface diversions to pumps.

2.2.1.2.1 Desalination in Southern California

California has over 150 desalting plants (DWR 1998) that create freshwater from brackish groundwater, municipal and industrial wastewater, and seawater. Desalination plants can be designed using several available technologies, including reverse osmosis (water is forced through a membrane through which salt cannot pass) and distillation (saline water is heated into steam and is then condensed). Increasing the number of desalination plants in the Projects' service area could provide an alternate water supply to Delta exports and decrease demand for pumping water from the Delta. However, designing, permitting, and constructing these facilities would require many years. Desalination could not be implemented immediately.

Desalination facilities would need to go through an environmental review and permitting process before construction. Desalination plants have several potentially significant environmental impacts, including those associated with producing additional power and disposal of the brine byproduct. The environmental review process would be complicated by the potential impacts and would likely take more than 1 year. Similarly, design and construction would take several additional years. Desalination may be part of the overall solution to the State's water needs; however, the time requirements to permit, design, and construct a desalination facility prohibit it from being an immediate solution to reducing Delta conflicts, so desalination was not carried forward in the analysis.

2.2.1.2.2 Increased Use of Colorado River Water

The South Coast hydrologic region (encompassing the coastal area from Ventura County south to the border of Mexico) imports water from the Colorado River and receives SWP supplies from the Delta. The Colorado River currently supplies about 25 percent of the region's water (DWR 1998); additional Colorado River supplies could offset the need for some Delta water. Reducing Delta demands would reduce the amount of water that the SWP would need to pump through the Delta, which could alleviate some conflicts at the export pumps.

The Law of the River determines water supply apportionment and includes the Colorado River Compact, several major court decisions, and a number of statutes involving seven states (DWR 1998). Although California's basic Colorado River apportionment is 4.4 million acre-feet (MAF), California has supplemented this amount in the past with unused apportionments from Arizona and Nevada, to use a total of 5.2 MAF. Because Arizona and Nevada have developed additional facilities to use their Colorado River apportionments, the amount of available supplemental water available to California has been reduced. The Department of the Interior asked California to reduce its use to the basic apportionment, which would require California areas dependent on the Colorado River to reduce their water demands or find alternate supplies.

California's Draft Colorado River Water Use Plan (May 11, 2000) proposed reduction in Colorado River use to 4.4 MAF by 2015. The Plan anticipated that California would be able to supplement its apportionment with surplus Colorado River water until 2015. Available surplus water would be allocated under the Colorado River Interim Surplus Guidelines (Reclamation 2001). Under these Guidelines, the California Colorado River contractors were expected to execute the Quantification Settlement Agreement (and its related documents) among the Imperial Irrigation District, Coachella Valley Water District, the Metropolitan Water District, and the San Diego County Water Authority by December 31, 2001. In the event the agreement was not executed by December 31, 2002, the interim surplus deliveries made under the Guidelines were to be suspended.

The California Colorado River contractors were unable to execute the Quantification Settlement Agreement by December 31, 2002. Consequently, delivery of surplus water to California Colorado River contractors was immediately suspended, and delivery of Colorado River water to California was immediately restricted to its legal appropriative limit of 4.4 MAF.

Even if the surplus were requested, other water agencies have rights to that surplus water, and the EWA would unlikely be able to obtain supplies from this source. Consequently, Colorado River supplies are not considered a viable option for developing increased water supplies to reduce conflict at the Delta pumps as an alternative to the EWA. As a result, this alternative was not carried forward in the analysis.

2.2.1.2.3 Funding Water Use Efficiency Measures

Water Use Efficiency is one of eight elements of the CALFED plan. Urban water conservation actions include installation of improved water efficiency plumbing fixtures, water metering, and improved landscape irrigation, among others (DWR 1998). Agricultural water conservation methods also include improving irrigation management and water delivery systems, especially high-volume gravity flow systems that deliver large amounts of water. Canal liners, piping in farm distribution systems, and tail water and spill recovery systems also aid in agricultural water conservation. Agricultural land retirement in impaired drainage areas qualifies as an agricultural conservation method as well. The Water Use Efficiency Program Plan describes the potential actions, including the possible efficiency gains that can be expected under the CALFED plan.

The CALFED ROD established that both water use efficiency measures and the EWA are necessary components of the CALFED plan and the Water Management Strategy. The Water Use Efficiency Program Plan establishes a goal for aggressive implementation of agricultural and urban water use efficiency actions beyond pre-existing programs, but these measures are not a substitute for the EWA. The estimated water use efficiency gains under the CALFED plan will be achieved over time and will take several years to identify, plan, coordinate with local water users, and implement, and will therefore not be realized during the EWA timeframe. Further, to meet the objectives of the EWA, water use efficiency measures beyond those proposed in the CALFED plan would likely be necessary. Additional measures would not be achievable during the EWA timeframe, and it may not be technically feasible to obtain more efficiency gains than predicted in the Water Use Efficiency Program Plan. Water use efficiency measures on their own would potentially result in less flexibility in operating the SWP and CVP pumps and create more difficulty for the Project Agencies to respond to drought conditions or unexpected behavior by the fish species of concern. Finally, the water supply benefits of water use efficiency measures are often spatially and temporally diffuse, unpredictable, and difficult to control centrally in a manner necessary to achieve the EWA objectives.

2.2.1.2.4 New Water Sources

Other alternative sources for "new water" in the CALFED plan for the EWA and other beneficial uses include increasing storage capacity in existing reservoirs and aquifers and constructing new conveyance mechanisms. Increasing storage capacity in surface reservoirs and underground aquifers could provide water to meet the needs of California's growing population and provide California flexibility to improve water quality and restore ecosystems. Capacity enlargement and new storage projects under consideration by the CALFED agencies include:

- Enlarging Shasta Lake;
- Enlarging Los Vaqueros Reservoir;
- Constructing North-of-the-Delta Upstream Storage;
- Constructing In-Delta Storage;
- Augmenting Upper San Joaquin River Storage; and
- Employing groundwater storage and conjunctive use operations.

The Integrated Storage Investigation (ISI) is evaluating the above-mentioned storage projects. Investigations will serve as an important opportunity to prepare a comprehensive assessment and evaluation. DWR and Reclamation continue working with local agencies to explore specific groundwater banking and conjunctive use opportunities.

Construction of new conveyance facilities is another potential action to increase the capacity of the SWP and CVP and would give the Projects greater flexibility to accommodate fishery protection actions in the Delta. The CALFED plan incorporated several conveyance projects to improve through-Delta conveyance of water. Some of these projects may be completed during the EWA timeframe and could provide benefits similar to the EWA; however, the ROD established that both the EWA and these conveyance improvements were necessary components of the CALFED plan and the Water Management Strategy. Additional conveyance improvements beyond those identified in the CALFED plan would need to be constructed to provide the additional benefits of the EWA. Additional conveyance improvements can reasonably be expected to take even longer to design, permit, and implement than those already included in the CALFED plan; therefore, the benefits of such actions would be well beyond the immediate EWA timeframe (CALFED ROD, p. 48-49).

2.2.1.2.5 Move Water with Water Bladders

Importing water into the South Coast region in 100-foot-wide nylon bags called "water bladders" would be another potential means to offset SWP demand for Delta water and reduce conflicts at the pumps. Floating "water bladders" behind tugboats to southern California could provide a reliable source of water for Project water users. A recent proposal involves transferring rainy season water from the Gualala and Albion Rivers to San Diego. The project proponent would install pipes at the mouths of the Gualala and Albion Rivers, below the alluvial soil at the river bottoms. The project proponent withdrew the proposal on December 13, 2002, but it is possible that other entities would develop similar proposals. Installation of loading and unloading docks, pumps, and local treatment and distribution infrastructure and transfer mechanisms would require the project proponent to develop local support, which would likely extend the project timeframe beyond the immediate EWA timeframe (Locke 2002; Wood 2002; Bell 2002; Mendocino County Board of Supervisors 2002; Swartz 2002).

2.2.1.2.6 Isolated Facility

The CALFED PEIS/EIR analyzed an isolated diversion facility - a canal connecting the Sacramento River in the north Delta to the SWP and CVP export facilities in the south Delta. The isolated facility would have a fish screen at the point of diversion from the Sacramento River; the fish screen would reduce fish entrainment at the Delta pumps. Reduction in fish entrainment would reduce the need for EWA water.

The PEIS/EIR's preferred program alternative did not include the isolated facility, but instead focused on improving through-Delta conveyance capacity. If the through-Delta conveyance system does not work, CALFED agencies would determine whether another alternative was necessary at the end of Stage 1 of the CALFED program implementation. If it were reconsidered, years of scientific evaluation would be necessary to determine whether an isolated facility would be feasible. Evaluation, design, and permitting the facility would take longer than the EWA timeframe.

2.2.1.2.7 Delta Infiltration Galleries to Eliminate Surface Diversions to Pumps

Infiltration galleries tap into saturated water zones directly beneath riverbeds. The "gallery" consists of an open well on the riverbank that is connected to the riverbed by a horizontal perforated water collection pipe. The collection pipes would draw surface water from the channels into buried perforated pipes through gravity flow. Galleries can either be horizontally or vertically designed according to local conditions.

A series of infiltration galleries constructed along the West Canal and Old River could channel water into Clifton Court Forebay, effectively eliminating the need for the Clifton Court Forebay Inlet Structure. Bypassing the inlet structure forestalls the need to reduce pumping operations for fish protection. EWA water acquisition options would no longer be needed to reduce conflicts at the Delta export pumps, but this option would not provide other EWA benefits (such as instream flows, Delta Cross Channel gate closure, and Delta outflow).

Planning an infiltration gallery would require a feasibility study to analyze water quality and water demand, available space for construction of galleries, proximity to population centers and potential pollution sources, depth to the water table, and nature of material in the unsaturated zone. If the study found that the galleries would be feasible, then the design would include placement of pipes through the levee structure to protect the levee and Forebay integrity. This project would include planning, scheduling, and analysis of construction-related effects and associated land conversion. The time required to produce the necessary analyses would extend beyond the immediate EWA timeframe.

2.2.2 Development of Alternatives Carried Forward for Further Evaluation

This section describes the evolution of the EWA alternatives carried forward for further evaluation. A collaborative process involving personnel from Reclamation, DWR, USFWS, NOAA Fisheries, and CDFG produced the EWA alternatives evaluated in this EIS/EIR. Each of the EWA action alternatives is required to include:

- Ranges of fish actions that would be possible, given the purchase limits;
- The quantity of water that would be purchased;
- CVP and SWP operational flexibility[1] dedicated to the EWA program;
- 500 cfs of pumping capacity at Banks Pumping Plant in July – September;
- An amount of groundwater storage capability; and
- A source shifting agreement.

The development of alternatives considered:

- The EWA guidance and framework described in the CALFED ROD that related to a need for immediate solutions using existing facilities, the description of the EWA, and the feasibility of meeting EWA program needs through implementation of other actions called for in the ROD (Section 2.2.2.1);
- The sources and mechanisms of conflict (Section 2.2.2.2); and
- The flexibility to respond to variability in environmental conditions and fish protection needs (Section 2.2.2.3).

The section below discusses how these factors affected the EWA alternatives development process. Section 2.2.2.5 describes the lessons learned about asset acquisition and management strategies during early EWA implementation that helped EWA agencies develop the final alternatives.

2.2.2.1 ROD Guidance and Framework

The EWA agencies reviewed the concepts considered by the larger group of agencies that developed the CALFED PEIS/EIR ROD. One of the critical conflicts identified in the PEIS/EIR was the conflict between threatened and endangered fish recovery/protection and water supply reliability reduced by pumping reductions (as

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1 Delta "operational flexibility" describes the ability of the Projects to alter pumping operations within the Delta, if fish and water quality conditions allow, to result in additional water or conveyance capacity for the EWA.

directed by Biological Opinions), an ongoing problem needing immediate attention. Although the objectives of the CALFED plan include improved water supply reliability coupled with environmental enhancement, the measures identified in the CALFED ROD to achieve these objectives will require additional planning and, in many cases, construction of facilities; thus, these measures are not an immediate solution to the fish protection/water diversion conflict (see Sections 1.4 and 2.2.1.2 for additional discussion of these measures).

When developing the ROD, the CALFED agencies evaluated the use of the existing CVP/SWP facilities and operations in addressing the fish protection/water diversion conflict in the short term and reviewed other water development and management programs under consideration both locally and regionally. These agencies determined that other elements of the water management strategy would not be able to address the conflict in the first years of the CALFED plan implementation. The intent of the CALFED agencies was to develop an EWA strategy to create a portfolio of water and operational capabilities, collectively referred to as EWA assets, which could be used to address this conflict. EWA assets would be acquired through the dedication of certain operational flexibilities of the CVP and SWP, by securing the ability to store and carry over assets, and by purchasing a quantity of water annually. The ROD provided initial direction for the acquisition of EWA assets and an estimate of the annual average quantity of water that would be available to EWA (up to 185,000 acre-feet per year). The specific CVP/SWP operational flexibilities dedicated to the EWA included:

- EWA will have a 50 percent share of SWP export pumping of (b)(2) water and ERP water from upstream releases;
- EWA will share the use of SWP pumping capacity in excess of the SWP's needs to meet contractor requirements[2] with the CVP on an equal basis, as needed (such use may be under Joint Point of Diversion provisions in the Project Agencies water right permits);
- EWA assets will include any water acquired through export/inflow ratio flexibility; and
- EWA will include exclusive use of 500 cubic-foot per second (cfs) increase in authorized Banks Pumping Plant capacity in July through September (from 6,680 to 7,180 cfs).

The CALFED ROD estimated that the EWA program would purchase an average of 185,000 acre-feet of water per year, with 35,000 acre-feet coming from areas upstream from the Delta[3] and 150,000 acre-feet from the export service area. The total average annual water quantity estimated to be available from purchases in the Upstream from the Delta Region, purchases in the Export Service Area, and CVP/SWP operational

[2] This use would be pursuant to the Joint Point of Diversion provisions in the Project Agencies' water rights permits. For more information on Joint Point of Diversion, see Section 2.3.1.1 and 4.1.3.2.

[3] The upstream purchase quantity was the amount of water target for the first year; higher amounts were anticipated in subsequent years.

flexibility was 225,000 acre-feet per year. The ROD also identified that using operational flexibility in the Delta could provide additional conveyance capacity to the EWA by increasing the maximum EWA Delta exports. (The increase in 500 cfs capacity is available only in the summer and under most circumstances does not generate assets for the EWA; the capacity only provides assured conveyance for water purchased upstream. Only with excess conditions in the Delta in the summer will this tool provide an increment of new water for the EWA.)

The CALFED agencies also recognized the need to define how the EWA would be implemented within the operational constraints of the CVP and SWP, to define the responsibilities of the participating agencies, and to further describe the tools and capabilities needed to create a functional EWA. To meet this need, the EWA Operating Principles Agreement was executed and was included as an attachment to the CALFED ROD. The EWA agencies used the Operating Principles in the development of alternatives for this EIS/EIR.

The development of alternatives for the EWA EIS/EIR also included a reassessment of the strategies identified in the CALFED ROD to determine their feasibility to develop a project for addressing the pump conflict problem. This reassessment considered strategies from the CALFED plan for improving water supply reliability, quantity, and quality; management options (e.g., conservation); proposed structural projects; and proposed changes to Bay-Delta hydrodynamics that could address the pump conflict. In all instances, these projects were either still in the planning stages or have some degree of uncertainty regarding their completion during the Stage 1 period of the CALFED program. None of the proposed projects would address the pump conflict issue immediately.

2.2.2.2 Sources of Conflict

An understanding of the causes of conflict between CVP and SWP operations and fishery managers helped guide the development of alternatives. Variability and unpredictability of water supply and biological conditions are two key factors that weighed heavily in the creation of the EWA. The hydrologic conditions in California change dramatically from one year to the next, season-to-season, and sometimes day to day. Water managers must take full advantage of their capabilities to secure water supplies in wet conditions to meet the higher demands during dry conditions. For the operators of the CVP and SWP, this means that when water is available, upstream reservoirs are operated to maximize storage while maintaining flood control capability. Reservoir releases above those that can be captured and delivered to CVP/SWP contractors downstream cause a loss of water supply and create conflict. In the Delta, the Project export facilities are operated to maximize Export Service Area deliveries to CVP/SWP contractors and storage facilities in the export service areas. The approach to the use of Delta export facilities continues until storage facilities in the export service areas are filled or operators reach a level of confidence that they can be filled. The approach to management of upstream reservoirs and Delta export facilities is driven by the knowledge that conditions can change quickly and dramatically. The loss of the opportunity to store or pump water when it is available creates conflict because of uncertainty regarding the recovery of foregone supplies under future conditions.

Fishery agency managers advise the CVP and SWP operators and others regarding the avoidance and minimization of project effects on key fish resources. Fish species in the Sacramento/San Joaquin rivers and Bay-Delta estuary have adapted to respond to the highly variable hydrologic conditions. Hydrologic changes often coincide with significant life history events for fish, such as initiation of migration or spawning. Hydrologic conditions also determine changes in the quantity and quality of habitats available to fish. Although the general timing of key life history events for the fish can be predicted, the specific timing each year is influenced by annually variable hydrologic events and the influences of human management on the system. Recent history has reflected the high variability in the timing and magnitude of hydrological and biological events that can influence fish resources and Project operations.

Historically, prescriptive measures to provide fishery management water, such as water quality standards and operational criteria, have been used to protect fisheries and other beneficial uses of Bay-Delta water. Instream flow recommendations, water temperature requirements, pumping thresholds based on the ratio of exports to inflow, water salinity standards, and minimum Delta outflow requirements are all examples of these prescriptive measures. The single greatest source of conflict has been the pumping reductions at the CVP/SWP Delta export pumps that are imposed when the number of fish entrained at the pumps reaches critical thresholds specified in incidental take statements in the existing regulatory baseline for fishery protection. When pumping reductions are needed, CVP/SWP water managers attempt to adjust Project operations to minimize the loss of export water supply. The development of EWA alternatives focused on resolving the conflicts at the pumps as a first priority, but also maintained the ability to support upstream actions beneficial to fish when and where possible and needed.

2.2.2.3 Flexibility, Reliability, and Managing Uncertainty

The flexibility of the EWA program was considered in the development of alternatives and in the evaluation of effects. Flexibility gives the EWA agencies the ability to respond to variability in hydrologic conditions, Project operations, fish needs, water market conditions, and budget constraints, and to provide protection to at-risk native fish species of the Bay-Delta estuary through environmentally beneficial changes in the operations of the CVP and SWP, that result in no uncompensated water cost to the Projects' water users.

The EWA alternatives needed to be compatible with the existing physical structures of the CVP and SWP Project facilities, because any alternative requiring new facilities cold not be implemented immediately. Although the CVP and SWP storage and service areas encompass much of California, the majority of California's water supply originates in watersheds upstream from the Delta. The existing CVP/SWP facilities collect and convey this water through the Delta to water contractors in the Export

Service Area. The first priority use of these facilities is to move CVP and SWP water from the Delta and upstream storage into the export service area. EWA assets purchased in areas upstream from the Delta can be moved only using dedicated summer capacity or the EWA's share of unused capacity at one or both of the pumping facilities. The amount of pumping capacity[4] available to the EWA effectively limits the amount of EWA water that can be purchased in areas that are upstream from the Delta.

The Delta export pumping capacity available to the EWA can vary from year to year; therefore, the EWA alternative development process considered a flexible asset acquisition and management strategy that takes advantage of CVP/SWP conveyance facilities and non-Project storage upstream from the Delta and elsewhere within the CVP/SWP areas. Effective management of EWA would require flexibility. For example, the EWA may need the ability to store purchased EWA assets upstream from the Delta until pumping capacity is available. At other times, the EWA may need the ability to convey assets according to the schedule on which purchased water is made available. Any alternative considered needed to address the Delta export pumping capacity available to the EWA program.

The EWA agencies could purchase, store, and use water in a variety of locations. Having access to a variety of CVP/SWP facilities would add flexibility by allowing for purchase, conveyance, storage, and release of EWA water assets according to varying schedules and needs. Use of CVP/SWP facilities would also give managers more control of the timing of EWA water releases to achieve instream habitat benefits and would provide for the conveyance of EWA water to replace contractors' water supply lost due to pump reductions.

The EWA Operating Principles Agreement added the concept of "functional equivalence" to the CALFED ROD acquisition measures to improve the flexibility in asset acquisition and management. Given the focus of EWA on facilitating export pump reductions, the EWA agencies defined functional equivalency to be determined by the volume of water needed to replace any Project water supply lost because of exports foregone as a result of a pumping reduction. This concept allows the development of annual purchase strategies that provide the EWA greater flexibility to respond to variability in hydrologic conditions, fish needs, availability of conveyance capacity and sources of water to purchase and to maximize the assets obtained with available funding. The EWA agencies considered two variations to water purchases described in the CALFED ROD: one alternative uses the unmodified purchase targets established in the ROD (150,000 acre-feet from the Export Service Area and 35,000 acre-feet upstream from the Delta), and the second alternative would use the concept of functional equivalency in the development of an annual purchase strategy.

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4 Delta pumping capacity is not simply limited by the size of the pumps, but also by regulatory limits on exports as described in Chapter 1 (e.g., fish protection requirements, the export/inflow ratio, and water quality requirements).

Flexibility also helps reduce uncertainties related to the annual quantity of water purchased. The ROD determined that the EWA would acquire an average annual quantity of 225,000 acre-feet of water plus conveyance capacity and storage facilities. These annual supplies were to be developed from both purchases (fixed assets) and the use of operational flexibility (variable assets). The volume of water that can be secured using operational flexibility (variable assets) will change each year as does the need, availability, and price of purchased supplies. Each year will be different from the next. Predicting the annual quantity of water to purchase so that it could be delivered when and where it was needed first requires knowledge of how much water was needed, and second where the water should come from.

The EWA agencies identified 600,000 acre-feet as a quantity of potential purchases for the EWA that may be needed in the most extreme case. This amount could be needed in the future for a combination of the following reasons:

1) The tools expected to produce variable amounts of EWA water each year have produced less water to date on average, relative to the anticipated average annual amount of 145,000 acre-feet. The CALFED ROD recognized that this amount would vary from year to year depending on hydrology; however, other circumstances affecting the amount obtainable have changed. There has been greater than expected use by DWR of Banks Pumping Plant pumping capacity in the spring to convey transfers to SWP contractors, thus precluding EWA use of some of this capacity to obtain EWA water and pay off debt. Because less CVPIA (b)(2) water is released upstream, the EWA share of this water that may be captured in the Delta by the SWP is reduced.

2) Under the concept of functional equivalency, SWP borrowing of up to 100,000 acre-feet has been substituted for the initial acquisition and long-term management of water equivalent to 200,000 acre-feet of storage within the Export Service Area because it has not been feasible to establish this asset. Only 100,000 acre-feet of this asset was expected to be used in any single year. If used, it would have to be replaced before it could be used again, but replacement would not necessarily have to occur in the next year. If the "borrowing" tool is used instead, any debt owed to the SWP under this arrangement may be carried into the subsequent year, when water could be purchased to extinguish a debt. Thus, for this tool to be truly equivalent to the stored water asset, the EWA needs the ability, when necessary, to purchase additional water up to the amount borrowed, not to exceed 100,000 acre-feet.

3) There has been a loss in the flexibility to manage the CVPIA (b)(2) water that contributed to the existing regulatory baseline of fishery protection. Providing the anticipated combined baseline and EWA benefits for fish may require additional EWA acquisitions.

4) EWA water purchase needs may increase in the future to address potential impacts of new facilities operations.

5) Water purchase amounts that may occasionally be needed for Tier 3, in the event that pumping effects on fish would be significant enough to justify pumping curtailments after EWA assets were exhausted, are included in this alternative.

The last factor considered by the EWA agencies concerns the constantly changing nature of water markets and effects that can occur by implementing a purchase. The volume of water that a willing seller may make available could change from year to year. The effects due to EWA water purchases are not necessarily based on the total volume purchased, but rather on the method by which the water is made available. The EWA could purchase previously stored surface water, surface supplies made available by groundwater substitution, previously banked groundwater, or surface supplies made available by crop idling. The locations vary throughout the two-valley region. Water asset acquisitions could be from a variety of different sources that are not necessarily interrelated.

The EWA agencies considered structuring alternatives around the water acquisition options (surface water, groundwater substitution, groundwater purchase, crop idling). Under this concept, different alternatives would have been eliminated, or restricted one or several of the water acquisition options. As noted above, however, not all years would have the same hydrology and fish actions, and not all acquisition options would be equally available each year. Any alternative that restricted the EWA to a limited set of purchase options might not be able to address the pump conflict in certain years if the EWA water acquisition options are either not available or restricted in some fashion. Therefore, the EWA agencies decided there must be an alternative that did not restrict the sources of EWA water asset acquisition options.

2.2.2.4 Basis for Alternatives Developed

The EWA agencies selected the two action alternatives carried forward because they best addressed the purpose and need, and project objectives, of the EWA and bracketed the potential range of effects that implementation of the program is expected to have. The two action alternatives: (1) are both based on the CALFED ROD; (2) take maximum advantage of the operational flexibility of both CVP/SWP facilities and facilities owned or controlled by willing sellers of water; and (3) adopt the concept of functional equivalency in asset acquisition and management. The two action alternatives address the immediate need to reduce the water supply reliability conflict at the Delta pumps and are flexible in maximizing the use of CVP/SWP facilities for asset management. The management options included in the alternatives do not interrupt water supply, and they achieve fishery protection and enhancement. The EWA agencies identified two action alternatives that could feasibly accomplish most of the stated project purposes and needs/project objectives and define the range of effects expected given the high degree of variability inherent to achieving the goals of the program; and, the two action alternatives could be implemented immediately.

2.2.2.5 Previous EWA Actions

In 2001, DWR tried to follow the ROD closely when negotiating asset acquisitions and use of non-Project facilities to manage assets.[5] From this experience, the Project Agencies reached the following conclusions about what an effective longer-term EWA would require to successfully operate.

- Upstream from the Delta water acquisitions are less expensive than acquisitions from the Export Service Area and could be used to produce secondary benefits, such as increased instream flows and Delta outflows.
- Storage may be difficult and expensive to obtain, but the SWP and CVP can help by providing unsecured loans to the EWA (in which a certain amount of water in CVP or SWP storage could be used for EWA actions before the EWA defined how the water would be repaid). Section 2.4.2.3.2 describes asset management.
- Source shifting should not be used unless the EWA cannot employ other assets, unless the price is affordable, or unless the Projects cannot permit the EWA to carry its debt beyond the date of the San Luis storage low point.
- Not all variable assets were available in the quantities estimated in the CALFED ROD. In some cases the quantities fell short of the estimates; in other cases, the actual acquired assets exceeded the CALFED estimates. These changes occurred because of changes in (b)(2) decisions and variable hydrology (see Section 2.4.2.2).

The Project Agencies concluded that more flexibility in purchases might help the EWA to be more efficient and effective. A flexible purchase approach was used during 2002, during which more water was acquired upstream from the Delta than in year one, and no storage agreements were enacted. During 2002 however, there were fewer fish near the export pumps, so less fish actions were needed and the flexible purchase strategy was not fully tested. A fixed purchase strategy and a flexible purchase strategy form the basis for the two EWA action alternatives.

2.3 No Action/No Project Alternative

The No Action/No Project Alternative describes the future conditions without EWA, defined as those CVP/SWP operational and environmental conditions that would reasonably be expected in the foreseeable future if the EWA program were not approved. The No Action alternative assumes the existing regulatory and legal

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[5] Because it was not able to purchase the 200,000 acre-feet of stored water on a long-term contract basis, DWR negotiated additional purchases, including a total of 105,000 acre-feet from upstream from the Delta sources, and in the export service areas acquired 159,000 acre-feet of stored groundwater. Reclamation contributed 72,000 acre-feet of water from the export service areas, giving the EWA total assets in 2001 of 374,000 acre-feet, after carriage losses. These purchases provided 100,000 acre-feet of water to account for the extractable portion of long-term storage that would have been available for use in one year. DWR made an agreement for source shifting for 100,000 acre-feet, with an additional option for 100,000 acre-feet.

constraints. This alternative also describes the conditions that would occur if the EWA did not receive funding in the future.

If the EWA were not implemented, actions to protect fish and benefit the environment would continue under the existing baseline of fishery protection, but the actions would be less than with the EWA. Compliance with the biological opinions (the baseline for fishery protection) would require pumping reductions, resulting in reduced CVP and SWP water deliveries. DWR and Reclamation would continue to attempt to re-operate the SWP and CVP, respectively, to avoid decreased water deliveries to export users. These actions are described below.

2.3.1 Actions to Protect Fish

2.3.1.1 Flow-Related Actions

The CALFED ROD identified a baseline level of fishery protection requirements for Project operations. Existing regulatory programs established these requirements prior to implementation of the CALFED ROD, and these programs alter Project operations in ways that improve Delta water conditions for fish. The No Action/No Project Alternative includes the environmental requirements identified below.

- **1993 Winter-run Biological Opinion (NOAA Fisheries).** In 1993, NOAA Fisheries assessed the potential effects of operations of the CVP and SWP on the Federally listed winter-run Chinook salmon. Based on this assessment, NOAA Fisheries issued a biological opinion concluding that operation of the CVP would likely jeopardize the continued existence of winter-run Chinook salmon. Reasonable and prudent alternatives to CVP operations were developed to avoid jeopardy, including specific flow, temperature, reservoir storage, and diversion requirements in the Sacramento River and in the Delta. NOAA Fisheries reinitiated consultation on CVP operations when the "Principles for Agreement" that formed the basis for the Bay-Delta Plan were originally signed. NOAA Fisheries subsequently issued a revised biological opinion in 1995. Reclamation currently operates the CVP in accordance with the NOAA Fisheries 1995 Winter-run Chinook Salmon Biological Opinion.

- **1995 Delta Water Quality Control Plan (1995 Delta WQCP) and SWRCB's Decision 1641.** The SWP and CVP met the flow-related objectives of this plan at the time the CALFED ROD was signed. The SWRCB has subsequently issued Decision 1641 (D-1641), which provided a decision regarding the obligations of the SWP and CVP to meet the flow-related objectives in the Water Quality Control Plan. Section 1.5.2.5 contains additional information on the 1995 Delta WQCP and D-1641.

- **Vernalis Adaptive Management Plan (VAMP).** The Vernalis Adaptive Management Plan (VAMP) is a science-based, adaptive management plan designed to determine and protect the survival and transport of salmon smolts through the Delta in relation to the flow of the San Joaquin River, SWP/CVP exports, and the operation of a fish barrier located at the Head of Old River. This study calls for a regulated pulse flow level at Vernalis and a predetermined SWP/CVP export rate for a 31-day period during April and May. Table 2-1 shows the allowable export rates as a function of the flow at Vernalis. The San Joaquin River Agreement (SJRA) stipulates the target flow rate of the San Joaquin River and includes an agreement that a group of water users would supply the flows during this period, based on the San Joaquin Valley Water Year Hydrologic Classification (index of water supply availability and wetness). VAMP was included in D-1641, a water rights decision that implemented the 1995 Delta WQCP. In the No Action/No Project Alternative, Reclamation would use CVPIA (b)(2) water to account for export reductions due to the limited pumping during April and May. CVPIA (b)(2) water has been used to account for decreased SWP exports in the past; the SWP would be unlikely to participate in VAMP in the No Action/No Project Alternative without a method to repay the SWP contractors for export losses.

Table 2-1
VAMP Export Limitations

Export Rates (cfs)	***Vernalis Flow Rate (cfs)***			
	7,000	***5,700***	***4,450***	***3,200***
1,500	X		X	X
2,250		X		
3,000	X			

- **1995 Delta Smelt Biological Opinion.** On March 6, 1995, USFWS issued a biological opinion on the effects of the long-term operation of the CVP and SWP on the Federally listed, threatened delta smelt and its critical habitat (USFWS 1995). The biological opinion concluded that CVP and SWP operations, as proposed,[6] are not likely to jeopardize the continued existence of the delta smelt or result in the destruction or adverse modification of proposed critical habitat for the delta smelt. To promote recovery of the species and to ensure that Project operations would not interfere with the survival and recovery of the species, USFWS issued a number of recommendations relating to (1) incidental take at various locations in the Delta; (2) fish salvage; (3) monitoring of Delta parameters such as X2 and outflow; and (4) conservation of the species. The CVP and SWP currently operate in accordance with the USFWS 1995 Delta Smelt Biological Opinion.

  The 1995 Delta Smelt Biological Opinion contains an export pump reduction (item 2 on page 19 of the opinion), commonly referred to as the “2 to 1 Vernalis flow/export ratio.” This pump reduction objective calls for the SWP and CVP to reduce combined exports, below that allowed in the 1995 Delta WQCP, during a 31-day period in April and May. The 1995 Delta WQCP allows exports to be

6 Operations “as proposed” included provisions from prior biological opinions, water quality standards, and the implementation of the Recovery Plan, which were expected to result in improved habitat.

100 percent of the base flow at Vernalis[7] during the April-May pulse period, when additional water is released to simulate historic snowmelt flows for fish. The 1995 Delta Smelt opinion reduces exports even further, so that exports can only be 50 percent of the base flow at Vernalis. CVPIA 3406(b)(2) water would be used to account for this decrease, and this water is part of the baseline fishery protection. Multiple interpretations of this requirement led to conflict between the SWP and USFWS, and the SWP would be unlikely to meet this requirement in the No Action/No Project Alternative without compensation for water supply loss.

- **2002 Spring-run Chinook and Steelhead Biological Opinion.**[8] On September 20, 2002, NOAA Fisheries issued a biological opinion on CVP and SWP Operations, April 1, 2002, through March 31, 2004, on Federally listed threatened Central Valley spring-run Chinook salmon and threatened Central Valley steelhead (NOAA Fisheries 2002). The Biological Opinion established non-discretionary terms and conditions that are intended to minimize the adverse effects of flow fluctuations associated with upstream reservoir operations on the incubating eggs, fry and juvenile steelhead, and spring-run Chinook salmon. These terms and conditions pertain to flow and water temperature requirements, ramping criteria, flow fluctuations, and incidental take/fish salvage of the species.

- **Full Use of 800 TAF Supply of Water Pursuant to Section 3406(b)(2) of the CVPIA**. At the August 2000 signing of the CALFED ROD, the decision by the Department of the Interior (Interior) regarding the use of (b)(2) water included "reset" and "offset,"[9] provisions that were further clarified in the CALFED ROD. The 2002 Federal District Court decision, however, determined that (b)(2) implementation should not include these reset and offset provisions (see Section 1.6.2). The District Court's ruling on offset and reset was upheld by the Ninth District Court. The No Action/No Project Alternative includes the dedication and management of the 800,000 acre-feet using a policy that reflects the opinion of the court.

- **Level 2[10] Refuge Water Supplies.** Section 3406(d) of the CVPIA authorizes and directs the Secretary of the Interior to provide firm water supplies of suitable quality to certain national wildlife refuges in the Central Valley of California, certain State of California wildlife management areas, and the Grassland Resource Conservation District (collectively referred to below as "refuges") in accordance with the 1989 *Report on Refuge Water Supply Investigations and the 1989 San Joaquin*

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7 Vernalis is a town on the San Joaquin River just downstream from the confluence with the Stanislaus River. The location is used as a measure of the San Joaquin River flow and water quality.

8 NOAA Fisheries issued this biological opinion after the signing of the CALFED ROD; however, it is included in the No Action/No Project because it also changes the operations of the Delta to benefit fish and the environment.

9 "Reset" and "offset" are defined on Page 56 of the CALFED ROD (CALFED, 2000b).

10 The Reclamation Report on Refuge Water Supply Investigations (March 1989) defined four levels of refuge water supplies: existing firm water supply (Level 1), current average annual water deliveries (Level 2), full use of existing development (Level 3), and permission for full habitat development (Level 4). CVPIA Section 3406(d) committed to providing firm water through long-term contractual agreements for Level 2 refuges.

Basin Action Plan/Kesterson Mitigation Plan (USFWS and Reclamation 2002). Level 2 supplies are defined in the Investigations Report as the historic annual average water deliveries to each refuge prior to enactment of the CVPIA and two-thirds of the water supplies identified for the Action Plan Lands (USFWS and Reclamation 2002). These firm water supplies must be provided at the refuge boundaries, as required by the CVPIA. To the extent available, the CVP will use its share of the benefits from Joint Point of Diversion (as explained in Section 2.3.2.1.1) to comply with its Level 2 refuge water supply mandates, but using such benefits will not create any limitation on the overall Level 2 supply that is available for refuges.

To implement these fish protection requirements, fishery and Project agencies could take several actions described in the sections below.

2.3.1.1.1 Reducing Delta Pumping

Pumping water through the Tracy and Banks pumping plants (see Figure 2-1) alters Delta hydrodynamics, changing conditions for rearing and migrating fish. Fish mortality at the pumps may result directly from entrainment[11] through fish screens, impingement,[12] predation, and handling of captured fish in the salvage process. The operation of the pumping plants may also have indirect effects on fish. Altered net flow patterns may change migratory patterns and increase the likelihood of predation. Pumping reductions may help reduce these effects on Delta hydrodynamics and reduce entrainment of fish at the pumping facilities.

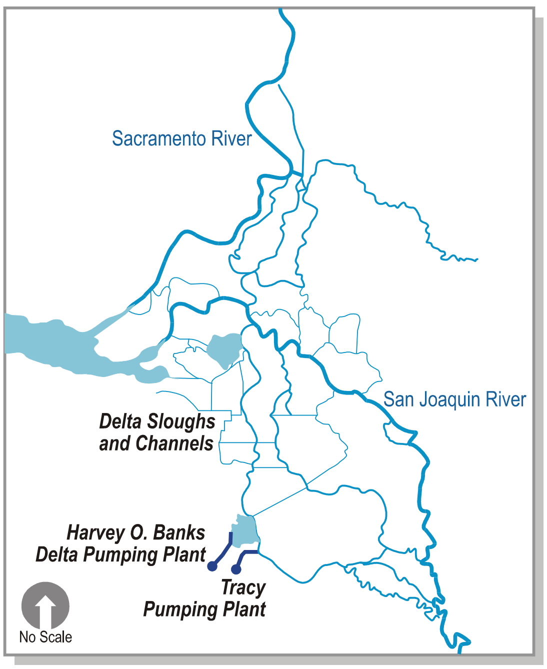

Figure 2-1
Location of Delta Export Pumps

In the No Action/No Project Alternative, Project Agencies would implement pumping reductions when the fish protection requirements mandated the reduction. The biological opinions would result in pump reductions when fish take at the pumps reached the "reconsultation level" established in the relevant opinion.[13] Table 2-2 shows the times that these protections would be likely to require pump reductions and the reasons that reductions would help fish.

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11 "Entrainment" occurs when fish are drawn into the pumps, which can injure fish or place them into unsuitable habitat. (Reclamation 2003.)

12 "Impingement" occurs when fish are trapped against the outer surface of a fish screen. (Environmental Protection Agency 2001.)

13 The biological opinions establish levels that define responses to fish mortality: "warning level" indicates that caution should be used, "reconsultation level" indicates that the action leading to fish mortality triggers reinitiating consultation, and "jeopardy" indicates that the action could place the continued existence of the fish species in jeopardy.

Table 2-2
Pump Reductions in the No Action/No Project Alternative

Timeframe	***Benefiting Fish***[14]	***Reason***	***Regulatory Mechanism***
December – January	Juvenile salmonids	Protect outmigrating juvenile salmonids	Biological opinion
	Adult smelt	Protect upmigrating adult smelt	Biological opinion
February – March	Juvenile salmonids	Protect outmigrating juvenile salmonids	Biological opinion
	Adult smelt	Protect upmigrating adult smelt	Biological opinion
April – May 31 days	Salmon smolts	Determine how export pumping affects survival and passage of salmon smolts through the Delta	D-1641 (VAMP) (SWP may not follow if not reimbursed)
June	Juvenile smelt	Protect juvenile smelt near the pumps	Biological opinion

In the No Action/No Project Alternative, the Projects would attempt to recover the water from reduced pumping through a variety of actions. The CVP would use (b)(2) water to account for the pumping reductions up to the 800,000 acre-foot upper limit. Both the SWP and CVP would use operational flexibility, as discussed in Section 2.3.2.1, to recover additional water. These sources are not likely to be sufficient to compensate for all pump reductions.

2.3.1.1.2 *Closing the Delta Cross Channel Gates*

The Delta Cross Channel (DCC), near the town of Walnut Grove, diverts Sacramento River water eastward to the Mokelumne River system where it more directly affects flows across the central Delta to the Project pumps (Figure 2-2). Net movement of water in a southerly direction through the Delta is not a natural hydrological process and can confuse migrating salmon that are attempting to follow streamflows.

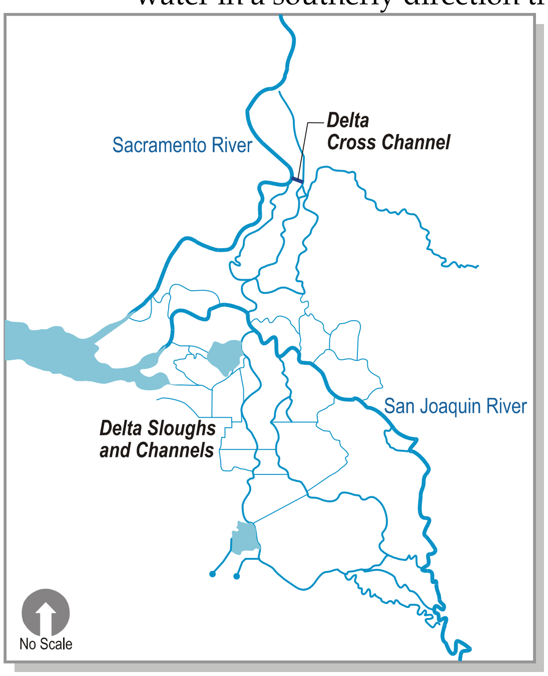

Figure 2-2
Location of Delta Cross Channel

Avoiding this effect is particularly important during the winter, when the winter-run Chinook salmon, a Federal- and State-listed endangered species, is migrating upstream to spawn. (The fall/late fall-runs are also migrating at this time, but they are classified as candidate – rather than endangered - species.) DCC gate closure during the winter also helps reduce the chance that emigrating spring-run and winter-run Chinook salmon and steelhead smolts might travel through the central Delta and swim toward the pumps instead of taking their natural route to the Bay.

Closing the DCC gates ensures that juvenile spring-run and winter-run Chinook salmon and steelhead smolts remain in the mainstem Sacramento River, improving their likelihood of successful outmigration through the western Delta and San

14 "Benefiting Fish" only include the fish that require pumping reductions through a regulatory mechanism. Incidental benefits to other fish would also result from some reductions.

Francisco Bay. The closure, however, also reduces the contribution of the Sacramento River to the central Delta, which may aggravate salinity intrusion. With the DCC closed, for the same exports, more flow comes from the western Delta, which is closer to the bay and has lower water quality. The Project Agencies may reduce export pumping in response to the changes in flow direction.

The regulatory baseline dictates DCC gate closures as follows:

1) Reclamation standing operating procedures call for gate closure when flow on the Sacramento River reaches 20,000 to 25,000 cfs.

2) State Water Resources Control Board Decision 1641 allows for the following operations of the DCC gates:

   – From November 1 through January 31 the gates will be closed for up to 45 days as requested by USFWS, NOAA Fisheries, and CDFG. These closures are determined as follows:

     - If the Knight's Landing catch index (KLCI) is > 5 and ≤ 10 salmon, the DCC gates will be closed for 4 days within 24 hours. If after 4 days the KLCI still exceeds 5, the gates will remain closed for another 4 days.

     - If the KLCI is > 10 salmon, the DCC gates are to be closed until the KLCI is ≤ 5.

   – The gates will be closed continuously from February 1 through May 20.

   – From May 21 through June 15 the gates will be closed for a total of 14 days, again as requested by USFWS, NOAA Fisheries, and CDFG.

2.3.1.1.3 Increasing Instream Flows

Increasing flows year-round in upstream river reaches would improve habitat conditions for anadromous and resident fish populations. Reclamation and USFWS may use CVPIA (b)(2) supplies to meet these objectives; therefore, the water would be used to increase flows on CVP-controlled streams, such as the Sacramento, American, and Stanislaus Rivers and Clear Creek. The improved flows would:

- Provide improved spawning and rearing habitat for salmon and steelhead;
- Improve survival of downstream migrating Chinook salmon smolts;
- Improve habitat conditions for white sturgeon, green sturgeon, American shad, and striped bass to migrate upstream, spawn, and allow progeny to survive;
- Aid in the downstream transport of striped bass eggs and larvae;
- Improve water temperatures and increase habitat for rearing juvenile steelhead; and

- Benefit delta smelt and other estuarine species.

The rationale and scientific basis for the improved flows are found in a variety of sources (including the Anadromous Fish Restoration Program[15] documents, published literature, CDFG reports, and other restoration programs) and are generally based on results of instream flow and temperature studies conducted by the USFWS, CDFG, or others, as well as relationships between flow and adult returns, correlation analyses, and other life-history information.

The flow objectives for each stream would be generally consistent with the Anadromous Fish Restoration Program's January 2001 Final Restoration Plan (AFRP Plan). These flow objectives would be higher than current existing minimum flow requirements in each stream. The targeted flow objectives would be based on thresholds of CVP reservoir storage and forecasted inflow and the amount of (b)(2) water available to meet the objectives. Fisheries and hydrologic monitoring would trigger higher flow releases. In general, spawning flows would be initiated in October or November when adult salmon are observed in the streams and river temperatures are 60 degrees or less.

2.3.1.1.4 Augmenting Delta Outflows

Water from the Delta flows to the San Francisco Bay, which is more saline than the Delta estuary. The water mixes in the Suisun Bay area, and the mixing zone location varies depending on the Delta outflow. Higher amounts of Delta outflow push the saltwater mixing zone farther out to the Bay, and lower flows allow the saltwater zone to move farther into the Delta. The No Action/No Project Alternative would include actions related to Delta outflow required by the SWRCB's Decision 1641.

2.3.1.2 Non-Flow-Related Actions

In the future under the No Action/No Project Alternative, a number of ongoing projects and programs are expected to continue, the purpose of which is to improve the condition of species and habitats. Under the CVPIA, funding in 2002 was dedicated to projects that will be designed and implemented during the EWA timeframe. Under the CALFED ERP, funding in 2002 was dedicated to projects that will be designed and implemented during the EWA timeframe. These activities are considered a part of the No Action/No Project Alternative because their purpose is for fish protection and environmental protection and because they may create beneficial and/or adverse effects during the EWA timeframe on similar resources, in the absence of the EWA.

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15 The U.S. Department of the Interior established the Anadromous Fish Restoration Program to satisfy Section 3406 (b)(1) of the CVPIA: "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..."

2.3.2 Water Management

In the No Action/No Project Alternative, it could be reasonably predicted that, in the foreseeable future, pumping reductions for biological opinions would result in reduced CVP and SWP exports. The CVP and SWP could use operational flexibility within the Delta to try to make up for the water lost during pump reductions. If the Projects could not access enough water, they would then reduce their deliveries to water users. The water users would likely then implement actions to reduce or address their shortages. These two groups of water management actions are described below.

2.3.2.1 Delta Operational Flexibility

In the No Action/No Project Alternative, the Projects would be able to access water from flexibly operating the Delta export facilities. These types of flexible operations were defined prior to the EWA and would be available for the Projects to help repay their users for pump reductions (see Section 2.3.1.1.1). Only the third item, relaxing the export/inflow ratio, would provide additional water for the project. The other two options would provide additional capacity for the Projects to move water through the Delta, but they would not provide additional water to reimburse water users for lost water. In the No Action/No Project Alternative, these actions would be unlikely to provide enough water or capacity to replace the water lost during fish actions. The sections below describe the available options to increase water and capacity.

2.3.2.1.1 Joint Point of Diversion

The Joint Point of Diversion, established by D-1641,[16] allows the SWP and CVP to pump water for each other during times of restriction for one set of pumps. D-1641 established a staged implementation, in which the Projects would gradually begin to use facilities jointly.

- **Stage 1:** the CVP can use Banks Pumping Plant to divert water for selected CVP contractors, and either Project could use the others' facilities to recover export reductions to protect fish if the Projects complete a Water Level Response Plan that outlines the responses to changing water levels in the south Delta.
- **Stage 2:** the Projects can divert water from either pumping plant for any of their permitted purposes up to permitted capacity. The Projects must submit an operations plan to protect fish and wildlife and other legal users of water.
- **Stage 3:** the Projects can divert water from either pumping plant up to the physical plant capacity if they completed an operations plan to protect aquatic resources and their habitat and protect other legal users of water and if they implement water barriers or other water level protection.

The stages of Joint Point of Diversion are discussed in more detail in Section 4.1.3.2.

[16] Water rights Decision 1641 is explained in more detail in Chapter 1.

Prior to the CALFED ROD, the Projects were in Stage 1 and Stage 2 of the implementation process and could use Joint Point of Diversion to replace water that had been lost during pump reductions to protect fish. It is reasonably foreseeable that without the CALFED ROD, the Project Agencies would have completed the requirements to move into Stage 3 in which they could use the Joint Point of Diversion to supply water to their contractors in the Export Service Area.

In the No Action/No Project Alternative, the Joint Point of Diversion could provide additional capacity to pump water into the Export Service Area, but the Projects would need to provide the water to be pumped.

2.3.2.1.2 Relaxation of the Section 10 Constraint

The SWP is limited under Section 10 of the Rivers and Harbors Act,[17] pursuant to U.S. Army Corps of Engineers (USACE) Public Notice 5820-A, to a 3-day average rate of diversion of water into Clifton Court Forebay of 13,250 acre-feet per day, or 6,680 cfs. Between December 15 and March 15, the SWP can increase diversions above 6,680 cfs by one-third of the San Joaquin River flow at Vernalis when this flow is greater than 1,000 cfs.

The USACE granted permission to the SWP to relax the Section 10 constraint and increase the base diversion rate by the equivalent of 500 cfs to an average of 7,180 cfs for the months of July through September. The relaxation was initially permitted for summer 2000–02. Another application for relaxation in 2003 and 2004 has been submitted and is expected to be approved in 2003. In the No Action/No Project Alternative, this 500 cfs, if renewed, would be used to replace water lost during pump reductions to benefit fish. The conveyance capacity would yield approximately 50,000 to 60,000 acre-feet per year, depending on operational restrictions.

2.3.2.1.3 Relaxation of the Export/Inflow Ratio

Under the SWRCB's D-1641 and Orders 2000-10 and 2001-5, Project exports are limited to a percentage of Delta inflow, usually 35 or 65 percent. This limitation is commonly called the Export/Inflow, or E/I, ratio, and the values throughout the year are shown in Table 2-3. D-1641 allows for these ratios to be relaxed at the discretion of the NOAA Fisheries, USFWS, and CDFG. In the No Action/No Project Alternative, water that is diverted because of the E/I ratio relaxation would be used to reimburse the Projects for water lost during pump reductions to protect fish.

2.3.2.2 Water Users' Actions

If EWA were not implemented and export users received reduced deliveries due to pumping reductions described in Section 2.3.1.1.1, the export users could engage in one or more of the following options:

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[17] Section 10 of the Rivers and Harbors Act prohibits the obstruction or alteration of navigable waters of the U.S. without a permit from the USACE. Under Section 10, the USACE regulates projects or construction of structures that could interfere with navigation. A Department of the Army permit is needed to construct any structure on any navigable water of the United States, to excavate or deposit material in such waters, or to do any work affecting the course, location, condition, or physical capacity of such waters.

Table 2-3 Export/Inflow Ratio	
Period	***Percent of Total Delta Inflow***
October – January	65
February	35 – 45
March – June	35
July – September	65

- Accept the shortage;
- Increase local water supplies by one or more of the following methods:
  - Groundwater pumping,
  - Local transfers,
  - Recycling,
  - Desalination, or
  - Water use efficiency or conservation;
- Idle or retire agricultural lands;
- Groundwater substitution and crop idling transfers in northern California.
- Pursue independent water transfers (similar to EWA-type transfers); or
- Turn to litigation and/or political pressure to revise the ESA. Although litigation and political pressure may occur in the foreseeable future, subsequent responses to these actions would likely be beyond the timeframe of this EIS/EIR (2002-07).

No other resolution of conflicts at the Delta export pumps can be reasonably predicted for the foreseeable future.

2.4 Flexible Purchase Alternative (The Proposed Action/The Proposed Project)

All action alternatives would need to address the EWA Operating Principles Agreement in relation to acquiring water to compensate for pump reductions and for taking beneficial fish actions as outlined in the CALFED ROD. The Flexible Purchase alternative would allow the EWA agencies the ability to acquire up to 600,000 acre-feet of water assets to address pump reductions, fish actions, and to compensate the CVP/SWP for water otherwise lost due to those actions. Any alternative has to be able to allow the EWA agencies to use water for a broader range of fish actions than envisioned in the CALFED ROD. These actions would include reducing Delta export pumping, closing the Delta cross channel, augmenting Delta outflow, or increasing instream flows. The EWA agencies would have the flexibility to choose from these actions to best protect at-risk fish, and would not need to solely focus on actions within the Delta. The Flexible Purchase Alternative would allow the EWA agencies to respond to changes in base condition operations, such as modifications to (b)(2), while providing higher levels of fish actions than either of the other alternatives. Any alternative would be limited primarily by funding in that the EWA agencies would determine the amount of assets to acquire largely based on available funding and asset prices. Any alternative would have flexibility to respond to changing fish and hydrologic conditions midway through a year.

The Flexible Purchase Alternative would allow the EWA agencies to vary water purchases from those defined in the CALFED ROD to meet needs in a specific year. The CALFED ROD identified a minimum of 185,000 acre-feet of water purchases per year, with at least 35,000 acre-feet coming from areas that are upstream from the Delta and 150,000 acre-feet from the export service areas. The Flexible Purchase Alternative would allow the EWA Project Agencies to purchase up to 600,000 acre-feet of water, although the EWA agencies would typically acquire 200,000 to 300,000 acre-feet annually, except in wet years or years with high fish needs (see Section 2.4.3 for a discussion of a typical year). Water purchases in this alternative would be neither fixed at 185,000 acre-feet per year nor held to specific purchase quantities upstream from the Delta or in the export service areas. The EWA agencies would use the concept of functional equivalence (as defined in Section 2.2.2.3) to combine methods, water sources, and operational flexibilities in this alternative to provide a broad range of fish actions, to help offset changes in levels of protection provided by (b)(2) assets, or to increase the EWA in the future. Variable assets would be acquired at the same rate as in the other action alternative.

This Alternative would allow the EWA Project Agencies to acquire up to 200,000 acre-feet of storage capabilities if a reasonably priced option were available; this EIS/EIR assesses the environmental effects of groundwater storage because it is the most likely storage option. If groundwater storage could not be implemented for financial or technical reasons, the alternative would allow other actions to achieve similar objectives.

If the EWA assets were fully used but were not sufficient to prevent jeopardy, then the EWA Management Agencies would initiate Tier 3. (See Section 2.1.3) In the Flexible Purchase Alternative, the EWA Management Agencies would not likely need to initiate Tier 3 frequently because the Flexible Purchase Alternative includes high upper limits for purchases. If Tier 3 were needed, additional acquisitions would be covered by this environmental document as long as the total assets (Tier 2 and Tier 3) were less than 600,000 acre-feet. Asset purchases above 600,000 acre-feet would require additional environmental analysis. The Flexible Purchase Alternative would cost more, have greater benefits for fish (supporting protection and recovery), and would likely result in a reduced frequency of initiating Tier 3 relative to the other alternatives.

Providing flexibility to operate differently each year could help the EWA agencies address varying needs for water in different year types. Fish actions at the export pumps are dependent on the presence of the fish near the pumps, a factor that is not always dependent on the hydrologic year type. After the EWA agencies undertake a fish action, the program must repay water to the affected CVP or SWP water users. As explained previously, the EWA agencies owe those projects the amount of water that could have been pumped during the time of a pump reduction. During a typical dry year the pumps are not very active because there is less exportable water in the Delta. The Projects do not pump as much water in dry years because supplies are limited. Therefore, the level of compensation required to the Projects would be less than in below normal to wet years. In wet years, the amounts of water in the Delta allow the Project Agencies to operate the export pumps at their maximum permitted capacity. The water that would have been pumped in a wet year is much greater than in a dry year. In wet years, the EWA agencies must be able to provide more water to repay the projects than in dry years.

The next two sections (2.4.1 and 2.4.2) describe the components of the Flexible Purchase Alternative, including the EWA agencies' actions to protect fish and benefit the environment, and the actions to acquire and manage assets. Section 2.4.3 includes a description of the "typical" year EWA operations. Section 2.4.4 describes the EWA agencies' acquisition strategy.

2.4.1 Actions to Protect Fish and Benefit the Environment

The EWA agencies have established operating tools that allow them to protect fish. These operational tools include (1) reducing export pumping, (2) closing the Delta Cross Channel gates, (3) increasing instream flows, and (4) augmenting Delta outflow. These actions were described in the No Action/No Project Alternative, Section 2.3.1.1. These actions take place throughout the year, under various conditions. The EWA agencies use their acquired assets, in addition to actions specified in the regulatory baseline fishery protection, to meet protection objectives for at-risk fish species within the Sacramento and San Joaquin Rivers and their tributaries and the Delta. Each tool, its timing, the protection it provides, and why and how each action is undertaken is described below. These descriptions are followed by an explanation of the process used to decide when actions should be taken.

2.4.1.1 Export Pumping Reductions

As described for the No Action/No Project Alternative, reducing export pumping can protect fish in the vicinity of the export pumps and also can provide secondary benefits to fish throughout the Delta. The Management Agencies typically use pump reductions from December to June, but vary them each year depending on the behavior of the fish and hydrologic conditions and water quality. The general times of year for pump reductions that benefit specific fish types would be similar to the No Action/No Project Alternative. The EWA agencies would not necessarily wait to reach "reconsultation level" conditions identified in the Biological Opinions before calling for export reductions. In the Flexible Purchase Alternative, the EWA agencies could use the assets to take fish actions when they deem most appropriate (likely sooner than in the No Action/No Project).

Actual EWA pump reductions would vary each year depending on fish conditions, hydrology, available EWA assets, and other factors. The potential reductions are discussed below by time of year.

2.4.1.1.1 Export Reductions in December and January

Reducing exports in December and January during critical outmigration periods would increase survival of outmigrating salmonids from the Sacramento basin, including listed winter-run Chinook, spring-run Chinook, steelhead trout, and candidate late-fall and fall-run Chinook. Adult delta smelt and Sacramento splittail are also migrating upstream to spawning areas at this time.

This reduction would increase the survival of juvenile Chinook salmon smolts (including winter-run presmolts and spring-run yearlings) migrating through the Delta in the winter. It is scientifically supported by several years (1993 – 2002) of mark/capture data that indicate the survival of juvenile late fall-run Chinook salmon in the central Delta decreases as exports increase. Further support for a pump reduction is based on a recent analysis that indicates that December is an important migration period for winter run pre-smolts and that the Delta Cross Channel gate closures during December appear to be correlated with low winter-run salvage at the export facilities later in the year.

Typical actions would reduce combined pumping at Banks and Tracy Pumping Plants to 6,000 cfs for 5 days at a time, and in some years those reductions occur several times during these months. For example, the EWA in past years reduced pumping for 10 days total in January and used 65,000 to 70,000 acre-feet of assets. During these months, the EWA agencies usually reduce pumping in conjunction with closing the Delta Cross Channel gates.

2.4.1.1.2 Export Reductions in February and March

Reducing pumping in the critical out-migration period in February and March would increase survival of out-migrating juvenile Chinook salmonids from the Sacramento basin, with a focus on ESA listed winter-run Chinook salmon and steelhead trout. Adult delta smelt and Sacramento splittail also are migrating upstream to spawning areas at this time.

This reduction would increase the survival of juvenile salmonid smolts migrating through the Delta in the late winter. Several years (1993 – 2002) of mark/recapture data indicate that the survival of juvenile late fall-run Chinook salmon in the central Delta decreases as exports increase. These export reductions would supplement the primary protective action of closing the Delta Cross Channel gates during this period. Reduced exports also decrease ESA incidental take of juvenile winter-run salmon, spawning adult delta smelt and Sacramento splittail when the species are in the south/central Delta. Typical actions would reduce pumping to 6,000 cfs –8,000 cfs for 5-10 days at a time in February through March.

2.4.1.1.3 *Export Reductions in April and May*

Reducing Delta exports during April and May would help out-migrating juvenile fall-run Chinook salmon. As described in the No Action/No Project Alternative, the VAMP program calls for specific flow releases from the Stanislaus, Tuolumne, and Merced Rivers and specific pump reductions during 31 days, generally from mid-April to mid-May. These actions would evaluate the relative effects of export and inflow to juvenile San Joaquin basin Chinook salmon survival and assist in providing protection for both anadromous and estuarine species. The CVP would use (b)(2) water to undertake the VAMP study in the No Action/No Project Alternative, but the SWP may not have water to contribute to the study. As part of the Flexible Purchase Alternative, the EWA could provide water for the SWP to participate in VAMP.

The Flexible Purchase Alternative could also include pumping reductions before April 15 to protect juvenile anadromous or resident species (including delta smelt). After May 15, the EWA agencies could request that exports continue at some reduced stable level or allow exports to ramp up gradually between May 16 and June 1. These additional days of reduced exports would provide additional protection for juvenile anadromous and resident estuarine species.

2.4.1.1.4 *Export Reductions in June and July*

Delta pumping reductions in June could decrease losses of juvenile delta smelt and splittail. Also, a gradual increase (ramp up) rather than a rapid increase of exports during June may be used to increase survival of both anadromous and resident estuarine species in the south/central Delta. In some years, these actions may continue into the early part of July.

Pumping reductions would decrease the effects of CVP/SWP export facilities on listed resident fish in the south Delta and would enable juvenile resident estuarine and anadromous species to migrate away from the export facilities where they are less vulnerable to direct loss and/or direct mortalities associated with export operations. Data indicate “incidental take” is greater when fish population densities are high near the export facilities or when exports increase. Additional information indicates that, generally, when the export rate increases rapidly under low Delta inflow and fish densities are high in the south/central Delta, fish losses at the facilities can be high.

2.4.1.2 Closing the Delta Cross Channel Gates

As discussed for the No Action/No Project Alternative, closing the DCC gates increases the likelihood that juvenile spring-run and winter-run Chinook salmon and steelhead smolts remain in the mainstem Sacramento River, improving their survival and likelihood of successful out-migration through the western Delta and San Francisco Bay.

When DCC gates are closed outside the regulatory baseline, EWA must compensate for water supply losses from these reductions. Additional gate closures would typically occur in November, December, January, May, or June, if additional closures were needed after the regulatory requirements of the No Action/No Project were met.

2.4.1.3 Increasing Instream Flows

Increasing instream flows would improve habitat conditions in tributary rivers and the Delta for anadromous and resident fish. The Flexible Purchase Alternative would include flow increases beyond those in the No Action/No Project Alternative. Table 2-4 shows fish species that could require supplemental flows in various rivers and tributaries to meet habitat requirements for the various life history stages. The table also displays the timing of each life history stage and the rivers (those affected by EWA actions) in which each fish species can be found.

Table 2-4
Anadromous Fish Life History Stages and Locations

Fish	*Run*	*Stage*	*Month*	*Location*
Chinook Salmon	Fall	Immigrating adult	July - December	Sacramento, Feather, Yuba, American, San Joaquin, Merced
		Spawning	October - December	
		Emigrating juvenile	January - June	
	Late-fall	Immigrating adult	October - April	Sacramento, Feather, Yuba
		Spawning	December - April	
		Emigrating juvenile	May - December	
	Winter	Immigrating adult	December - July	Sacramento
		Spawning	Late April - mid-August	
		Emigrating juvenile	August - March	
	Spring	Immigrating adult	March - September	Sacramento, Feather, Yuba
		Spawning	Mid-August - October	
		Emigrating juvenile	November - June	
Steelhead	Central Valley	Immigrating adult	August - March	Sacramento, Feather, Yuba, American, San Joaquin, Merced
		Spawning	December - April	
		Emigrating juvenile	January - October	
American shad		Immigrating adult	April - May	Sacramento, Feather, Yuba, American, San Joaquin
		Spawning	June - July	
		Emigrating juvenile	August - October	
Green Sturgeon		Immigrating adult	February - June	Sacramento
		Spawning	March - July	
		Emigrating juvenile	June - August	
White Sturgeon		Immigrating adult	February - May	Sacramento, American, San Joaquin
		Spawning	May - June	
		Emigrating juvenile		

Source: Final Restoration Plan for the Anadromous Fish Restoration Program (AFRP Plan) (USFWS 2003)

Supplemental flows, over the existing baseline for fishery protection requirements for instream flows, provide additional water primarily to benefit salmon and steelhead adult immigration, spawning, egg incubation, rearing, and emigration of juveniles through the regulation of pulse flows, water temperature, water quality, and the maintenance of attraction and flushing flows. While not the primary objectives of the EWA, instream flows may also aid white and green sturgeon emigration, spawning, egg incubation, and rearing and American shad spawning, incubation, and rearing.

The EWA instream flow actions would occur on the waterways where the EWA purchases assets, including the Sacramento, Feather, Yuba, American, Merced, and San Joaquin Rivers. The EWA actions to increase instream flows would use the AFRP as a guide to identify the times and locations that supplemental flows are needed. CALFED's Environmental Water Program (EWP) and the CVPIA (b)(2) water would also help to meet the above objectives. CVPIA (b)(2) water can currently be used to augment instream flows, and the EWP may be able to take these actions in the future. The EWP is described further in Chapter 22, Cumulative Analysis Framework.

2.4.1.4 Augmenting Delta Outflows

Fresh water from the Delta flows to the San Francisco Bay, which is more saline than the Delta estuary. The fresh water mixes with salt water in the Suisun Bay area, and the mixing zone location varies depending on the Delta outflow. Higher amounts of Delta outflow push the saltwater mixing zone farther out to the bay, and lower flows allow the saltwater zone to move farther into the Delta. Augmenting Delta outflows could move the saltwater mixing zone farther into the bay, improving the water quality within the Delta. The Flexible Purchase Alternative could include actions to augment Delta outflow in addition to outflows required by the SWRCB's Decision 1641 and existing baseline level of fishery protection. Augmenting Delta outflow would also help to restore a westward-moving flow pattern through the Delta, which would help outmigrating fish.

In addition to taking direct actions to augment Delta outflows, other actions within the Flexible Purchase Alternative would have the secondary benefit of increasing Delta outflows. When the EWA agencies reduce Delta export pumping, the water that would have been pumped instead becomes Delta outflow. Delta outflow would also increase during the summer months when EWA assets are moved through the Delta because the transfers must include outflow water (carriage water) to maintain water quality (see Section 2.4.2.1 for additional information).

2.4.1.5 Decision-Making Process

A multi-agency team called the EWA Team (EWAT) decides when fish actions should be taken, using a consensus process based upon biological indicators for the species considered to be at immediate risk. This decision is not solely based on the take limits at the export pumps. Appendix D includes the existing decision trees for delta smelt and Chinook salmon.

EWAT considers the technical input of the Data Assessment Team (DAT), which includes stakeholder representatives, when deciding when fish actions should be taken. When the EWAT cannot reach consensus or decides issues should be elevated, issues are presented to the Water Operations Management Team (WOMT) for resolution. Decisions are reported to the CALFED Operations Group, including agency and stakeholder representatives.

The EWA agencies in November and December begin the process of identifying placeholders[18] for the next year in coordination with the (b)(2) interagency team. These placeholders are determined based upon biological objectives and hydrology (which includes the latest forecast/allocation study for both the CVP and SWP). These placeholders are then evaluated monthly to determine whether they are still applicable for the current month or for the following months (up until June). The use of the EWA placeholders in a particular month is based upon the biological decision trees for salmon and delta smelt and real-time monitoring. The placeholders, if not used in a particular month, can be reassigned and used in another month. The purposes in identifying these placeholders are to assist the Project Agencies in acquiring contracts for water purchases and to inform the EWA agencies of upcoming EWA actions.

2.4.2 Asset Acquisition and Management

This section is organized according to the geographic areas in which the EWA Project Agencies acquire and/or manage assets for the Flexible Purchase Alternative: upstream from the Delta (Section 2.4.2.1), the Delta (Section 2.4.2.2), and the export service areas (Section 2.4.2.3). Figure 2-3 shows each of these areas.

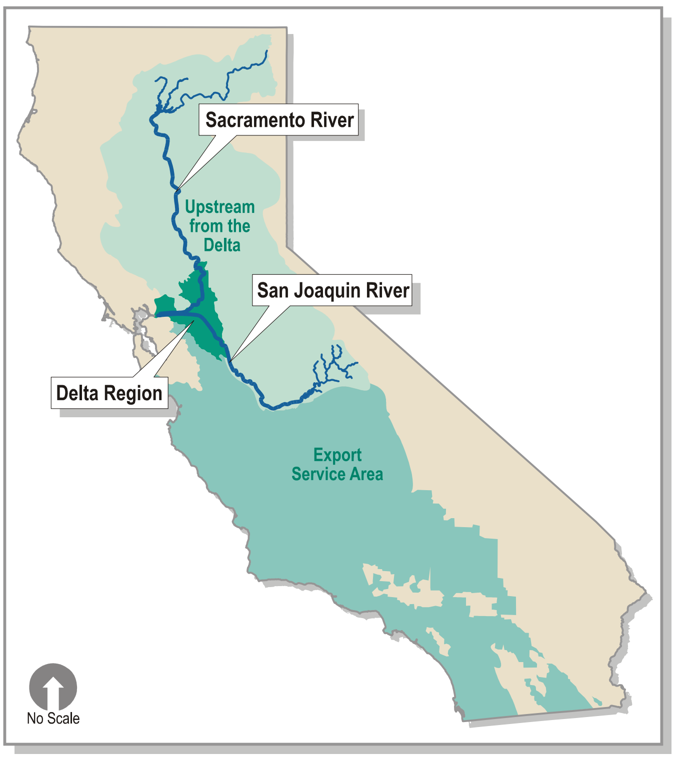

Figure 2-3
Asset Acquisition and Management Areas

The EWA Project Agencies can use any of the acquisition methods described below to purchase water. Flexibility to purchase from any of these sources is critical to helping the EWA run efficiently because it allows the Project Agencies to purchase the least expensive water available in any given year. Table 2-5 lists agencies that may be willing to sell water to the EWA or have sold water to the EWA in past years,[19] along with a general range of potentially available water volumes. None of the purchases in Table 2-5 are guaranteed; the EWA Project Agencies could only make purchases if a seller is willing to participate.

The numbers presented in Table 2-5 are estimates and do not necessarily reflect the amount of water that would be available in any given year. Generally, these estimates

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18 Placeholders are an estimate of reductions necessary to protect fish.

19 Information on past EWA transactions can be found online at http://wwwoco.water.ca.gov/calfedops/2001ops.html or http://wwwoco.water.ca.gov/calfedops/2002ops.html

reflect the potential upper limit of available water in order to include the maximum extent of potential transfers in the environmental analysis. Some of the agencies listed

Table 2-5
Potential Asset Acquisition and Management for the Flexible Purchase Alternative (Upper Limits)

	Range of Possible Acquisitions (TAF)				Management	
Water Agency	**Stored Reservoir Water**	**Groundwater Substitution**	**Crop Idling/ Subst.**	**Stored Groundwater Purchase**	**Ground-water Storage Services**	**Source Shifting/ Pre-Delivery**
Upstream from the Delta Region						
Sacramento River Area of Analysis						
Glenn-Colusa ID		20-60	100			
Reclamation District 108		5	45			
Anderson Cottonwood ID		10-40				
Natomas Central MWC		15				
Feather River Area of Analysis						
Oroville Wyandotte ID	10-15					
Western Canal WD		10-35	70			
Joint Water Districts		20-60	65			
Garden Highway MWC		15				
Yuba River Area of Analysis						
Yuba County WA	100	85				
American River Area of Analysis						
Placer County WA	20		10			
Sacramento GW Authority				10		
Merced/San Joaquin River Area of Analysis						
Merced Irrigation District		10-25				
Export Service Area						
San Joaquin Valley						
Kern County WA			115	50-165	X	X
Semi-Tropic WSD[1]					X	
Arvin-Edison WSD[1]					X	
Westlands WD			195			
Tulare Lake Basin WSD			110			
Santa Clara Valley						
Santa Clara Valley WD						X
Southern California						
Metropolitan WD						X

Abbreviations:
GW: Groundwater
ID: Irrigation District
MWC: Mutual Water Company
WA: Water Agency
WD: Water District
WSD: Water Storage District
Footnote 1: Semi-Tropic WSD and Arvin-Edison WSD are within Kern County Water Agency. Their groundwater storage facilities are separate from the Agency, but they may participate in other programs that the agency helps administer, such as crop idling.

in Table 2-5 indicated an interest in transferring water to the EWA, but could not provide a range of potentially available water supplies. The numbers in the table include estimates provided either by water sellers or the Project Agencies. Actual purchases would depend on the year type, EWA funding, and the amounts that sellers would be willing to transfer in a given year.

The EWA agencies would only purchase water from a willing seller.

The potential acquisitions in Table 2-5 would not all occur within a single year. The table is simply a menu that illustrates the flexibility the EWA Project Agencies have in making purchases. These EWA Project Agencies may negotiate one-year or multi-year purchases when acquiring assets. Figure 2-4 shows the locations of the water agencies listed in Table 2-5.

Table 2-5 does not contain an exhaustive list of potential EWA sellers; additional agencies may decide at any time that they wish to sell water to the EWA. An analysis of the potential environmental effects of transferring water, however, requires information on the transfer sources. This environmental document will analyze the effects associated with the potential transfers in Table 2-5 and will serve as a document from which to tier, should other EWA transfers require a supplemental document. EWA water transfers that meet and implement the environmental measures incorporated into the project and mitigation measures developed in this document for the specific areas identified should not need additional environmental documentation once the programs have been reviewed and are complying with these measures.

Some sections of this document consider additional groundwater substitution or idling transfers in the analyses to assist potential future EWA transfers. The modeling includes increased transfers upstream from the Delta to provide analysis for potential additional future EWA transfers. This increase will prevent the EWA agencies from needing additional modeling if new transfers are suggested in the future. The analysis, therefore, considers increased asset acquisitions from waterways upstream from the Delta to assess the effects of transferring the amounts of water listed in Table 2-5 as well as potential new EWA transfers.

2.4.2.1 Upstream from the Delta Region

As shown on Figure 2-3, the Sacramento and San Joaquin Rivers flow into the Delta; therefore, these rivers and their tributaries are designated in this document as the Upstream from the Delta Region. Potential asset acquisitions in the Upstream from the Delta Region include stored reservoir water, groundwater substitution, crop idling/substitution, and stored groundwater purchase. (See sections 2.4.2.1.1 – 2.4.2.1.4.) The EWA agencies could use assets acquired in this region for multiple purposes, but would generally use assets to protect and restore fish species that are affected by the conflicts at the Delta export pumps, the primary objective of the EWA. The EWA protects fish at the pumps by reducing pumping when it would help at-risk fish species, then transferring EWA assets across the Delta at other times to repay CVP and SWP users for water lost during pump reductions.

Both the CVP and SWP have pumping plants in the southern portion of Delta - the Tracy Pumping Plant and the Harvey O. Banks Delta Pumping Plant, respectively. The Project Agencies use these facilities to pump water to users south of the Delta. The Project Agencies also use these pumps when available to move EWA water to the export service areas. Cross-Delta transfer capacity is generally available to the EWA when the Delta is in balanced conditions (as defined in Section 1.6.3), the SWP pumps are operating below their maximum permitted capacity to deliver water to contractors, and there is no reduction for fish purposes. Typically, the CVP pumps are

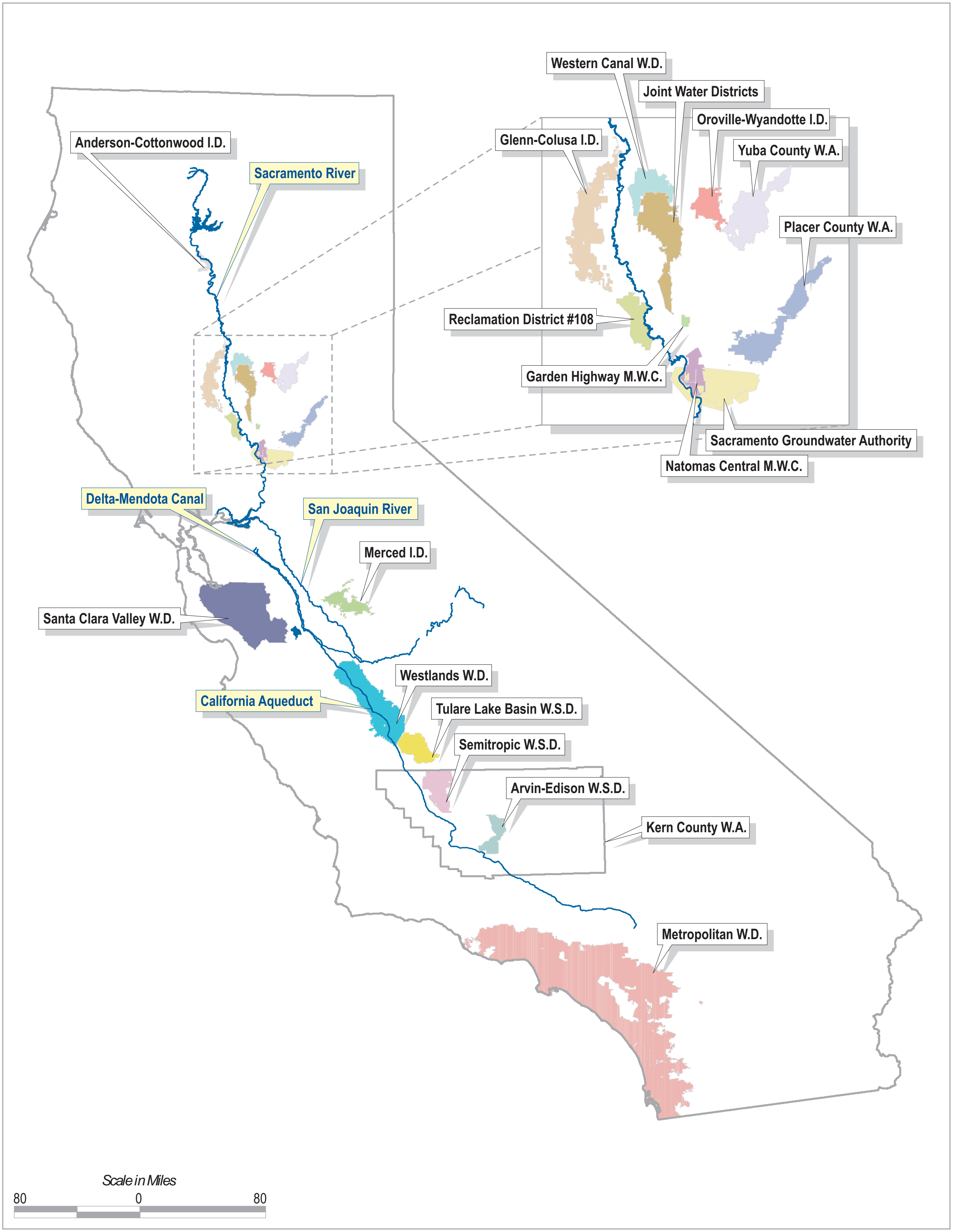

Figure 2-4
Potential Asset Acquisition and Management Participants

operating at full capacity for most of the year (except in dry years), so the EWA primarily uses the SWP pumps.

Delta pump availability varies by year type. The pumps are active during the wet season when the winter rains and spring snowmelt provide high flows into the Delta. New Bay-Delta standards,[20] however, impose pumping restrictions during some of the high-flow periods. During wet years, high flows and the opportunity to divert those flows extend later in the spring than during dry years. In dry years, more unused capacity at the Delta pumps is available, and more transfer water can be moved through the Delta. The Project pumps would not begin to move EWA water until the fish have left the vicinity of the Delta pumps, as discussed in more detail in Section 9.2.4.2. Typically, EWA water would be moved through the Delta from July through September, although the Project operators could start moving EWA water in mid-June if fish were not in the area of the export pumps.

The asset acquisition types have associated date ranges (discussed in each section below) during which water may be transferred, depending on local conditions and Delta conveyance availability. The ranges listed cover the entire length of time when transfers may occur, but the transfers will not usually continue for the entire period. For example, if a reservoir takes approximately 1 month to release water, the range may include 3 months because water could be released at any time during that timeframe.

Shifting pumping to times that are less sensitive to fish would increase pumping during times when fish are absent, which sometimes requires increased Delta outflow to comply with water quality regulations in the Delta. Carriage water is defined as the additional water needed for Delta outflow to compensate for the additional exports made on behalf of a transfer to assure compliance with water quality requirements of the SWP and CVP. Generally, more water must be released during a transfer than could reach the pumps, as some of the transferred water flows to the ocean as Delta outflow. The Project Agencies computed the carriage requirements at 15 percent of the transfer volume for the 2001 summer transfer season and 20 percent for the 2002 summer transfer season (Pettit-Polhemus 2003b). EWA transfers from the Upstream from the Delta region would incorporate enough carriage water to maintain water quality within the Delta at without-EWA constituent levels. The EWA's process for incorporating carriage water is described in more detail in Chapter 5.

Transfers along the San Joaquin River are charged a 10 percent conveyance loss to include seepage and evaporation losses. The EWA agencies must factor Delta carriage and conveyance losses into the determination of the total amount of water that must be acquired to fully compensate for EWA actions to benefit fish and the environment.

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[20] These standards include requirements from several biological opinions and the 1995 Delta WQCP, as defined in Section 2.3.1.1.

2.4.2.1.1 *Stored Reservoir Water*

The EWA Project Agencies could acquire water by purchasing surface water stored in reservoirs owned by non-Project entities (those that are not part of the CVP or SWP). To ensure that purchasing this water would not affect downstream users, EWA agencies would limit assets to water that would not have otherwise been released downstream. In most cases, the stored reservoir water sellers could demonstrate that they would have maintained water in storage without the transfer.

When the EWA purchases stored reservoir water, these reservoirs would be drawn down to lower levels than without the EWA, as shown in Figure 2-5. To refill the reservoir, a seller must prevent some flow from going downstream. Sellers must refill the storage at a time when downstream users would not have otherwise captured the water, either in downstream Project reservoirs or with Project pumps in the Delta. Typically, refill could only occur during Delta excess conditions (when there is more water than the Projects can pump).[21] Refill criteria have been established for non-Project reservoirs to prevent EWA purchases from affecting downstream users; Section 4.2.3 describes these criteria in more detail. Stored reservoir water is released in addition to reservoir water that would be released without the EWA, thereby increasing flows in downstream waterways.

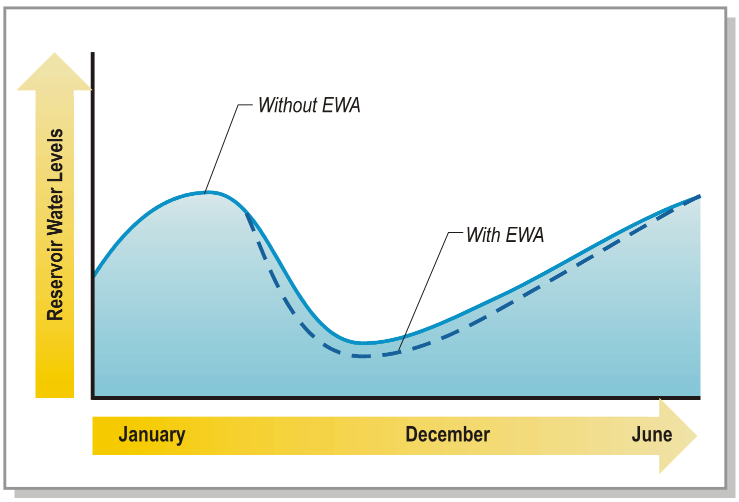

Figure 2-5
Reservoir Level Changes Due to Stored Reservoir Water Purchases

The EWA Project Agencies may purchase stored reservoir water from Oroville-Wyandotte Irrigation District (Sly Creek and Little Grass Valley Reservoirs), Yuba County Water Agency (New Bullards Bar Reservoir), and Placer County Water Agency (French Meadows and Hell Hole Reservoirs). The sections below describe operations associated with each of these potential acquisitions.

<u>Feather River</u>

Oroville-Wyandotte Irrigation District has multiple reservoirs as part of its South Fork Project and would sell water to the EWA out of Little Grass Valley and Sly Creek Reservoirs (see Figure 2-6). Water from Little Grass Valley Reservoir would flow through the South Fork Diversion tunnel into Sly Creek Reservoir. Sly Creek Reservoir receives water from upstream tributaries, Little Grass Valley, and Slate Creek (a tributary to the Yuba River). The water from Sly Creek Reservoir would pass into Lost Creek Reservoir, where it would enter a series of tunnels to generate power

21 Delta excess water conditions, also referred to as unbalanced conditions, are defined in the Coordinated Operation Agreement as "periods when it is agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley in basin uses, plus exports."

between Lost Creek and Ponderosa Reservoirs. The water released from these reservoirs would not typically enter the South Fork of the Feather River or Lost Creek as it flows downstream to Lake Oroville.

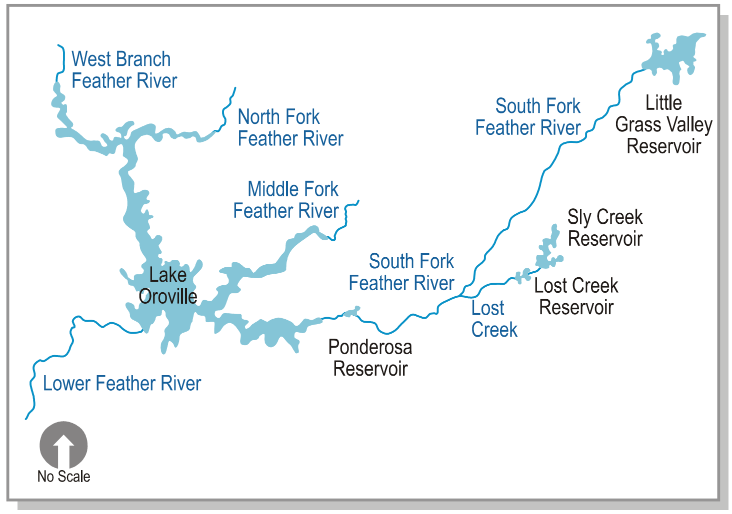

Figure 2-6
Feather River Water Facilities

Oroville-Wyandotte's water is available from October to December, prior to the typical EWA transfer season and the time when the assets would be used, so it would be stored in Lake Oroville through the winter and into the following summer when the Delta pumps have available capacity.

As a result of an acquisition from Oroville-Wyandotte Irrigation District, water levels in Sly Creek and Little Grass Valley Reservoirs would be lower than under non-EWA conditions from when the transfer occurred until the reservoirs refill. Lake Oroville would store the releases until the following summer, increasing Oroville water elevations relative to non-EWA conditions from October until September. The acquisition water would be released from Lake Oroville in mid-June through September, increasing downstream flows over the conditions without the EWA.

Sly Creek and Little Grass Valley Reservoirs would refill, as excess water is available, decreasing releases from these reservoirs. Of the releases from these reservoirs that exceed the required downstream flows, most are diverted into the power generation facilities; therefore, refilling the reservoirs should not change riverflows. Sly Creek, however, receives some water from Slate Creek, a tributary of the Yuba River, and refill may also affect the Yuba River.

This pattern of releases results in EWA water stored in Lake Oroville through the wet season, but as the EWA has the lowest priority for storage, EWA assets would be the first to spill if the reservoir storage reaches flood control levels. This option carries a risk that the assets may not be available in the spring. As part of the purchase contract, the EWA agencies would include a "spill protection term" to ensure that if the water spills from Oroville, the EWA would not have to pay for it.

Yuba River

Yuba County Water Agency would sell water to the EWA from New Bullards Bar Reservoir, on the North Fork of the Yuba River. These acquisitions would be stored in New Bullards Bar Reservoir until the Delta pumps have available capacity to transfer the water south. Once released from New Bullards Bar Reservoir, the water would travel through a series of tunnels to generate power and enter the upstream end of Englebright Lake (Figure 2-7).

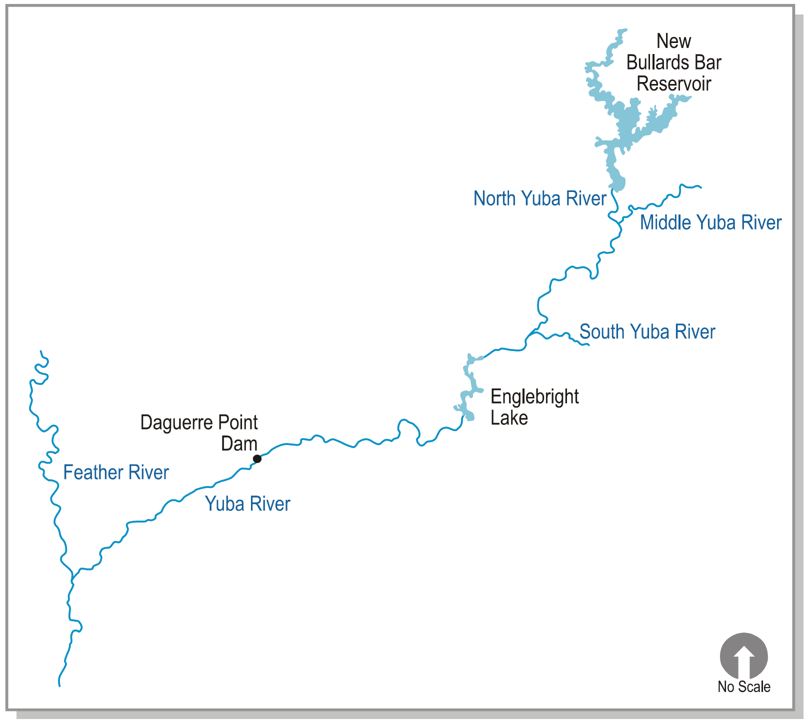

Figure 2-7
Yuba River Water Facilities

Withdrawing water from the reservoir would lower the surface water elevations relative to the non-EWA conditions from mid-June until the reservoir is refilled. If assets were released in mid-June through September, flows would increase in the Yuba River downstream from Englebright Lake. New Bullards Bar Reservoir would refill as water is available in the Yuba River, which would decrease flows downstream from the reservoir.

American River

Placer County Water Agency would sell water to the EWA Project Agencies from Hell Hole and French Meadows Reservoirs, on the Middle Fork of the American River (see Figure 2-8). It would take the agency 2-3 months to move the water downstream to Folsom Lake, where the water could be held until the EWA agencies are ready to release it. The water would be released from Hell Hole and French Meadows as early as June and until as late as October. Hell Hole and French Meadows would have lower surface water elevations than they would without the EWA from June until the reservoirs refill. Refilling the reservoirs would decrease flows downstream from the Ralston Afterbay.

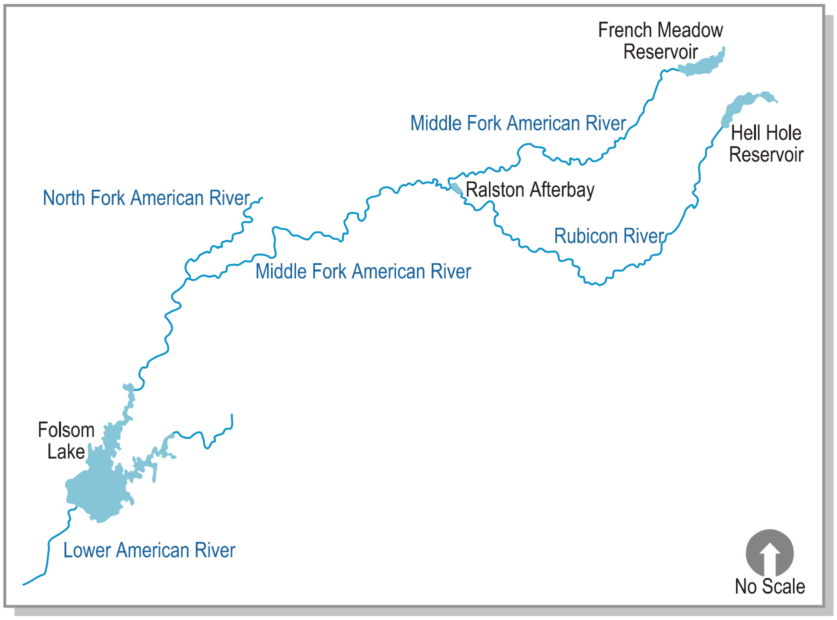

Figure 2-8
American River Water Facilities

Water from both French Meadows and Hell Hole Reservoirs would enter a series of tunnels through power generation facilities, and these tunnels would release the water at Ralston Afterbay. While water is being released, the Middle Fork of the American would convey increased flows from Ralston Afterbay downstream to Folsom Lake. These releases could occur from June through October. Folsom Lake would hold the water until the EWA agencies are ready for it to be released. Folsom Lake elevations would be higher with the EWA water than would be the case without the water. As the EWA assets were released, the lake level would be restored to the non-EWA levels.

On the American River, the EWA agencies may use assets to accomplish instream objectives and may move assets to users downstream from the Delta to make up for pumping reductions. If used for additional instream flows, the water may be released at a time when it could not be pumped through the Delta. During the summer (mid-May to mid-October), water may be released for steelhead temperature requirements. Additional instream flows are needed in October to December for Chinook salmon and steelhead spawning. The EWA agencies would release the water from Folsom to meet these multiple objectives, resulting in release periods from June through December.

2.4.2.1.2 Groundwater Substitution

Groundwater substitution transfers occur when users forego their surface water supplies and pump an equivalent amount of groundwater as an alternative supply. Because the EWA's potential groundwater substitution transfers are from agricultural users, the water from this acquisition method would be available during the irrigation season of April through October. Typically, surface water made available through groundwater substitution is stored upstream until the Delta pumps have the capacity available for EWA assets (except on the Sacramento River, as described later).

Groundwater substitution transfers would withdraw additional water from the groundwater basin below the participating users, so this option could only be used in basins that are not in a state of groundwater overdraft, or in areas where the water supplier determines that the water transfer would not contribute to the groundwater overdraft.[22] (Groundwater overdraft is discussed in more detail in Chapter 6, Groundwater Resources.)

The Delta pumps would be unlikely to have available capacity for the EWA at the start of the irrigation season. EWA water that would have been released for irrigation would instead be held in reservoirs until later in the season, which would cause reservoir levels to be slightly higher than without the EWA while the water is held back (except on the Sacramento River, as described later). The reservoir levels would not reverse their typical summer declines because the EWA would not add new water to the reservoir; rather, the levels would decrease more slowly (see Figure 2-9). EWA water acquired through groundwater substitution would be released later in the irrigation season, typically mid-June through September, at times when Delta pumping capacity is available. The change in reservoir elevations as the water is released would depend on the Delta conveyance capacity. If the conveyance capacity were available constantly throughout the period of mid-June through September, then the reservoir elevations would slowly return to the without-EWA levels (see Scenario 1 on Figure 2-9). If more conveyance capacity were available in July than later in the summer, then the EWA could borrow water from the storage facility and release additional water at those times that the conveyance capacity is available (see Scenario 2 on Figure 2-9). The Projects would determine if the EWA could borrow water on a case-by-case basis.

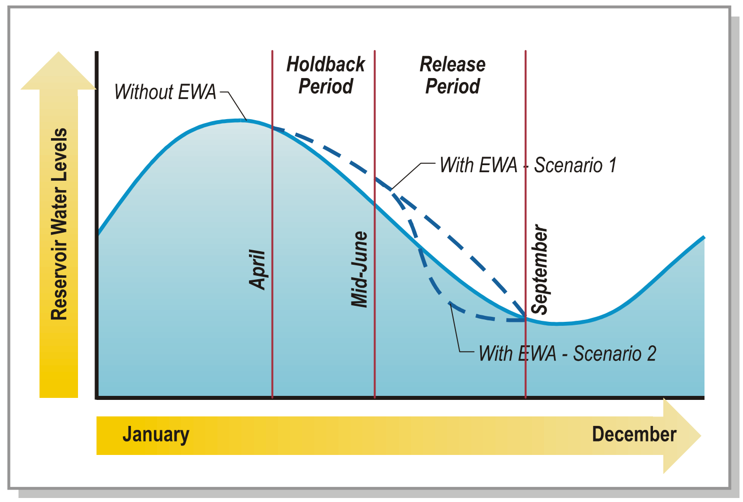

Figure 2-9
Reservoir Level Changes Due to Groundwater Substitution Transfers

22 According to California Water Code 1745.10: A water user that transfers surface water pursuant to this article may not replace that water with groundwater unless the groundwater use is either of the following:

(a) Consistent with a groundwater management plan adopted pursuant to state law for the affected area.

(b) Approved by the water supplier from whose service area the water is to be transferred and that water supplier, if a groundwater management plan has not been adopted, determines that the transfer will not create, or contribute to, conditions of long-term overdraft in the affected groundwater basin.

The EWA Project Agencies may engage in groundwater substitution transfers with Glenn-Colusa Irrigation District, Reclamation District 108, Natomas Central Mutual Water Company, Anderson Cottonwood Irrigation District, Western Canal Water District, the Joint Water Districts,[23] Garden Highway Mutual Water Company, Yuba County Water Agency, and Merced Irrigation District. The sections below describe operations associated with each of these potential acquisitions.

Sacramento River

Sacramento River agencies (Glenn-Colusa Irrigation District, Reclamation District 108, and Natomas Central Mutual Water Company) receive CVP water that is stored upstream from their service areas in Lake Shasta, a CVP facility. While theoretically possible, the EWA agencies would probably not be able to reduce releases from Lake Shasta to store water until Delta pumps were available because all of the flow released from Lake Shasta is typically needed to meet downstream temperature requirements or the flow requirement at Wilkins Slough.[24] There is a possibility that EWA water could be held back in Lake Shasta during certain years (usually dry or critical years) when releases are not needed to meet downstream requirements. In most years, however, the EWA would ask that agencies agreeing to groundwater substitution transfers only transfer water when the Delta pumps have available capacity (where irrigators would continue to use their surface water supply until about June, then switch to groundwater). Less water would be available with this strategy than with others, but the water has a higher likelihood of being usable for EWA actions. It would be possible for each scenario to occur in different year types.

If water were held back in Lake Shasta, the water surface elevations during the hold-back period (April through June) would be slightly higher than they would be without the EWA. As the water is released, the reservoir levels may be higher or lower than the without-EWA levels and would slowly return to the without-EWA levels by the end of September. The river between Shasta and the water agencies' usual diversion point would convey less water than it would without the EWA during the hold-back period (April through June) because the EWA water would be held in Shasta. Flows would not decrease below those needed for flow or temperature requirements. The river would then carry more water than during non-EWA conditions in mid-June through September, when the Delta pumps have availability for EWA water.

If users shift from surface water to groundwater after the Delta pumps are available, the riverflows would not decrease because no water would be held back in Shasta. Riverflows would increase from the water agencies' usual diversion point downstream to the Delta pumps. The effect analysis focuses on the option of holding water back because the analysis includes the potential adverse effect of decreasing riverflows as well as increasing riverflows when the Delta pumps have available capacity.

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[23] The Joint Water Districts include four member districts that have a joint operating agreement with DWR. The Joint Water Districts include Butte Water District, Biggs-West Gridley Water District, Sutter Extension Water District, and Richvale Irrigation District.

[24] These requirements are described in detail in the Modeling Description, Attachment 1.

Feather River

The Feather River districts, including the Western Canal Water District and the Joint Water Districts, receive SWP water stored in Lake Oroville (an SWP facility). Water levels in Lake Oroville would be higher than without the EWA from April through June, while water would be held back because of Delta pump unavailability. The water levels in Lake Oroville may be lower or higher than without the EWA from July to September, depending on when cross-Delta conveyance is available. These districts do not divert from the river, but rather divert water that is released from Lake Oroville directly into the Thermalito Afterbay (see Figure 2-10). This water does not flow through the river in the absence of the EWA, so an EWA acquisition would not change riverflows if the SWP held EWA assets in Lake Oroville early in the season. The assets would be conveyed through the river later in the season (from mid-June through September), when the Delta pumps are available, increasing flows over the conditions without the EWA.

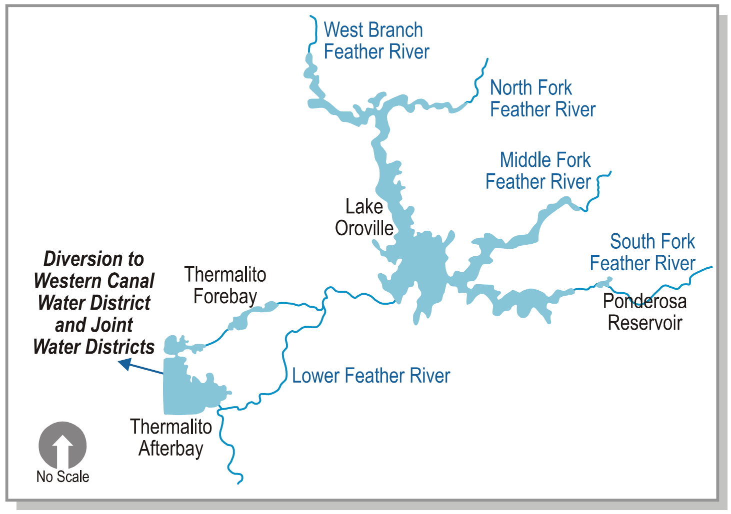

Figure 2-10
Diversion Locations for Feather River Sellers

Yuba River

Yuba County Water Agency, on the Yuba River, owns New Bullards Bar Reservoir and would store groundwater substitution assets there until release. Water elevations in New Bullards Bar Reservoir would be slightly higher than without the EWA from April through June as a result. During the release period, the EWA agencies would try to maintain relatively constant flows on the Yuba River because of fish concerns; therefore, the water levels in New Bullards Bar Reservoir would stay higher than the levels without the EWA from July to September. Many of the Yuba County Water Agency's customers divert at Daguerre Point Dam, which is downstream of New Bullards Bar Reservoir. Flows between New Bullards Bar Dam and Daguerre Point Dam would decrease relative to the conditions without the EWA early in the season (April through mid-June). Flows downstream from New Bullards Bar Dam would increase relative to the conditions without the EWA later in the season, when the Delta pumps have availability (mid-June through September).

Merced River

The Merced Irrigation District is on the Merced River and would store EWA water in its reservoir, Lake McClure, until release (see Figure 2-11). Water elevations in Lake McClure would be slightly higher from April through November than they would be without the EWA. The EWA agencies would convey a Merced Irrigation District groundwater substitution transfer through the Merced and San Joaquin Rivers. EWA agencies have worked together to schedule these transfers for periods when the transfer would reach the Delta with minimal losses and the temperature would be acceptable for fish migration. Assets would be transferred via the rivers in October and November, increasing flows during those times and providing an attraction flow for spawning salmon.

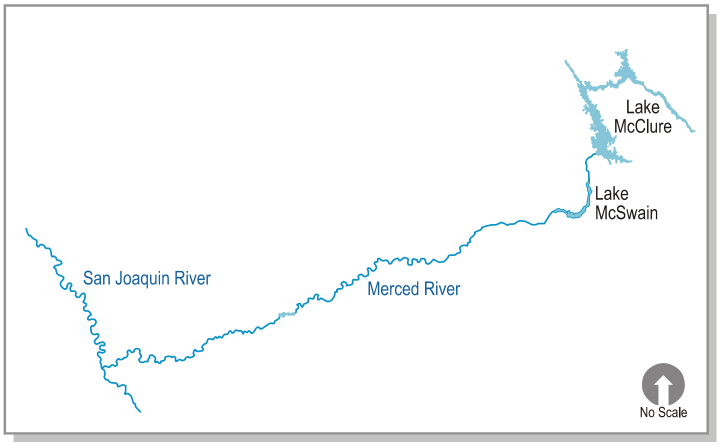

Figure 2-11
Merced River Water Facilities

2.4.2.1.3 *Crop Idling or Crop Substitution*

Crop idling transfers come from water that would otherwise have been used for agricultural production. For crop idling acquisitions, the EWA agencies would pay farmers to idle land that they would otherwise have placed in production. Crop idling acquisitions would be retained in reservoirs upstream from the selling water agencies until they could be transferred through the Delta and pumped south. Payment by the EWA agencies for water transferred would be computed based on pre-agreed consumptive use values, which may be refined as the science for generating these values improves. The EWA agencies are considering purchasing water from idled rice crops only in the Upstream from the Delta Region for several reasons:

- Rice provides the largest amount of water per acre idled (approximately 3.3 acre-feet per acre);
- Rice crops are less labor-intensive than other potential crops, requiring approximately 2.7 full-time labor equivalents per 1000 acres;
- Rice farmers have expressed interest and have participated in idling programs in the past; and
- Like other small grain crops, rice is not a permanent crop and brings in less revenue than permanent, horticultural crops (e.g., fruits and nuts), so farmers would likely be more willing to idle land.

The potential also exists for the EWA agencies to purchase water through crop substitution, in which water users substitute a crop with lower water needs than the crop that they would have otherwise planted. The associated decrease in water use could be transferred to the EWA or other programs. Crop substitution would have similar but lesser effects than crop idling, so it is considered to be a part of the crop idling discussion for the remainder of the document.

To minimize socioeconomic effects on local areas, the EWA agencies would not purchase water via crop idling if more than 20 percent of recent harvested rice acreage in the county would be idled through EWA water acquisitions. The EWA agencies chose this figure because of historical precedents and Water Code Section 1745.05 (b).

- The agricultural industry experiences normal variation in crop acreage; therefore, agricultural economies and local public services adapt to address this variation. Historical amounts of idled rice vary year-to-year by close to 20 percent, which indicates that the local economy has adjusted to similar amounts of rice idling.
- Water Code Section 1745.05 (b) requires a public hearing under some circumstances where water from land idling exceeds 20 percent of the water that would have been applied or stored absent the water transfer.

Section 11.2.3 includes a more detailed discussion of the reasons for the 20 percent limitation on rice idling.

The EWA Project Agencies may purchase water through crop idling transfers from Glenn-Colusa Irrigation District, Reclamation District 108, Western Canal Water District, and the Joint Water Districts.

The mechanisms for transferring water from crop idling would be very similar to those described above for groundwater substitution. The transferred water would be held in reservoirs during months when it could not be pumped through the Delta export pumps, then released during the months when the Delta pumps have availability.

Sacramento River

The EWA Project Agencies could purchase water through crop idling from Glenn-Colusa Irrigation District and Reclamation District 108 on the Sacramento River. As described above for groundwater substitution transfers, releases from Lake Shasta would probably need to be maintained during April and May to meet downstream temperature and flow requirements. Therefore, water acquired from sellers on the Sacramento River could not be backed up into Lake Shasta and cannot be transferred until the Delta pumps are available to the EWA. Unlike groundwater substitution, farmers could not postpone crop idling until June. Crop idling water would be available at the beginning of the season as soon as the crop is not planted. The EWA agencies would likely receive less water from crop idling transfers along the Sacramento River than from crop idling transfers along other rivers because the water made available along the Sacramento River in April, May, and possibly June might not be pumpable in the Delta. The modeling efforts indicate that the EWA agencies could not capture and use approximately 30-50 percent of the water, except in extremely dry years when added flows in April and May would provide systemwide benefits that the EWA agencies could use.

Feather River

Crop idling transfers from Western Canal Water District and the Joint Water Districts on the Feather River would function in the same way as transfers from groundwater substitution. Water elevations in Lake Oroville would be higher than they would be without the EWA during the April through June holdback period. From July to September, the levels would be higher or lower than they would be without the EWA, depending on the through-Delta conveyance capacity. The participating districts do not divert water directly from the Feather River, but instead divert water that is released from Lake Oroville directly into the Thermalito Afterbay. This water does not flow through the river without the EWA, so an EWA acquisition would not change riverflows if assets were held in Lake Oroville early in the season. Riverflows would increase when the Delta pumps have availability, typically during July through September.

2.4.2.1.4 Stored Groundwater Purchase

The EWA Project Agencies could obtain water by purchasing groundwater assets that were previously stored by the selling agency with the intent to sell a portion of those assets at a later date. This option differs from groundwater substitution in that groundwater substitution transfers would not come from water that had been previously stored. In the Upstream from the Delta Region, the EWA Project Agencies may purchase previously stored groundwater from the Sacramento Groundwater Authority (SGA).

American River

The EWA Project Agencies would purchase water from the SGA, which would deliver water through an exchange at Folsom Lake. Agencies in the authority would exchange some of their allotment in Folsom Lake with the EWA and pump previously stored groundwater[25] within their agencies to make up for the decrease in surface water supply. Any members of the Sacramento Groundwater Authority may participate; potential participants include San Juan Water District, the City of Sacramento, Fair Oaks Water District, and Citrus Heights Water District.

San Juan Water District withdraws and treats water for itself, the Fair Oaks Water District, Citrus Heights Water District, and some other SGA members, directly from Folsom Lake; this water does not enter the lower American River (see Figure 2-12). SGA agencies would begin pumping groundwater and transferring surface water to the EWA once Reclamation is certain that Folsom Lake would not spill water, usually May at the earliest. The transfer could continue until mid-October, when the CVP would need to start preparing for flood control requirements and minimum flow requirements on the river. The EWA agencies would move the assets downstream through the Lower American River from June through December, depending on Delta pump availability and instream needs on the American River, as described above for stored reservoir purchase. This transfer would cause a slight increase over non-EWA

[25] If the EWA agencies enter into a contract with Sacramento Groundwater Authority, the EWA agencies would verify that the water was previously stored to prevent effects to local groundwater.

conditions in Folsom Lake surface water elevations starting in May (before the Delta pumps are available). Reservoir surface levels would return slowly to the non-EWA conditions, as the water would be released completely by December. Flows in the lower American River would be increased over non-EWA conditions from June through December during the transfer.

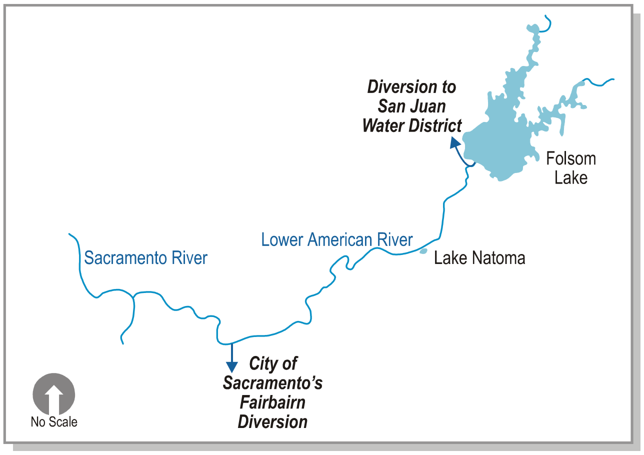

Figure 2-12
Diversion Locations for SGA Participants

The City of Sacramento would reduce its diversions at its Fairbairn diversion point, shown on Figure 2-12. The city would not start pumping groundwater and transferring its surface water until Delta pumping capacity became available, typically starting in June. Releases from Folsom Lake would maintain the same pattern as before the transfer, but the transferred portion of Sacramento's water would flow to the Delta instead of being diverted. This type of transfer would cause no change in Folsom Lake, but flows in the American River below Fairbairn would increase June through September.

2.4.2.2 Delta Area

The EWA Operating Principles specify methods for gaining assets in addition to those described above. These additional methods do not involve active acquisition; assets obtained by these other methods are termed "variable assets." The EWA agencies could obtain variable assets (water or pumping capacity) through changes in Delta operations.

The CALFED ROD lists the quantities of each of these assets that were expected to be available. During the past 2 years of EWA operation, the Project Agencies have found that some of these assets are not available on the same pattern as predicted by the CALFED ROD (shown in Table 2-6). Variable asset acquisition may be different because real conditions vary somewhat from the assumptions used to predict asset amounts (as is true for Export/Inflow Ratio Relaxation) or because conditions have changed since the predictions were completed. For example, the first variable asset involves acquiring (b)(2) water that has been released to meet instream flow objectives, but is diverted by the SWP because of limitations of the CVP's pumping capacity. Such flows may occur less often than the CALFED ROD predicted and less than in past years because of changes in (b)(2) water accounting imposed as a result of legal decisions (see Chapter 1 for a more detailed explanation).

Table 2-6
Acquired Variable Assets

Variable Asset Type	CALFED ROD Estimate of Quantity	Acquired EWA Water from 10/2000 - 9/2001[26]	Acquired EWA Water from 10/2001 – 9/2002
EWA share of (b)(2)/ERP Upstream Releases	40,000 acre-feet	46,079 acre-feet	3,308 acre-feet
Export Inflow Ratio Relaxation	30,000 acre-feet	1,829 acre-feet	79,306 acre-feet

Source: Pettit-Polhemus 2003a

2.4.2.2.1 *Sharing of (b)(2) and ERP Water*

The SWP and the EWA would share, on a 50-50 basis, water pumped by the SWP that meets the following requirements:

- Water released from storage or made available for upstream purposes under either (b)(2) or the ERP, arrives in the Delta with no further (b)(2) or ERP purposes to serve, and exceeds the export capacity of the CVP Tracy pumping plant;
- Water that the SWP and/or EWA have demand for south of the Delta; and
- Water the SWP has capacity to pump.

This type of variable asset would result in additional water for the EWA.

2.4.2.2.2 *Joint Point of Diversion*

The SWP could use excess capacity at its Harvey O. Banks Pumping Plant to pump water for both the CVP and the EWA, to be shared on a 50-50 basis, if the Projects meet the conditions in D-1641 (described in Section 2.3.2.1.1). The CVP water could be from either storage or the CVP's Delta water rights (to divert excess water). The EWA water could be from either non-Project water acquired Upstream from the Delta or stored or unstored water pumped under CVP or SWP water rights. If either the CVP or EWA were demand-limited,[27] the other's use of the Joint Point of Diversion would not count against its 50 percent share.

As stated in the EWA Operating Principles Agreement, use of excess capacity at Banks for the EWA and CVP would take precedence over all other non-Project pumping, except water wheeling in response to facility outages and wheeling to supply CVP contractors for whom the SWP has traditionally wheeled water. Pump

26 These numbers do not reflect conveyance losses from the pumping facilities to San Luis Reservoir. The CALFED modeling that produced the ROD estimates did not account for these losses; therefore, they are not included in the EWA numbers to provide accurate comparisons.

27 A project is demand-limited if there are no contractors that want any more water than they are receiving currently and if available storage facilities and/or conveyance facilities are full.

usage for the EWA Operating Principles Agreement would be on an equal priority with Level 4 refuge supplies.[28]

The Project Agencies could use the Joint Point of Diversion to move EWA assets through the Delta, but the EWA agencies would still need to provide the assets to move. The Projects also have water rights to divert excess flows in the Delta, and the EWA Operating Principles Agreement allows the EWA to use these rights if excess pumping capacity and flows are available.

2.4.2.2.3 Relaxation of the Section 10 Constraint

As discussed in Section 2.3.2.1.2, the USACE granted permission to the SWP to relax the Section 10 constraint (of the Rivers and Harbors Act) and increase the base diversion rate by the equivalent of 500 cfs to an average of 7,180 cfs for the months of July through September, through 2002. If similar permission were obtained, this 500 cfs would be dedicated to pumping for the EWA, but the EWA agencies would still need to provide the assets to be pumped. During wet years, this conveyance capacity would likely be the only capacity available to the EWA. The conveyance capacity would yield approximately 50,000 to 60,000 acre-feet per year, depending on operational restrictions.

2.4.2.2.4 Relaxation of the Export/Inflow Ratio

Under the SWRCB's D-1641 and Orders 2000-10 and 2001-5, Project exports are limited at certain times of the year to a percentage of Delta inflow, usually 35 or 65 percent. This limitation is called the Export/Inflow, or E/I, ratio. Both D-1641 and the 1995 Water Quality Control Plan, consistent with the 1994 Principles for Agreement (Bay-Delta Accord), allow for these ratios to be relaxed when certain requirements are met. The EWA agencies would seek relaxation of the E/I ratio as appropriate to create EWA assets in the export service areas. By relaxing the E/I ratio, it was estimated that the EWA could export an annual average of 30,000 acre-feet, but amounts could be greater in some years.

2.4.2.3 Export Service Area

The Export Service Area include the areas served by the CVP and SWP Delta pumping facilities, encompassing agricultural and urban development in the Central Valley and central and southern coasts**.**

The EWA Project Agencies could acquire assets from sources within the export service areas. The EWA agencies would not need to arrange to move these assets through the Delta. This advantage is especially important during wet years, when Delta pumping capacity for the EWA is limited because the export pumps are fully utilized to move Project water. Assets purchased in the export service areas, however, are often more expensive than other assets because potential sources in the export

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28 The Central Valley Habitat Joint Venture defined four levels of refuge water supplies: existing firm water supply (Level 1), current average annual water deliveries (Level 2), full use of existing development (Level 3), and full habitat development, by permit (Level 4). CVPIA Section 3406(d) directed the Secretary of the Interior to provide firm water through long-term contractual agreements for Level 2 refuges.

service areas are more limited; water agencies usually are paying for facilities needed to capture and convey the limited supplies.

2.4.2.3.1 *Water Acquisition Types*

The EWA Project Agencies have two potential methods for acquiring water in the export service areas, crop idling and stored groundwater purchase, as described below.

Crop Idling or Crop Substitution

Crop idling transfers in the export service areas also involve agricultural water users leaving their fields idle and selling their surface water allotment to the EWA. Sellers in this area normally receive CVP or SWP water that is stored in San Luis Reservoir or pumped directly out of the Delta. The EWA agencies are considering purchasing water from idled cotton fields for several reasons:

- Cotton farmers have shown a willingness to sell water to the EWA;
- Cotton is less labor-intensive than other potential crops, requiring approximately 6.6 full-time labor equivalents per 1,000 acres;
- Unlike cotton, most other crops in the region are permanent crops; and
- Most other farmers in the region raise crops that produce more profit than cotton per acre and therefore would be less willing to sell to the EWA than cotton farmers because the profit from selling water would not be attractive enough to idle land.

To minimize socioeconomic effects on local areas, the EWA agencies would not purchase water via crop idling if more than 20 percent of recent harvested cotton acreage in the county would be idled through EWA or other program water acquisitions. As discussed in Section 2.4.2.1.3, the EWA agencies chose this figure because of historical precedents and Water Code Section 1745.05 (b). Section 11.2.3 includes a more detailed discussion of the reasons for the 20 percent limitation on cotton idling.

Policy and regulatory barriers restrict crop idling in certain areas, including those areas that receive water from the SWP. The long-term water supply contracts allow interested SWP contractors to sell some of their allocated Table A[29] amounts to a "turn-back pool" for purchase by other interested SWP contractors or DWR (or by non-contractors if DWR does not want the water). The SWP contracts do not allow contractors to sell water for use outside their service area. While water stored under ground in the Export Service Area may be SWP water, CVP flood flows, or Kern River

[29] Table A is a tool for apportioning available supply and cost obligations under the SWP contract. When the SWP was being planned, the amount of water projected to be available for delivery to the contractors was 4.2 million acre-feet (maf) per year. Table A lists by year and acre-feet the portion of the 4.2 maf deliverable to each contractor. The Table A amounts are not an indication of the SWP water delivery reliability, nor should these amounts be used to support an expectation that a certain amount of water will be delivered to a contractor in any particular timespan.

Flows, the Kern groundwater storage projects have stored primarily SWP water, having anticipated that local water users would use it. As discussed earlier, the SWP contracts prohibit any contractor's sale of SWP water to other parties, except for the Monterey Amendment's turnback pool arrangement for other SWP contractors and DWR. Monterey Amendments specify that contractors who store SWP water outside their service area cannot sell water in the turnback pool. To help EWA during its start-up phase, Kern County Water Agency sold SWP water stored in 1995 through 1999, when SWP contractor's received 100% of their requests for SWP water. Although SWP contracts prohibit sale of SWP water by contractors, DWR concluded that sale of stored SWP water from the 1995 to 1999 period did not have any adverse impacts on other SWP contractors.

The EWA Project Agencies may purchase water through crop idling transfers from Kern County Water Agency, if these regulatory and policy barriers are removed. The EWA agencies also could purchase water through crop idling transfers from Westlands Water District and Tulare Lake Basin Water Storage District. Any of these areas could also participate in crop substitution transfers, as described in Section 2.4.2.1.3, which are included as part of crop idling transfers because they would produce similar but lesser effects.

In the export service areas, the EWA agencies would receive crop idling water at O'Neill Forebay (adjacent to San Luis Reservoir) on the same schedule that would have otherwise been employed for water user deliveries. Operations in conjunction with San Luis Reservoir will be discussed in greater detail in Section 2.4.2.3.2, Borrowed Project Water.

<u>Stored Groundwater Purchase</u>

Stored Groundwater Purchases in the export service areas would function in the same way as the upstream stored groundwater purchases (Section 2.4.2.1.4), in which entities would sell water to the EWA that they had previously stored in the ground. The EWA agencies could receive this water through two mechanisms:

- The selling agency could exchange its surface water allocation with the EWA and pump stored groundwater to satisfy local needs; or
- The selling agency could pump water out of its aquifer directly into the California Aqueduct for transfer to the EWA.

Stored groundwater is available to the EWA year-round, although the delivery would generally be during the irrigation season, usually April through September, if the water were delivered through surface water exchange.

The EWA Project Agencies may purchase stored groundwater from projects within Kern County. Several agencies have stored excess surface water in projects in the Kern County groundwater aquifer. Several projects in Kern County have stored groundwater that could be sold to the EWA:

- **Kern Water Bank:** water stored by a Joint Powers Authority consisting of local water agencies.
- **Pioneer Banking Project:** a coalition of local agencies recharges and recovers water. Kern County Water Agency could sell part of its 25 percent share of stored water to the EWA.
- **Berrenda Mesa Project:** Berrenda Mesa Water District owns this project in partnership with several other local agencies and could sell water if it chose to participate.

In addition, Semitropic Water Storage District and Arvin-Edison Water Storage District operate water storage facilities. These districts do not store their own water, but instead engage in agreements with outside parties. These external groups provide surface water for storage underground and pay a fee to the districts to store the water. The EWA Project Agencies could purchase water from the parties that store water in Semitropic or Arvin-Edison. Santa Clara Valley Water District has water in storage in Semitropic that it could sell to the EWA, and Metropolitan Water District of Southern California has water in Semitropic and Arvin-Edison. These projects, as well as the three banking projects listed above, are described in greater detail in Chapter 6, Groundwater Resources.

Although water stored underground in the Export Service Area may be SWP water, CVP floodflows, or Kern River floodflows, the Kern groundwater storage projects have primarily stored SWP water, anticipating that local water users would use it. As discussed earlier, the Monterey Amendment specifies that unused SWP water should go to the turnback pool for other SWP contractors. The SWP water that was stored within Kern County did not first go to the turnback pool, creating regulatory concerns with selling that water to a non-SWP contractor. To help the EWA during its startup phase, Kern County Water Agency has sold SWP water stored in 1995 through 1999, when SWP contractors received 100 percent allocations. DWR and other SWP contractors agreed to this stipulation before Kern County Water Agency sold the water to the EWA, but agreed that it would only apply to water sold to DWR for the EWA.

With current SWP policies, Kern projects would not be able to sell SWP water that was stored during other years when allocations were not 100 percent. Without additional water to recharge, it is likely that Kern County Water Agency would have less water available to sell to the EWA in upcoming years. This issue is discussed in greater depth in Chapter 6, Groundwater Resources, which includes a discussion of the amount of stored water from each of the different sources.

If the EWA agencies acquire stored groundwater through a transfer of the selling agency's surface water allocation, the exchange would be made at O'Neill Forebay. The EWA agencies would acquire water on the same delivery schedule that the selling agency would have had without the transfer. If the selling agencies pump groundwater directly into the California Aqueduct, the seller must work cooperatively with DWR to ensure that the groundwater meets DWR's water quality requirements. Chapter 5 discusses this cooperative process and DWR's water quality requirements in more detail.

2.4.2.3.2 *Asset Management*

The EWA requires facilities and operational arrangements in order to make its assets available when needed for accomplishing EWA objectives. The CALFED ROD defined several tools to manage assets, including the ability to borrow Project water if needed and store it for use at a time other than when the asset was acquired. Project facilities and agencies assist the EWA by conveying, storing, and loaning water when possible.

Borrowed Project Water

Borrowing Project water is a management arrangement available to the EWA agencies, as long as the borrowed water could be repaid without affecting the current or following year's allocations and deliveries to Project contractors. Borrowing of Project water, specifically in San Luis Reservoir, is intended to enhance the effectiveness and use of EWA assets. Borrowing could take place only when the borrowed water would not exacerbate water quality and supply problems associated with the San Luis low point[30] and if the reservoir could still meet reasonable carryover storage objectives.

The EWA agencies would use borrowed Project water from the San Luis Reservoir in conjunction with Upstream-from-the-Delta transfers. If the Projects are unable to convey water through the Delta because of EWA pumping reductions, the EWA agencies could borrow water from San Luis Reservoir, provide it to Project Contractors during the reduction, then repay the water to the reservoir later by moving EWA assets from upstream reservoirs when the Delta pumps have

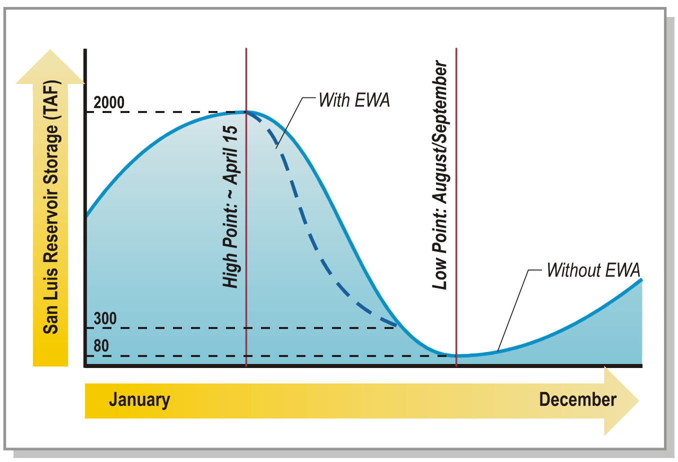

Figure 2-13
Reservoir Level Changes Due to Borrowing Water From San Luis Reservoir

30 The low point is the summertime seasonal lowest level of San Luis Reservoir. As the elevations in San Luis Reservoir approach the low point, the low point problem occurs when the volume of water in San Luis Reservoir drops to approximately 300,000 acre-feet. At 300,000 acre-feet of storage, algal blooms can cause water quality problems for urban water users that receive supplies, especially Santa Clara Valley Water District. Water quality concerns for industrial users start when the reservoir has only 300,000 acre-feet of storage, and the EWA is not allowed to cause the reservoir to reach this storage level sooner than it would without the EWA. If drawdown of the reservoir continues, CVP and SWP deliveries are no longer possible when the reservoir reaches "dead storage" at approximately 80,000 acre-feet.

capacity. (See Figure 2-13.) EWA agencies may thus at times carry a debt to the San Luis Reservoir that would affect water elevations in the reservoir.

Figure 2-13 illustrates a year in the San Luis Reservoir during which water is borrowed from the Projects. By borrowing water, the EWA agencies would decrease reservoir levels.

In addition to borrowing Project water, as described above, the EWA agencies could also borrow Project storage if space were available. Some EWA assets are available at times when they cannot immediately be used for fish actions, such as the variable assets described above. The EWA agencies could store these assets in San Luis Reservoir, but they would have the lowest priority for storage (other than water stored for non-Project entities). San Luis Reservoir fills in most years, so it is likely that the water would convert to Project water and no longer be available to the EWA.[31] Additionally, the EWA could borrow Project storage in other facilities, such as Lake Shasta, Lake Oroville, and Folsom Lake. The EWA agencies would typically use this option to store water over the winter, but this water would be the first to spill from the reservoir if the reservoir reached the flood control limits.

Groundwater Storage

The CALFED ROD states that the EWA agencies should purchase 200,000 acre-feet of storage (initially full) south of the Delta to provide initial assets and to store assets that have been acquired in excess of immediate needs. Groundwater storage requires the ability to percolate or inject the excess water into a groundwater basin for later extraction, or have Project water that could be transferred to the EWA as a mechanism to return the water to the EWA. Having facilities for groundwater storage of EWA assets would provide the EWA the flexibility to acquire and store water throughout the year, which would allow additional flexibility in asset acquisition.

Groundwater storage is different from the acquisition method of purchasing stored groundwater because the EWA agencies would be providing the assets to be stored (after the initial purchase of the full storage area). If the EWA agencies purchased stored groundwater, it would purchase water that the sellers had previously stored in the ground.

The groundwater storage would likely be operated with 100,000 acre-feet of flexible storage that could be exercised yearly or extracted in any one year and 100,000 acre-feet of water that would remain in storage as a backup supply.

Obtaining groundwater storage involves negotiating a lease agreement with an entity that operates a groundwater banking program. The agreement would require payment for use of recharge and extraction facilities, as well as charges for occupying or reserving the storage space. Assets stored in water banks are generally charged for

[31] If San Luis Reservoir had filled without the EWA, then the EWA would not be able to keep water in storage in that reservoir. EWA water would then convert to Project water.

losses upon both recharge and extraction. If the EWA agencies acquire water banking capacity, the assets would probably be charged a small percentage of loss representing basin losses. Upon extraction, similar losses would be applied.

Stored groundwater could be returned to the EWA through two mechanisms:

- The banking entity could extract the water out of the ground and into a waterway or Project conveyance facility; or
- The entity could transfer its surface water allotment to the EWA and pump groundwater for local use.

The EWA agencies have not yet acquired this groundwater storage, but have acquired additional assets to account for the lack of storage. The EWA Project Agencies may acquire groundwater storage services from Kern County Water Agency, Semitropic Water Storage District, and Arvin-Edison Water Storage District. The EWA Project Agencies could also negotiate groundwater storage services with Santa Clara Valley Water District or Metropolitan Water District of Southern California, which have water storage capacity in Semitropic and Arvin-Edison Water Storage Districts.

Source Shifting

Source shifting is a tool that was developed in the CALFED ROD to help make the EWA more flexible. With source shifting, the EWA agencies would borrow scheduled water from a Project contractor for a fee, returning the water at a later date. The result of this option is to delay delivery of SWP or CVP contract water.

The purpose of implementing source shifting would be to help protect the San Luis Reservoir against reaching storage volumes where the low point problem begins earlier with the EWA than it would have without the EWA. Source shifting would allow the EWA to borrow water from one or more Project contractors and use it to repay debts to the San Luis Reservoir before the low point problem has begun. The objectives of source shifting would be to prevent San Luis Reservoir from reaching the point at which it could not continue to make Project deliveries (approximately 80,000 acre-feet of storage) or at which water quality creates problems for contractors (approximately 300,000 acre-feet of storage) before it would have without the EWA.

If projections show that the EWA could cause San Luis Reservoir to reach 300,000 acre-feet of storage sooner than it would have without the EWA, then the EWA agencies would implement source shifting agreements. In some years, San Luis Reservoir storage would fall below 300,000 acre-feet without the EWA. In this situation, the EWA agencies would not be responsible for source shifting to bring storage back up to 300,000 acre-feet, but would only need to implement source shifting to bring the storage back up to the without-EWA levels.

To participate in source shifting, contractors must have storage from which to draw while their deliveries are delayed. The EWA agencies could engage in source shifting agreements with Metropolitan Water District of Southern California or Santa Clara

Valley Water District. Metropolitan Water District is considering using surface water reservoirs (Diamond Valley Lake, Castaic Lake, Lake Mathews, and Perris Lake) and groundwater storage programs to participate. Santa Clara Valley would use surface water storage within Anderson Reservoir. If source shifting were implemented in surface water storage facilities, it would cause the participating reservoir levels to fall earlier in the year than they would without the EWA, but the reservoir levels would return to levels that would occur without the EWA as the water is paid back (see Figure 2-14).

The EWA agencies could also create a source shifting agreement with Kern County Water Agency, which would use groundwater supplies during the delayed deliveries. Water from Kern County could be delivered by exchanging surface water deliveries or through direct groundwater pumping into the California aqueduct (as described in the Stored Groundwater Purchase section, above).

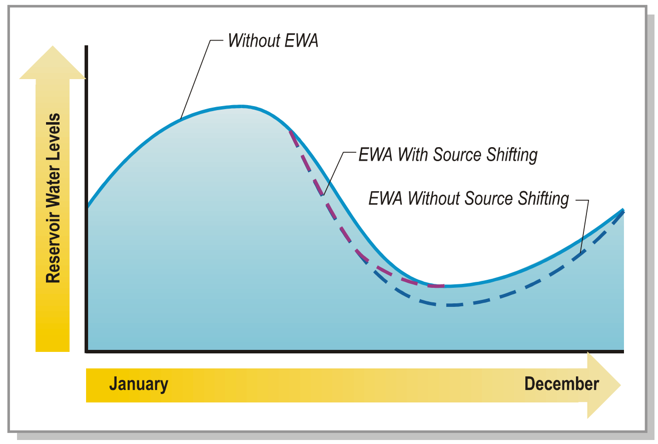

Figure 2-14
Reservoir Level Changes Due to Source Shifting

If the EWA agencies activated a source shifting agreement, the deferred surface water deliveries would be transferred to the EWA at O'Neill Forebay and could be stored in San Luis Reservoir. After the San Luis Reservoir reached its low point, source shift water could be returned to the Projects at O'Neill Forebay and then conveyed to those contractors that provided source shifting services (those that agreed to delay delivery of their contract water).

At the start of source shifting operations, water surface elevations in the reservoirs or groundwater basins used as the alternate supply source by the source shifting contractor would decrease relative to non-EWA conditions. The water levels would then return to non-EWA conditions as the water was paid back, which could continue into the next year. Source shifting does lower water levels temporarily, but only within existing operating parameters. The reservoirs or groundwater aquifers would not be operated outside their standard operations.

<u>Pre-Delivery</u>
As a permutation of source shifting, the EWA agencies could engage willing partners to receive water earlier than they would typically receive water. The EWA agencies would consider this tool if the EWA had water in storage in San Luis Reservoir during the winter that could convert to Project water as San Luis fills. To implement pre-delivery, the EWA agencies would deliver water to users in the Export Service Area that have their own storage facilities in which to store that water. The EWA would essentially be borrowing storage space from these users. This action would increase reservoir levels in surface storage facilities. The EWA Project Agencies may engage in

pre-delivery with Metropolitan Water District of Southern California or Santa Clara Valley Water District. In some cases, such as the Santa Clara Valley Water District's Anderson Reservoir, there may also be some risk of spill of the EWA asset that would be addressed through contract terms.

Exchanges

The EWA agencies could engage willing partners to receive water earlier than their normal delivery schedule. The EWA agencies would consider using this tool if they had remaining assets at the end of June and they did not anticipate using these assets before the end of the water year. In a dry summer period, the EWA could exchange its surplus assets with an agricultural contractor with the agreement that the contractor return the water on request in the next relatively wet year; for example, a year with SWP allocations of 70 percent or higher. The agricultural contractor would then take delivery of the EWA water from July through the end of the irrigation season instead of pumping local groundwater or drawing on other sources. The exchange would reduce groundwater pumping in the first year of the exchange, and would require the contractor to reduce dependence on contract supplies in the year of the return of the water.

Similarly, the EWA agencies could exchange surplus assets with a contractor that has available surface water storage. The contractor would take deliveries of the EWA water during the same time period instead of drawing on local surface water supplies. The exchange would result in slightly higher reservoir levels throughout the winter and until the contractor returns the water to the EWA in a relatively wet year.

Exchanges would have similar effects to other water management methods discussed in earlier sections. Exchanging water with an agricultural contractor to use in lieu of groundwater would result in the same types of effects as groundwater storage. Exchanging water with contractors that have surface water storage is similar to pre-delivery. The resource area analyses do not specifically analyze exchanges because these effects are covered as a part of the analysis of groundwater storage and pre-delivery.

2.4.3 Typical Year EWA Operations

In a typical year, the EWA would purchase 200,000-300,000 acre-feet for its annual operations. In the driest years, and when assets were carried over from the prior year, the total acquisitions could be closer to 200,000 acre-feet. In near average water years, the acquisition target would be closer to 300,000 acre-feet or even higher.

In the wetter years when operational curtailments would be expected to cost more water because the base Delta pumping rate would be higher or when the EWA ends the prior year with substantial debt, water needs for fish may be in the 400,000-600,000 acre-foot range. Initial acquisition targets may be lower in those years, and water acquisitions likely would reach the higher end of the range only if Tier 3 assets were called upon to complete the acquisition of the needed water. Tier 3 assets could be made available when Tier 2 assets were exhausted and the Management Agencies determine that jeopardy would occur due to Project operations unless additional measures were undertaken.

Table 2-7 provides an analysis of possible operational ranges of the EWA under different year types as defined by the Sacramento River Index.[32] The table is based on EWA asset acquisition priorities identified by the EWA agencies (see Section 2.4.4) and upper limits for each source category defined in Table 2-5 of this document.

Table 2-7
Estimated EWA Acquisition Patterns Keyed to SWP Allocation, Cross-Delta Capacity, and Acquisition Priorities
(Values in Thousand Acre-Feet)

Year Type	SWP Allocation	Purchase Target	Upstream from the Delta Sources				Export Service Area Sources	
			Reservoir Storage	Groundwater Substitution	Crop Idling	Groundwater Purchase	Groundwater Purchase	Crop Idling
Critical	20-40%	200-240	75-175	25-125	0-100	0-10	0-50	0-50
Dry	35-60%	210-270	75-175	25-125	0-100	0-10	0-150	50-100
Below Normal	50-80%	230-300	75-150	25-125	0-50	0-10	50-165	50-290
Above Normal	70-90%	250-300[1]	75-150	25-50	0	0	50-165	180-340
Wet	80-100%	250-300[2]	75-150	25-50	0	0	50-165	230-490

[1] In wetter years, purchases above 300 TAF may be required, depending on fish actions. Tier 3 assets may be required.
[2] In the wettest years, purchases above 300 TAF and as high as 600 TAF may be required, depending on fish actions. Tier 3 assets may be required.

The following text describes how the EWA agencies would pursue water acquisitions as the year type unfolds. In all years, the EWA agencies would begin negotiating with willing sellers in the prior summer and fall, well in advance of knowing hydrologic conditions. In some cases, multi-year agreements, most involving options, would be in place. The purchases would be structured largely as described in Appendix E, EWA Acquisition Strategy for 2003, except that the EWA agencies anticipate more multi-year agreements.

The EWA agencies would negotiate options both upstream from the Delta and within the export service area to be able to maximize use of cross-Delta transfer capacity in the SWP's Banks Pumping Plant, which would be minimal in wet years, but would become more available in dry years when SWP allocations to contractors would be relatively low. Cross-Delta transfer capacity also would be influenced by the amount of water transfers originating Upstream from the Delta Region arranged by Project contractors, DWR, and the CVP. Holding option contracts would allow the agencies to maximize the purchase of less costly Upstream-from-the-Delta water when transfer capacity was available and would allow purchase of sufficient water from the export service area in wet years with limited transfer capacity.

[32] The Sacramento River Index classifies water years based on the unimpaired runoff from the Sacramento River system.

The EWA would lose an estimated 20 percent of the water obtained from the Sacramento River and its tributaries to carriage losses in the Delta. Water obtained from the San Joaquin River basin is subject to a 10 percent conveyance loss. However, the net cost of the water from the Upstream from the Delta Region water after losses would be less than assets from the export service area. Each year the carriage water loss allotment would be reevaluated.

2.4.3.1 Critical Year

In the driest years, the SWP would have a low water supply allocation to its contractors, probably in the range of 20 to 40 percent of requested amounts. The EWA would have significant cross-Delta transfer capacity available and would primarily seek upstream water. Stored reservoir water would be the first priority water source, followed in sequence by groundwater substitution, stored groundwater, and crop idling (rice). The priorities among source categories would remain the same in all year types.

In sequential dry and critical years, reservoir levels may be drawn down to the point that transfers of stored reservoir water to the EWA become unlikely or highly restricted. In such times, the EWA agencies would need to increase the emphasis on transfers involving groundwater substitution, groundwater purchase, and crop idling. The EWA agencies would be less likely to pursue crop idling transfers unless reservoir levels were lower than usual early in the winter.

As shown in Table 2-7, the maximum purchase target would be greatest for stored reservoir water, then groundwater substitution, groundwater purchase, and lastly crop idling, still in potentially significant amounts if reservoir water appeared limited. Stored groundwater purchase quantities would be minimal, largely due to limited availability north of the Delta.

The total purchase quantity would be relatively low in critical years, as Delta pumping would be low and operational curtailments would be less costly in terms of the pumping foregone that must be replaced by the EWA. EWA variable asset tools, however, would likely produce less water for the EWA in drier years.

2.4.3.2 Dry Year

In a dry year, SWP allocations would likely be in the 35 to 60 percent range. Cross-Delta transfer capacity available to the EWA may begin to be constrained at the upper range of these allocations, depending on runoff timing, competing transfers, and other operational factors. The EWA purchase target would be somewhat greater than in a critical year because operational curtailments would represent a larger reduction in Delta export pumping. The EWA agencies would pursue a strategy very similar to the critical year strategy, with most assets coming from the upstream from the Delta region. At higher SWP allocations, cross-Delta transfer capacity may become a constraint on the ability to move water from upstream when needed, and the EWA agencies may need to acquire water from the export service area as well.

As noted above, in sequential dry and critical years, reservoir levels may be drawn down to the point that transfers of stored reservoir water to the EWA would be unlikely or highly restricted. In such times, the EWA agencies would need to increase the emphasis on transfers involving groundwater substitution, groundwater purchase, and crop idling. Crop idling transfers would be less likely to be pursued unless reservoir levels were lower than usual early in the winter.

Acquisition target ranges would be about the same upstream from the Delta as for a critical year.

2.4.3.3 Below Normal Year

In a below normal year, the SWP allocation could range between from approximately 50 to 80 percent. In this range, the ability of the EWA to move water across the Delta would become more constrained, and at the higher allocations may become limited to the 500 cfs capacity dedicated to the EWA, or about 60,000 acre-feet, depending on runoff timing, competing transfers, and other operational factors. Purchase options play a key role in adjusting the locations where water would be purchased to match the cross-Delta transfer capacity as the SWP allocation would be established in the spring.

Because the water cost of operational curtailments would increase as SWP allocations and Delta pumping increase, the EWA's acquisition target would increase. Acquisitions can involve significant purchases from the upstream from the Delta region in the lower range of below normal year allocations, but at higher allocations the purchases would shift to the Export Service Area, where stored groundwater and crop idling play a major role. As previously stored groundwater is depleted by EWA purchases, the crop idling (cotton) source would become more important.

2.4.3.4 Above Normal Year

In an above normal year, the SWP allocation could range from approximately 70 to 90 percent. In this range, the ability of the EWA agencies to move water across the Delta may become limited to the 500 cfs of dedicated capacity, or about 60,000 acre-feet, depending on runoff timing and other operational factors. The EWA agencies would seek at least 75,000 acre-feet of stored reservoir water north of the Delta, exporting 60,000 acre-feet and providing an estimated 15,000 acre-feet (20 percent) for carriage water. If additional transfer capacity were available in that year, the EWA would seek additional water from stored reservoir supplies and groundwater substitution sources to fill the available capacity.

Water costs in some above normal years could exceed 300,000 acre-feet, possibly requiring Tier 3 purchases.

The water needed to cover operational curtailments at the Delta pumps would increase further in an above normal year, and the EWA's acquisition target would increase. The balance of needed assets would be obtained from banked groundwater and crop idling south of the Delta.

2.4.3.5 Wet Year

In the wet years, the SWP allocation would likely be at least 80 percent and in some years 100 percent. The cost of operational curtailments could become greater, especially if the wet hydrology brings fish into the vicinity of the pumps more often. Water costs in the wet years, possibly including Tier 3 purchases, could reach the upper limit selected for this alternative, 600,000 acre-feet.

In the wet years, the ability of the EWA agencies to move water across the Delta may become limited to its 500 cfs dedicated capacity, or about 60,000 acre-feet. The EWA agencies would seek at least 75,000 acre-feet of stored reservoir water from the upstream from the Delta region, exporting 60,000 acre-feet and providing an estimated 15,000 acre-feet (20%) for carriage water. If additional transfer capacity were available in that year, the EWA would seek additional water from stored reservoir supplies and groundwater substitution sources to fill the available capacity.

The balance of needed water would have to be sought from the export service area, through a substantial amount of crop idling and some stored groundwater. Some of the crop idling may have to be arranged after initial planting, when the consequences of the wet hydrology and fish behavior become more completely known. Only when it is necessary to purchase Tier 3 assets would the EWA agencies actually acquire the maximum quantity of water identified in the flexible purchase alternative.

2.4.4 Acquisition Strategy

The EWA agencies would acquire water using an acquisition strategy that meets multiple goals and objectives when acquiring water. These goals include:

- Acquire water at a unit cost that is most effective considering the benefits achieved;
- Protect assets by creating arrangements to carry over water between years;
- Continue coordination with other water purchase programs;
- Maximize the existing and future funding opportunities; and
- Improve flexibility by:
    - Expanding the types of purchases and the number of potential sellers;
    - Developing actions that continue for more than 1 year.

The Draft Final EWA Acquisition Strategy for 2003 is included in Appendix E. The sections below describe several components of the strategy that are relevant to assessing the environmental effects of the Flexible Purchase Alternative.

2.4.4.1 Tie Water Purchases to Hydrologic Conditions to Minimize Costs

The amount of water available for transfer is typically greater in areas upstream from the Delta than in the export service areas because more than 70 percent of runoff comes from northern California (DWR 1998). This difference is reflected in the market rates received by willing sellers in these two areas. The differences in water prices upstream from the Delta and the export service areas are greater than simply the costs of transporting water across the Delta. The differences reflect a structural difference in the water economies of these two areas.

Water from the areas upstream from the Delta is less expensive, but the EWA has limited conveyance capacity to convey water across the Delta in some hydrologic conditions. Therefore, the EWA would pursue a strategy in which it maximizes purchases from areas that are upstream from the Delta to the extent that it can convey water across the Delta.

Some water purchases in areas upstream from the Delta are generally less expensive, have fewer environmental effects, and are more flexible; therefore, the EWA Project Agencies would prioritize these types of acquisitions for purchase. The highest priority would be stored reservoir purchase, followed by groundwater substitution and stored groundwater purchase. The lowest priority would be crop idling transfers because of their increased environmental effects and decreased flexibility. In some cases (e.g. Sacramento River area idling transfers), the foregone consumptive use in April, May, and parts of June may not be effectively captured and exported by the EWA because the water must be released to meet downstream requirements, yet it cannot be pumped in the Delta.

Acquisitions in the export service area generally follow the same pattern: stored groundwater purchase is less expensive, more flexible, and has fewer environmental effects than crop idling transfers. Unfortunately, potential supplies in the export service areas are decreasing, and may not be available into the future. For purchases from the export service area, the EWA Project Agencies would prioritize stored groundwater purchases if available.

2.4.4.2 Continued Coordination with other Acquisition Programs

Other water acquisition programs would also acquire water in the same regions as the EWA, and some programs would seek to use this water to achieve similar goals. Coordination could help maximize environmental benefits of these programs and avoid cumulative effects.

2.4.4.3 Set Water Purchase Targets

With a high upper limit on the purchases for the Flexible Purchase Alternative, the EWA would try to set water purchase targets based on Management Agencies' predictions of fish needs for different year types. Setting these purchase targets before the EWA Project Agencies negotiate acquisitions would help in purchasing enough assets to meet fish needs.

2.4.4.4 Aggressively Use Purchase Options

The EWA Project Agencies could negotiate purchase options, in which they secure a contractual ability to call upon water to be transferred at a future date. Aggressive use of options upstream from the Delta would provide the EWA agencies flexibility to deal with changing hydrologic conditions. One concern related to options is that in many cases the call dates[33] needed by the sellers occur early in the year, before much is known about the hydrologic conditions. The EWA would seek option call dates as late into the year as possible, consistent with the needs of the sellers.

2.4.4.5 Increase Use of Multi-Year Transfers

The EWA Project Agencies could negotiate longer-term contracts with willing sellers to acquire water from the same source in multiple years. Multi-year agreements would likely decrease the cost of the water and improve flexibility by having a source that is available without additional negotiations.

2.5 Fixed Purchase Alternative

In the Fixed Purchase Alternative, the EWA agencies would make purchases as identified in the CALFED ROD, shown in Table 2-8. The EWA agencies could take the same types of fish actions identified in the No-Action/No Project and Flexible Purchase Alternatives, but the assets available would limit the magnitude of the actions. This alternative includes a conservative assumption whenever there is discretion to make a determination of functional equivalence[34] or where the CALFED ROD contemplates certain future actions (e.g., increased Upstream from the Delta purchases in future years). This alternative limits the EWA agencies to purchases of the 185,000 acre-feet identified in the CALFED ROD and would not use functional equivalency to adjust purchase location. Water purchases would be limited to the 185,000 acre-feet per year regardless of water year type. In this alternative, the volumes that the EWA agencies would purchase from each region would remain constant every year at 35,000 acre-feet upstream from the Delta[35] and 150,000 acre-feet in the export service areas. The Fixed Purchase Alternative has the benefits of variable assets, source shifting, and groundwater storage as described in the ROD. The EWA agencies would likely enact source shifting agreements more frequently in the Fixed Purchase Alternative than in the Flexible Purchase Alternative because of restricted purchase quantities. In this alternative, the EWA agencies would acquire variable assets at the same rate as in the Flexible Purchase Alternative.

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33 The "call date" is the last date that the EWA could call for the water.

34 The Operating Principles Agreement specifies methods for asset acquisition and management, but allows the Project and Management Agencies the ability to use methods that function in an equivalent manner.

35 The CALFED ROD included footnote 3 shown in Table 2-7, which indicated that Upstream from the Delta purchases may increase in subsequent years. The Fixed Purchase Alternative is fixing the Upstream from the Delta purchases, and this amount would not increase. The EWA agencies may, however, purchase additional water upstream from the Delta to account for carriage water requirements; the 35,000 acre-foot total would reflect the amount of water that reaches the Delta export pumps.

Actions taken by the EWA agencies in any given year under the Fixed Purchase Alternative would be limited to the availability of carryover assets from prior years, annual purchases of 185,000, variable assets, source shifting, and the capacity to borrow from the Projects based on the availability of groundwater storage.

The fixed upper limits on purchases would increase the probability that Tier 3 assets would be needed as part of the Fixed Purchase Alternative. The Fixed Purchase Alternative analysis only assesses the effects associated with purchases up to 185,000 acre-feet. If the EWA agencies used all these assets and jeopardy occurred, the Project Agencies would curtail pumping, but the EWA agencies would need supplemental environmental documentation before they could acquire water to compensate water users for these actions.

Table 2-8
EWA Tier 2 Assets in Accordance with the ROD

Action Description	Water Available Annually (Average) [2]
SWP Pumping of (b)(2) ERP Upstream Releases[1]	40,000 acre-feet
Export/Inflow Ratio Flexibility	30,000 acre-feet
Purchases – Export service areas	150,000 acre-feet
Purchases – Upstream from the Delta[3]	35,000 acre-feet
Total	255,000 acre-feet
Storage acquisition	200,000 acre-feet of storage, filled; acquired in Year 1
Source Shifting agreement	100,000 acre-feet

(1) The EWA and the SWP will share equally the (b)(2) and ERP upstream releases pumped by the SWP after they have served their (b)(2) and ERP purposes.
(2) The amount of water derived from the first four actions will vary based on hydrologic conditions.
(3) For the first year, 35,000 acre-feet is targeted; higher amounts are anticipated in subsequent years.

Sections 2.5.1 and 2.5.2 discuss the actions that the Fixed Purchase Alternative could undertake to protect fish and the environment and the types of asset acquisition and management, respectively. Section 2.5.3 includes the environmental commitments, and Section 2.5.4 describes the EWA agencies' acquisition strategy for the Fixed Purchase Alternative.

2.5.1 Actions to Protect Fish and the Environment

Under the Fixed Purchase Alternative, the EWA agencies could take the following actions to protect fish and the environment: (1) reduce export pumping, (2) close the Delta Cross Channel gates, (3) increase instream flows, and (4) augment Delta outflow. These actions are described in more detail in Sections 2.3.1 and 2.4.1.

Because the Fixed Purchase Alternative limits the EWA agencies' asset acquisitions, the EWA agencies must prioritize fish actions and in many years only undertake the highest priority actions. In contrast to the other alternatives, which may use a variety of actions in multiple areas, the Fixed Purchase Alternative would focus on actions within the Delta; the primary action would be to reduce export pumping to help fish in the vicinity of the pumps. The Fixed Purchase Alternative includes less flexibility to engage in upstream actions; in most years, the assets available in this alternative would be entirely consumed by repayments for water not exported during pump reductions. The EWA agencies would determine the frequency of pump reductions according to the fish behavior in that year and would take actions when they would most benefit the fish. In some years, the fish may not spend time near the pumps; therefore, the EWA agencies would not need to reduce pumping as often during such periods. In those years, the Fixed Purchase Alternative has the potential to provide the other benefits listed above.

2.5.2 Asset Acquisition and Management

The Fixed Purchase Alternative would include water acquisitions from the sources outlined in the CALFED ROD (Table 2-8). Within the Program area, the EWA Project Agencies have the option to choose from a number of sources. The EWA agencies could use any of the acquisition methods described below to purchase water. Flexibility to purchase from any of these sources is critical to helping the EWA run efficiently because it allows the Project Agencies to purchase the least expensive water available in any given year. Table 2-9 lists agencies that may be willing to sell water to the EWA or have sold water to the EWA in past years,[36] along with a general range of potentially available water volumes. None of the purchases in Table 2-9 are guaranteed; the EWA agencies could only make purchases if a willing seller wished to participate.

The numbers in Table 2-9 are estimates and do not necessarily reflect the amount of water that would be available in any given year. Generally, these estimates reflect the potential upper limit of available water in order to include the maximum extent of potential transfers in the environmental analysis. Some of the agencies listed in Table 2-9 indicated an interest in transferring water to the EWA, but could not provide a range of potential available water supplies. The numbers in the table include estimates provided either by water sellers or the Project Agencies. Actual purchases would depend on the year type and the amounts that sellers would be willing to transfer in a given year. These numbers vary from the Flexible Purchase Alternative because the Fixed Purchase Alternative includes 35,000 acre-feet upstream from the Delta and 150,000 acre-feet in the Export Service Area, so the upper limit of each individual transfer cannot exceed that cap.

The potential acquisitions in Table 2-9 would not all occur within a single year. The table is simply a menu that illustrates the flexibility the EWA has in making purchases. Figure 2-4 shows the locations of the agencies listed in Table 2-9. Section 2.4.2 provides detailed descriptions of the potential actions.

[36] Information on past EWA transactions can be found online at http://wwwoco.water.ca.gov/calfedops/2001ops.html or http://wwwoco.water.ca.gov/calfedops/2002ops.html

Table 2-9
Potential Asset Acquisition and Management for the Fixed Purchase Alternative (Upper Limits)

	Range of Possible Acquisitions (TAF)				Management	
Agency	**Stored Reservoir Water**	**Groundwater Substitution**	**Crop Idling/ Subst.**	**Stored Groundwater Purchase**	**Groundwater Storage Services**	**Source Shifting/ Pre-Delivery**
Upstream from the Delta Region						
Sacramento River Area of Analysis						
Glenn-Colusa ID		20-35	35			
Reclamation District 108		5	35			
Anderson Cottonwood ID		10-35				
Natomas Central MWC		15				
Feather River Area of Analysis						
Oroville Wyandotte ID	10-15					
Western Canal WD		10-35	35			
Joint Water Districts		20-35	35			
Garden Highway MWC		15				
Yuba River Area of Analysis						
Yuba County WA	35	35				
American River Area of Analysis						
Placer County WA	20		10			
Sacramento GW Authority				10		
Merced/San Joaquin River Area of Analysis						
Merced Irrigation District		10-25				
Export Service Area						
San Joaquin Valley						
Kern County WA			115	50-150	X	X
Semi-Tropic WSD[1]					X	
Arvin-Edison WSD[1]					X	
Westlands WD			150			
Tulare Lake Basin WSD			85			
Santa Clara Valley						
Santa Clara Valley WD						X
Southern California						
Metropolitan WD						X

Abbreviations:
GW: Groundwater
ID: Irrigation District
MWC: Mutual Water Company
WA: Water Agency
WD: Water District
WSD: Water Storage District
Footnote 1: Semi-Tropic WSD and Arvin-Edison WSD are within Kern County Water Agency. Their groundwater storage facilities are separate from the Agency, but they may participate in other programs that the agency helps administer, such as crop idling.

2.5.3 Acquisition Strategy

In the Fixed Purchase Alternative, the EWA agencies would negotiate water purchases using an acquisition strategy that meets multiple goals and objectives when acquiring water. These goals include:

- Acquire water at the most effective unit cost;
- Expand the asset base;
- Improve flexibility by developing actions that continue for more than 1 year;
- Protect assets by creating arrangements to carry over water between years;

- Continue coordination with other water purchase programs; and
- Maximize the effectiveness of CALFED program investments.

The elements of the strategy are similar to those discussed in Section 2.4.4 for the Flexible Purchase Alternative. The sections below summarize some of the strategy components relative to the Fixed Purchase Alternative.

2.5.3.1 Select Acquisitions That Minimize Costs

The EWA agencies would prioritize acquisitions that minimize costs and environmental effects. The highest priority would be stored reservoir purchase, followed by groundwater substitution and stored groundwater purchase. The lowest priority would be crop idling transfers because of their increased environmental effects and decreased flexibility.

Acquisitions in the export service area generally follow the same pattern: stored groundwater purchase is less expensive, more flexible, and has fewer environmental effects than crop idling transfers. The EWA Project Agencies would prioritize stored groundwater purchases.

2.5.3.2 Continued Coordination With Other Acquisition Programs

Other water acquisition programs would also acquire water in the same regions as the EWA, and some programs would seek to use this water to achieve similar goals. Thorough coordination could help maximize environmental benefits of these programs and avoid cumulative effects.

2.5.3.3 Increase Use of Multi-Year Transfers

The EWA Project Agencies could negotiate longer-term contracts with willing sellers to acquire water from the same source in multiple years. Multi-year agreements would likely decrease the cost of the water and improve flexibility by having a source that is available without additional negotiations.

2.6 Comparison of Three Alternatives

The three alternatives (No Action/No Project, Flexible Purchase, and Fixed Purchase) are summarized in Table 2-10.

2.7 Identification of the Environmentally Preferred Alternative

As described in the upcoming resource chapters, neither the Fixed Purchase Alternative nor the Flexible Purchase Alternative has potentially significant unmitigable impacts. The primary environmental delineator is the benefit produced by each alternative. The Flexible Purchase Alternative would include higher levels of asset acquisition, which would allow the EWA agencies to take more actions to benefit fish. The Fixed Purchase Alternative would include less asset acquisition;

therefore, the EWA agencies would have to prioritize actions to protect fish in the Delta and could take fewer actions to benefit fish.

Because the Flexible Purchase Alternative includes increased asset acquisitions, the EWA agencies could take more actions to benefit fish and would likely not reach Tier 3 very often. The Fixed Purchase Alternative would have an increased likelihood of reaching Tier 3, when uncompensated actions to protect fish may occur. Both alternatives increase water supply reliability over the No Action/No Project Alternative, but the Fixed Purchase Alternative would not be as reliable because of the increased potential of uncompensated Tier 3 actions.

The Flexible Purchase Alternative is the environmentally preferred alternative because of the increased benefits it would provide and because it has no significant unmitigable impacts. The benefits to aiding in the recovery of at-risk native fish species populations are described in more detail in the upcoming resource chapters.

Table 2-10
Comparison of Alternatives

	No Action/No Project	***Flexible Purchase Alternative***	***Fixed Purchase Alternative***
Regulatory Baseline	Project operations would be limited and guided by regulatory baseline that includes; D-1641, (b)(2), Biological Opinions, 1986 COA, other SWRCB Orders, USACE flood control, and FERC requirements.	No change in the regulatory baseline.	No change in the regulatory baseline.
Pump Reductions	Fish actions would be limited to curtailments taken after anticipated incidental take threshold is reached. Curtailments would be limited to quantity necessary to avoid reaching red light (a lower standard).	Fish actions would be taken prior to “take” thresholds and to provide additional environmental support. Magnitude and duration of reductions would be met by available supplies. Larger available supplies would support a more rapid trajectory to recovery	Fish actions would be taken prior to “take” thresholds being reached. Magnitude and duration of curtailments taken to support recovery (a higher standard) would be limited by available supplies.
Delta Cross Channel Gates Delta Cross Channel Gates (continued)	DCC gates would be closed during the time periods dictated by the regulatory baseline, including CVP operating standards and D-1641.	DCC gates could be closed more than with the No Action/No Project. Available assets to pay back users affected by closure would limit the additional closures (600,000 acre-feet plus variable assets).	DCC gates could be closed more than with the No Action/No Project. Available assets to pay back users affected by closure would limit the additional closures (185,000 acre-feet plus variable assets).

Table 2-10
Comparison of Alternatives

	No Action/No Project	***Flexible Purchase Alternative***	***Fixed Purchase Alternative***
Instream Flows	No incremental benefits would accrue. Projects would be operated according to regulatory baseline.	Upstream purchases would provide additional flows in both Project and non-Project controlled streams. Releases would be scheduled to benefit where possible and, at a minimum, have no negative effects. The magnitude of potential benefits would vary between rivers but would be limited by the volume of upstream purchases moved during the transfer window, which could be up to 600,000 acre-feet.	Upstream purchases would provide additional flows in both Project and non-Project controlled streams. Releases would be scheduled to benefit where possible and, at a minimum, have no negative effects. The magnitude of potential benefits would vary between rivers but would be limited by the volume of upstream purchases moved during the transfer window, which could be up to 35,000 acre-feet.
Water Purchases	Water users could be active in the water market to replace some or all water supplies lost in years when uncompensated water supply reductions occur because of modification to Project operations to protect at-risk species. Potential sellers and sources of water would be the same as those identified in this EIS/EIR. Other State and Federal water purchase programs would also participate in the water market. Water users would rely more on groundwater and would be more involved in water markets purchasing supplies in years that it would be needed to replace uncompensated cuts.	EWA would purchase up to 600,000 acre-feet, if needed. Normal EWA purchases in the 200,000 to 300,000 acre-foot range. Sources would not be specified, but would depend on location of sellers, economics, hydrology, conveyance capacity, and other factors.	EWA would purchase 185,000 acre-feet annually. This quantity would be equal to the fish actions, less assets from Delta operational flexibility. Sources would not be specified, but would depend on location of sellers, economics, hydrology, conveyance capacity, and other factors.
Functional Equivalency	Would not exist	Broadly defined. This alternative would use the functional equivalency principle from the ROD to make purchases from a different mix of sources. EWA agencies would have flexibility to scale upstream from the Delta purchases to available conveyance capacity in the Delta by water year. This would help the EWA agencies accomplish more with fixed budgets, but would use conveyance capacity that might otherwise be available to others.	Narrowly defined. Geographic distribution of purchases would follow those described in the ROD. Cost of water in export service areas in dry years would be high.
Sharing (b)(2) & ERP	SWP would receive full benefit of (b)(2) and ERP that CVP cannot capture.	Half of yield would be dedicated to EWA.	Half of yield would be dedicated to EWA.

Table 2-10
Comparison of Alternatives

	No Action/No Project	***Flexible Purchase Alternative***	***Fixed Purchase Alternative***
JPOD	Transfers by SWP contractors to replace supplies lost because of uncompensated cuts would have priority over all others for use of Banks Pumping Plant capacity. The remaining capacity would be available to CVP and other non-SWP contractors.	Capacity would be given to EWA as defined in Operating Principles Agreement. Use of opportunity during excess conditions would be important. Use during balanced summertime conditions would be limited to half of the available capacity, unless the CVP did not choose to use its share of capacity. Capacity available to CVP and non-SWP contractors would be reduced by the volume of upstream purchases by EWA.	Capacity would be given to EWA as defined in Operating Principles Agreement. Use of opportunity during excess conditions would be important. Use during balanced summertime conditions would be limited by the volume of upstream purchases or carryover water in upstream storage facilities. Upstream purchases would be limited to 35,000 acre-feet, which would be able to be pumped by the 500 cfs increase at Banks Pumping Plant (see below).
500 cfs Summer Conveyance Capacity	Used by DWR to replace uncompensated cuts for fish. Requires increased summer releases from Oroville to support exports unless water was held back in Oroville during pumping curtailments.	Capacity would be given to EWA. EWA would need to support exports with upstream purchases. Use would not be limited to years when SWP uses all available permitted capacity. EWA could also use in any year that upstream purchases exceed half the capacity available under JPOD.	Capacity would be given to EWA. EWA would need to support exports with upstream purchases. Use would be limited to years when SWP uses all available permitted capacity. The EWA would use this capacity when all purchased EWA water cannot be moved through the Delta within the EWA's share of the otherwise permitted capacity at Banks Pumping Plant.
E/I Relaxation	E/I relaxation would be available to Projects as potential tool to replace uncompensated cuts, if the Management Agencies approve.	Yield would be dedicated to EWA.	Yield would be dedicated to EWA.
Source Shifting	Could occur as a result of uncompensated cuts.	Would be used as a tool by EWA to prevent the EWA from aggravating low point water quality problems in San Luis Reservoir. Not restricting purchase quantities could result in less frequent use of source shifting. Purchasing greater quantities in export service areas could reduce frequency of the need to use by providing water prior to low-point.	Would be used as a tool by EWA to prevent the EWA from aggravating low point water quality problems in San Luis Reservoir. Restricting purchase quantities could result in more frequent use of source shifting. Purchasing greater quantities in export service areas could reduce frequency of the need to use by providing water prior to low-point.

Table 2-10
Comparison of Alternatives

	No Action/No Project	Flexible Purchase Alternative	Fixed Purchase Alternative
Tier 3	Would not exist	Would be used only if EWA assets were not available and continued Project operations would jeopardize species. Flexible purchasing could reduce frequency that Tier 3 is needed. This alternative includes purchases up to 600,000 acre-feet, so additional Tier 3 acquisitions would be covered if they combine with other EWA acquisitions to total less than 600,000 acre-feet.	Would be used only if EWA assets were not available and continued Project operations would jeopardize species. Limiting purchases could lead to greater frequency that Tier 3 is needed. This alternative does not include acquisitions for Tier 3 (over 185,000 acre-feet), so EWA agencies would need to complete additional documentation if purchases for Tier 3 exceeded 185,000 acre-feet.

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Chapter 3
Introduction to the Environmental Setting, Impacts, and Mitigation Measures

3.1 Introductions and Chapter Organization

This chapter defines the scope and extent of the environmental analysis, including a delineation of the overall study area, the framework for the impact analyses, an explanation of resource areas evaluated and not evaluated, and a list of environmental documents incorporated by reference.

3.2 EWA Study Area

The EIS/EIR study area includes those areas of California that might receive benefits from EWA actions or areas potentially affected by EWA because they serve as a site for EWA water asset acquisition, conveyance, or storage. The EWA study area is divided into three study units, based on the unit's relation to the Delta. Water conveyance through the Delta is a significant constraint to EWA operation, influencing both the acquisition of water assets and the effects analysis. The effects analysis of each alternative was conducted under a regional framework because of the similarity of effects within each of the three units (see Figure 3-1). The three study units (or regions) are defined as the land and tributaries upstream from the Delta, the Delta, and the Central Valley Project/State Water Project (CVP/SWP) Export Service Area. The CVP/SWP Export Service Area is defined as those lands that receive SWP and CVP water via the south Delta pumping plants, as well as reservoirs that are used for EWA asset management.

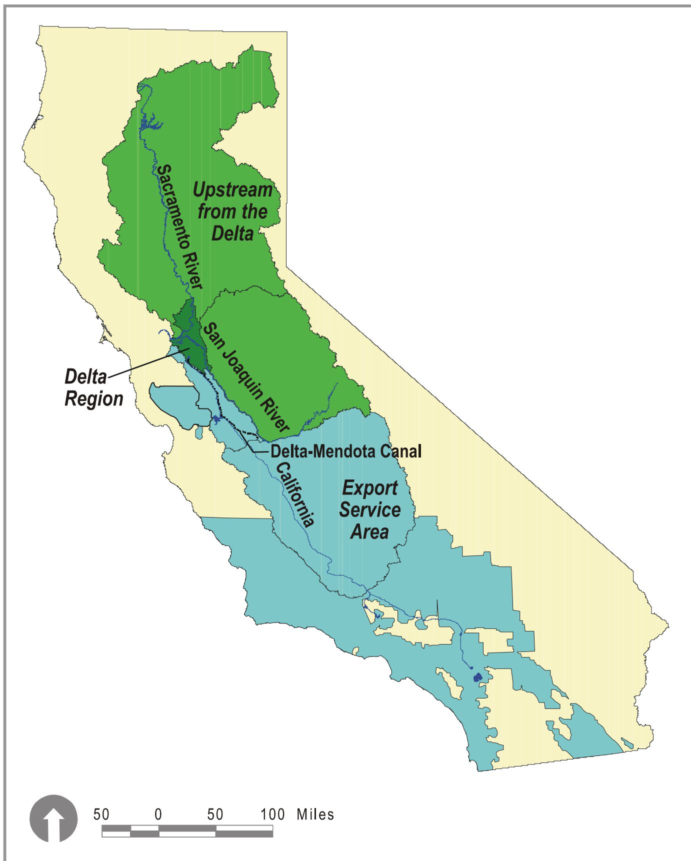

Figure 3-1
EWA Study Area

The overall EWA study area includes specific areas of analysis for each resource that may be directly or indirectly affected by potential EWA acquisitions (see individual chapters 4 through 21 for descriptions of specific areas of analysis for each resource). In a general sense, these areas of analysis comprise (1) watersheds of rivers that may be the source of stored reservoir water or may participate in groundwater substitution or crop idling; (2) rivers used to convey EWA assets; (3) lands that may be used for crop idling; (4) groundwater basins that may be affected by groundwater substitution, crop idling, stored groundwater purchase, or groundwater storage; (5) reservoirs that may be used for source shifting; (6) SWP or CVP conveyance facilities; (7) SWP or CVP storage facilities; and (8) storage facilities owned by other entities. These water bodies, lands, and water supply facilities are delineated below.

- Upstream dams and reservoirs on the Sacramento, Feather, Yuba, American, and Merced Rivers where EWA assets may be acquired or stored, including:
  - Lake Shasta (Sacramento River);
  - Little Grass Valley, Sly Creek, and Oroville Reservoirs (Feather River);
  - New Bullards Bar Reservoir (Yuba River);
  - Hell Hole, French Meadows, and Folsom Reservoirs (American River);
  - Lake McClure (Merced River);
- Water bodies downstream from the above reservoirs, including:
  - Sacramento River;
  - South Fork Feather River, Middle Fork Feather River (downstream from the South Fork), and the lower Feather River;
  - Yuba River;
  - Middle Fork American River, North Fork American River (downstream from the Middle Fork), and the lower American River;
  - Merced and San Joaquin Rivers;
- Instream and riparian areas corresponding to the above reservoirs and streams;
- The Sacramento-San Joaquin Delta;
- Portions of the CVP and the SWP systems;
- San Luis Reservoir;
- Two terminal Department of Water Resources (DWR) reservoirs in which the Metropolitan Water District (WD) controls a portion of the storage: Perris and Castaic;
- Metropolitan WD facilities: Diamond Valley Lake, Lake Mathews, and groundwater basins;
- Santa Clara Valley WD facility: Anderson Reservoir;
- Other non-CVP/SWP facilities where the local water agency participates in EWA (e.g., Kern Water Bank);

- Agricultural lands in the Sacramento Valley (Butte, Colusa, Glenn, Placer, Sutter, and Yolo Counties) and the San Joaquin Valley (Kings, Fresno, Kern, Tulare Counties) in which farmers participate in crop idling; and
- Groundwater basins that participate in acquisition of EWA water via groundwater substitution, stored groundwater purchase, or groundwater storage.

Regulating and other reservoirs downstream from reservoirs where EWA assets may be acquired or stored are dismissed in the effects assessment because these reservoirs are normally operated to receive variable flows, and EWA actions will not affect operations of those downstream reservoirs. Increases in reservoir inflow would not affect the regulator reservoir storage levels because increased releases would match the increased inflow.

Because one of goals of the EWA program is to improve water supply reliability in the Export Service Area, there is a potential for indirect growth, economic effects (from more stable crop production or crop idling), or indirect groundwater effects (from groundwater substitution). However, EWA is a dynamic program with the potential for effects varying from one locality to another each year. Therefore there is difficulty in anticipating where these effects may occur; thus, the program study area only includes those areas delineated above. The respective analytical chapters of this document describe any differences between this overall EWA area of analysis described above and the area of analysis for a particular resource area (e.g., each discipline has a different area of analysis, as described in Chapters 4 to 21).

The effects analysis requires the differentiation of EWA action into three regions because of the importance of the Sacramento-San Joaquin Delta (Delta region) as a conveyance system for the transfer of water from "Upstream from the Delta" to SWP and CVP contractors downstream from the Delta pumps (Export Service Area). EWA water transfers originating Upstream from the Delta would require moving water through the Delta. Constraints to transferring water through the Delta range from physical limitations to regulatory requirements. Careful coordination of EWA transfers with existing SWP and CVP operations in meeting water rights, water quality, and fishery protection measures would be necessary when the EWA acquisitions are transferred through the Delta.

3.2.1 Upstream from the Delta Region

The Upstream from the Delta Region includes the Sacramento Valley, the Sacramento River, and its tributary rivers: Feather River, Yuba River, and American River. Because the San Joaquin River also flows into the Delta upstream from the Delta pumps, the portions of the San Joaquin Valley that are drained by the San Joaquin River are also considered to be "upstream" from the Delta. The Merced River, a San Joaquin River tributary, is also part of the Upstream from the Delta region.

3.2.1.1 Sacramento River Area

The Sacramento River area is bounded by the ridgetops of the Sacramento River watershed (hydrologic region). The Sacramento, American, Feather, and Yuba Rivers have been identified as potential sources of EWA acquisitions. The Feather and American Rivers are major tributaries to the Sacramento River; the Yuba River is a major tributary to the Feather River (see Figure 3-2).

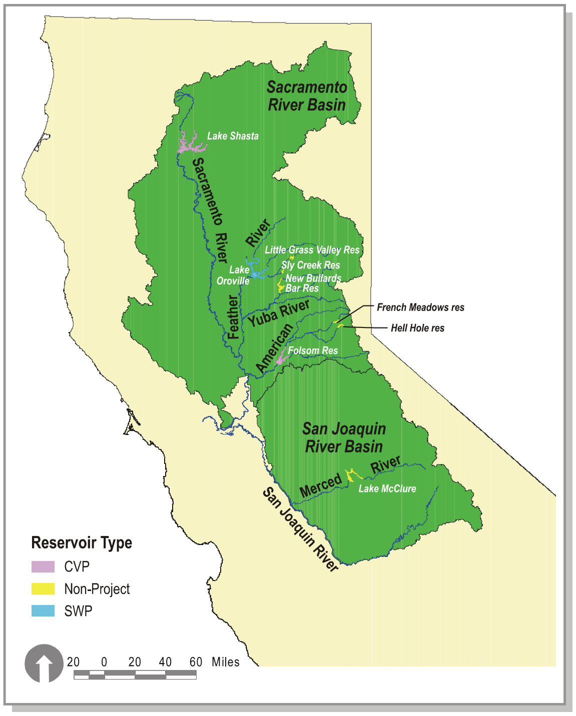

Figure 3-2
Upstream from the Delta Region

3.2.1.2 San Joaquin River Area

The major rivers of the San Joaquin River watershed are the Stanislaus, Tuolumne, Merced, and San Joaquin. The Merced River is a potential source of EWA acquisitions. The San Joaquin Valley is separated into two hydrologic basins: in the north, the San Joaquin Sub-basin, which drains to the Delta; and the Tulare Sub-basin to the south. The Tulare Sub-basin is in the Export Service Area region because the Tulare Sub-basin drains to the Delta only when rare floodflows carry its water north into the San Joaquin Sub-basin.

3.2.2 Sacramento/San Joaquin Delta Region (Delta Region)

The Delta Region is separate from the Sacramento River and San Joaquin River watersheds because of its legal status and its use as a conveyance system for upstream acquisitions. As the location of the SWP and CVP pumping plants, the San Francisco Bay/Sacramento-San Joaquin Delta is the site of conflicts regarding the take of endangered or threatened fish species. In addition, the Delta lies at the confluence of the Sacramento and San Joaquin Rivers and serves as the major hub for the operations of the SWP and CVP. The Delta's use as a conveyance system by the SWP and CVP highlights its importance to the EWA program. The SWP operates its Harvey O. Banks Pumping Plant in the southern Delta to lift water into the California Aqueduct for delivery to SWP customers in the south San Francisco Bay Area, San Luis Obispo and Santa Barbara Counties, the San Joaquin Valley, and southern California. The CVP operates the Tracy Pumping Plant to lift water from the Southern Delta into the Delta-Mendota Canal to service CVP contractors in the San Joaquin Valley and the Tulare Basin (see Figure 3-3).

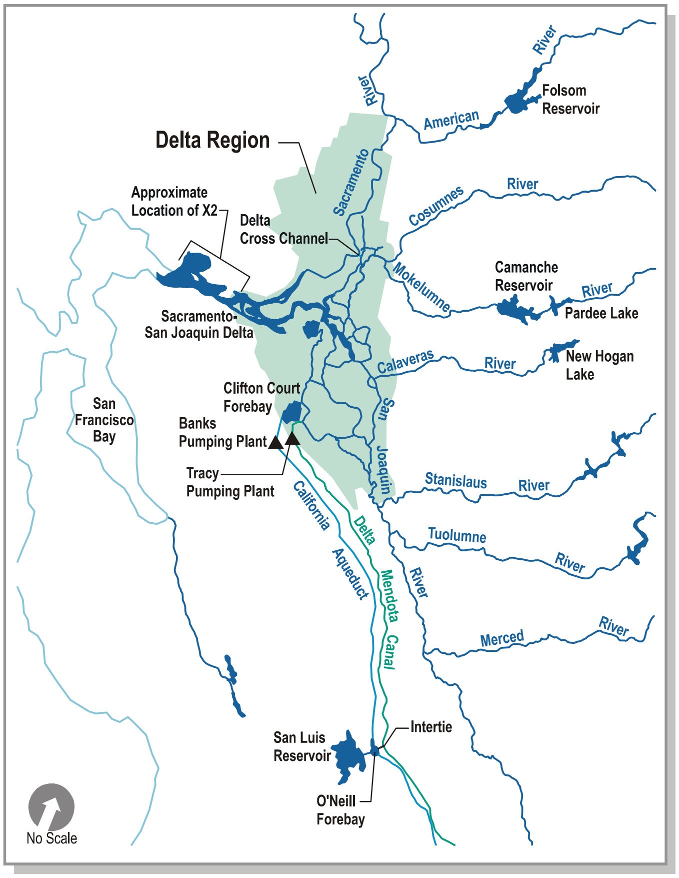

Figure 3-3
Delta Region Facilities

A series of regulations and agreements with the State Water Resources Control Board (SWRCB), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NOAA Fisheries), California Department of Fish and Game (CDFG), and U.S. Army Corps of Engineers (USACE) govern current SWP and CVP operations in the Delta. These regulations and agreements limit the volume of water that can be exported from the Delta based on Delta hydrodynamics, water quality, and potential impacts on fisheries as determined by (1) fish abundance at the pumps, as indicated by screening operations; (2) a real-time monitoring program implemented by the Interagency Ecological Program throughout the Bay-Delta; and, (3) fish monitoring conducted on tributaries upstream from the Delta.

3.2.3 Export Service Area

The Export Service Area is defined as the area that receives, stores and uses CVP and SWP water pumped from the Delta. It includes the San Joaquin Valley and CVP/SWP customers in the Bay Area, south central California Coast, and southern California.

3.2.3.1 San Joaquin Valley

EWA asset acquisition and management actions would affect areas of Fresno, Kern, Kings, and Tulare Counties in the southern San Joaquin Valley (Figure 3-4). This area receives water from multiple sources, including the SWP, the CVP, local surface water sources (Kings, Kaweah, Tule, and Kern Rivers), and groundwater. EWA actions in this area include crop idling, stored groundwater purchases, and groundwater storage.

3.2.3.2 Export Service Area Reservoirs

The California Aqueduct delivers imported water to the Metropolitan WD service area from northern California sources to storage reservoirs such as Pyramid Lake, Castaic Lake, Silverwood Lake, and Lake Perris. Other Metropolitan WD water supplies include the Colorado River Aqueduct, local groundwater supplies, Metropolitan WD storage reservoirs (e.g., Diamond Valley), and reclaimed water. Metropolitan WD's SWP allocation is 2.01 million acre-feet of water per year.

Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Reservoir are four facilities in southern California that would potentially be used for EWA asset management. The Castaic Dam and reservoir facility is about 45 miles northwest of Los Angeles. Castaic Lake is the terminus for the west branch of the California Aqueduct. Lake Perris is about 11 miles southeast of Riverside and 60 miles southeast of downtown Los Angeles. The lake is the southern terminus of the SWP's East Branch of the California Aqueduct.

Figure 3-4
Export Service Area

Diamond Valley Reservoir, recently completed by the Metropolitan WD, is 80 miles southwest of Los Angeles. This reservoir receives water distributed through Metropolitan WD's water distribution system, which includes all Metropolitan WD's water sources.

Anderson Reservoir, in Santa Clara County, is another facility that would potentially be used for EWA asset management. Santa Clara Valley WD uses Anderson Reservoir for groundwater recharge and as a secondary drinking source. The reservoir is the largest lake in the county.

3.2.4 CVP/SWP Project Facilities

CVP/SWP Project facilities that are potentially affected by EWA acquisitions include San Luis Reservoir from which the EWA could borrow water or use for storage; SWP and CVP storage reservoirs (Lake Shasta, Lake Oroville, and Folsom Lake), which may be used for EWA asset storage; and SWP and CVP pumping and conveyance facilities, which would be used for transporting EWA acquisitions. The facilities are identified on Figures 3-2, 3-3, and 3-4.

3.2.4.1 San Luis Reservoir

San Luis Reservoir is an offstream storage reservoir within the Export Service Area jointly operated by the CVP and SWP. It is near Los Banos, has a capacity of 2,041,000 acre-feet, and stores exports from the Delta to be used when the water is needed in the Export Service Area. Both the CVP and SWP systems use San Luis Reservoir to increase water allocations. San Luis Reservoir water supplements other CVP or SWP water during periods of constrained operations in the Delta and when demands exceed maximum capacity at the pumping plants.

3.2.4.2 Other State Water Project Facilities

The SWP is the largest State-built, multipurpose water project in the country. DWR operates the SWP to export Delta flows and store and transfer water from the Feather River basin to the San Joaquin Valley, the South Bay, North (of Suisun) Bay, coastal counties, and ultimately to southern California. The State legislature authorized the SWP in 1951 for water supply, flood control, hydropower generation, recreation, and fish and wildlife purposes. About 22 million of California's estimated 33 million residents benefit from SWP water, which irrigates about 600,000 acres of farmland, mainly in the south San Joaquin Valley.

SWP facilities include 28 dams and reservoirs, 26 pumping and generating plants, and approximately 660 miles of aqueducts. In the southern Delta, the SWP diverts water from Clifton Court Forebay for delivery south of the Delta. Banks Pumping Plant lifts water from the Clifton Court Forebay into Bethany Reservoir. The water delivered to Bethany Reservoir flows into the California Aqueduct, the main conveyance facility of the SWP. The balance of the water is pumped from Bethany Reservoir into the South Bay Aqueduct for delivery to urban contractors in the South Bay Area. Along the western San Joaquin Valley, the California Aqueduct transports water through the Gianelli Pumping-Generating Plant for storage in San Luis Reservoir until it is needed for later use. The 444-mile-long California Aqueduct conveys water to the primarily agricultural lands of the San Joaquin Valley and the mainly urban regions of Southern California. The west branch of the aqueduct ends in Castaic Lake, and the east branch terminates at Lake Perris.

3.2.4.3 Other Central Valley Project Facilities

The CVP is a multipurpose project operated by Reclamation to store and transfer water from the Sacramento, San Joaquin, and Trinity River Basins to the Sacramento and San Joaquin Valleys. Congress authorized the CVP in 1935. The authorized purposes of the CVP are navigation, flood control, water supply, fish and wildlife, hydropower generation, recreation, and other beneficial uses. The CVP service area extends about 430 miles through much of California's Central Valley, from Trinity and Shasta Reservoirs in the north to Bakersfield in the south. About 15 percent of CVP water goes to municipal and industrial uses, providing water to approximately 2 million urban residences in Contra Costa, Santa Clara, and Sacramento Counties.

The remaining CVP water irrigates 3 million acres of land in the Sacramento and San Joaquin Valleys.

The Delta-Mendota Canal is the main conveyance facility of the CVP. It conveys water from the Tracy Pumping Plant in the southern Delta to agricultural lands in the San Joaquin Valley. Water not delivered directly is diverted from the Delta Mendota Canal at O'Neill Pumping Plant into O'Neill Forebay. The water then flows along the San Luis Canal to CVP contractors in the San Joaquin Valley or is lifted into San Luis Reservoir through Gianelli Pumping/Generating Plant for later use. The majority of the rest of the water continues to the southern Central Valley, with some water being diverted to Santa Clara County.

3.2.5 Comparison of EWA Program Area Boundaries and CALFED PEIS Boundaries

The EWA study area boundaries are very similar to the CALFED Programmatic Environmental Impact Statement/Environmental Impact Report (CALFED PEIS/EIR) boundaries (see Figure 3-5). With the exception noted below, the boundaries of the Delta Region and Export Service Area coincide with those of the "Delta Region" and "Other CVP and SWP Service Areas," respectively, in the PEIS. For the Delta Region, the analyses in this document end at Suisun Bay. The boundaries of the Sacramento River Basin coincide with the "Sacramento River Region" of the CALFED PEIS/EIR. The major differences are the exclusion of the Bay Region from the study area, and the grouping of all watersheds that drain into the Delta (the Sacramento River Basin and the San Joaquin River Basin) into one region, Upstream from the Delta. This required separating the San Joaquin Region sub-basins as presented in the CALFED PEIS/EIR. As noted previously, the northern part of San Joaquin Valley that flows into the Delta, is part of the Upstream from the Delta Region while the southern part of San Joaquin Valley is in the Export Service Area.

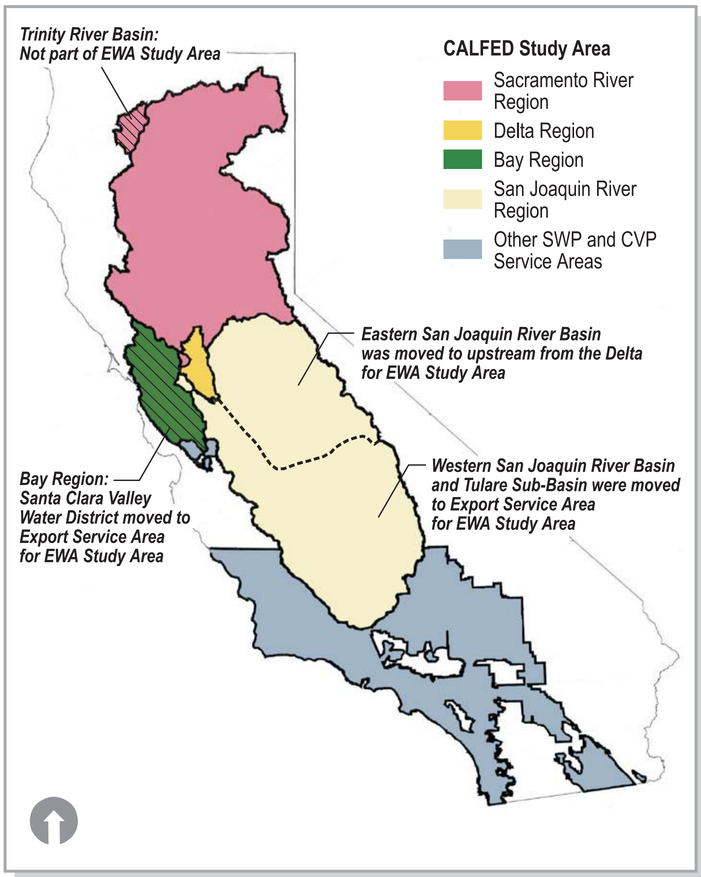

Figure 3-5
EWA and CALFED Program Area Boundaries

Also as noted previously, each

resource area has a different area of analysis depending on the type of EWA asset acquisition or management action. The reader is referred to each resource area chapter for the definitions of the boundaries for each resource area.

3.3 Framework for Environmental Consequences/ Environmental Impacts Analysis

This Report presents pertinent information for assessing the alternatives' potential adverse impacts on the environment, in accordance with National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) requirements. The document includes 17 analytical chapters, each for a specific resource: water supply, water quality, groundwater resources, geology and soils, air quality, fisheries and aquatic ecosystems, vegetation and wildlife, regional and agricultural economics, agricultural social issues, agricultural land use, recreation, flood control, power production, cultural resources, visual resources, environmental justice, and Indian Trust Assets. Chapters 4 through 22 contain all the required CEQA/NEPA components, including:

- The Affected Environment/Existing Conditions presented by the three EWA study area regions, including a detailed presentation of existing environmental conditions within the areas of analysis for each of the resource areas.
- Environmental Consequences/Environmental Impacts, including assessment methods, significance criteria, and qualitative and quantitative descriptions of potential impacts on the physical, biological, and social environments by alternative.
    - No Action/No Project Alternative
    - Flexible Purchase Alternative
    - Fixed Purchase Alternative
- Comparative Analysis of Alternatives
- Mitigation Measures (for resources with potentially significant impacts)
- Cumulative Effects (Chapter 22)

In general, the effects analysis evaluated only those asset acquisition and management actions that were included in the project description for that alternative. In other words, only the purchase of specific amounts of water known to be available from particular water agencies was evaluated in the environmental consequences chapters. It is possible that water from other willing sellers will become available in the future. If other water becomes available, it would likely be pursued by the Project Agencies for EWA needs. However, purchases in amounts or from locations outside the scope of this EIS/EIR would require additional NEPA and CEQA analysis. Many of the environmental resources, such as groundwater, agricultural resources, and cultural resources require site-specific information to complete a full impact analysis.

It is not possible to accurately predict the amount of water needed for EWA actions each year, or know the names and locations of willing sellers with available water each year. The EWA program does not allow for a definitive list of all EWA acquisitions that may occur. The quantities of water available each year depend on the weather and resulting water supply conditions. The alternatives in Chapter 2 describe likely quantities of water that may be available from specific water agencies. The quantities of water listed in Table 2-5 represent the largest range of possible purchases that could be made available by these willing sellers.

The effects analysis of some resources, namely fisheries and water quality in the Delta, does not depend on the location of the particular water seller, but on the total amount of EWA water to be transferred via a particular tributary and receiving water body. Fisheries and water quality effects, therefore, were evaluated based on the largest amount of water that EWA agencies could manage in the Delta for fish actions (approximately 600,000 acre-feet, per the analyses in this EIS/EIR), regardless of whether the specific water sellers could be identified at this time. Therefore, the effects analysis represents a "worst-case scenario" based on the maximum amount of water that may be purchased by the EWA agencies.

Another caveat to the above approach relates to the selection of possible EWA water acquisitions described in the Chapter 2. Some of the water acquisitions were included in the EWA program description not only because of the EWA agencies' awareness of them, but also because the acquisitions are in the same geographic area of other potential unidentified acquisitions. For example, additional acquisitions not identified in Chapter 2 (Table 2-5) are expected to be available for the EWA from agencies drawing water from the Sacramento and Feather Rivers. The EWA agencies anticipate that the site-specific effects analysis included in this EIS/EIR also will provide analysis for the effects of other water acquisitions from neighboring agencies along these tributaries with similar physical conditions (e.g., groundwater conditions, crop types). To the extent that the effects analyses included in this EIS/EIR do not adequately cover potential, unidentified EWA asset acquisitions, this document instead provides a programmatic level of analysis for these future EWA acquisitions.

3.4 Basis of Comparison

This document is a environmental impact statement addressed to NEPA requirements and an environmental impact report developed to address CEQA requirements. NEPA and CEQA use different terms for similar definitions. Important NEPA and CEQA terms are presented in Table 3-1. The text that follows describes the differences between NEPA and CEQA in formulating the basis of comparison for the determination of project-related effects.

Table 3-1
Important NEPA and CEQA Terms

NEPA	CEQA
Cooperating agency	Responsible agency
Proposed Action	Proposed Project
No-action alternative	No-project alternative
Environmentally preferred alternative	Environmentally superior alternative
Purpose and need	Project objectives
Affected environment	Environmental setting
Environmental Consequences	Environmental Impacts
Environmental Impact Statement (EIS)	Environmental Impact Report (EIR)
Notice of Intent (NOI)	Notice of Preparation (NOP)
Notice of Availability (NOA)	Notice of Completion (NOC)
Record of Decision (ROD)	Notice of Determination (NOD)/Findings

Under CEQA Guidelines, the basis of comparison, the benchmark from which to compare the "Proposed Project" with the condition of no project, is called the "Environmental Setting," usually defined as the physical environmental conditions in the vicinity of a project that exist at the time of the filing of the Notice of Preparation (NOP). DWR filed an amended NOP on May 28, 2002 (Appendix F). The Affected Environment/Environmental Setting sections in this EIS/EIR describe existing conditions of the human, physical, and natural environments. These conditions vary for each resource evaluated in the EIS/EIR. In addition, there are regional differences in the settings for specific resources. For example, for agricultural economics, there are current trends that predict a different setting for the future. For Placer County, the current trend is the conversion of farmland for residential uses indicating less agricultural land use. For the Westlands area, legislated cropland retirement programs could mean less agricultural land for Fresno and Kings Counties. While for other counties, such as Colusa and Butte, no significant change in agricultural land use is anticipated, making existing and future conditions similar.

CEQA and NEPA guidelines also require a lead agency to evaluate a "No Project/No Action" alternative that describes future conditions without the project. For the purpose of analyzing water-related resource areas and impacts of the EWA action alternatives, the operation of the CVP/SWP under existing operational rules (Environmental Setting) was determined to be the same as the operating rules under the No Project/No Action Alternative. No CVP or SWP operational changes are expected during the 2004-2007 timeframe being analyzed in this EIS/EIR. The basis for comparison for water-related resources and impacts in this EIS/EIR is therefore termed the Environmental Setting/No Project condition. Because there is a potential for changes in the physical environmental setting in the near future, the assessment of some non-water-related resource areas (e.g., wildlife and land use) is based on two considerations: the "Environmental Setting" and the "No Project" condition. Therefore, for some resources, the effects of the EWA action alternatives are calculated relative to both the existing "Environmental Setting" and the expected "No Project" condition.

Under NEPA, the basis for determining effects is termed the "No Action" Alternative, defined as the Future Conditions Without the Project. The "Future Conditions" are the same as for the CEQA "No Project" Alternative and the NEPA "No Action" Alternative allowing for compliance with both acts. There are actions currently taking place for some of the resources that are causing changes from that described for the present conditions. Each resource section describes those actions and the expected changes. These likely immediate future conditions were considered in the description of the No Project/No Action conditions.

3.5 Resources Evaluated and Not Evaluated

Through the Environmental Water Account Team (EWAT), the Management and Project Agencies participated in the identification of the potentially significant environmental issues that are analyzed in depth in this EIS/EIR. The EWAT discussions lead to the determination of which resources are to be addressed in detail in this document.

EWA alternatives do not include new construction of water facilities, infrastructure, or any other type of construction or change in land disturbance. EWA agencies would use existing groundwater extraction and reservoir and riverflow control facilities. This EIS/EIR does not evaluate construction impacts.

The EWA program has a 4-year timeframe that would only create short-term water supply reliability. Therefore, this analysis does not assume any development, growth or additional demands on public services; increases in traffic congestion; reductions in the level of service standards; or increased safety risks.

EWA actions do not involve construction; therefore there would not be any construction-related noise impacts. Crop idling would decrease the amount of farming activities, thereby decreasing noise associated with activities generally present in agricultural areas. No increases in noise levels are anticipated; therefore, noise was not evaluated.

EWA alternatives do not involve construction or disturbances within water bodies that would result in fill or discharge of pollutants or contribute to conditions that might cause mudflows or other water-related hazards. EWA alternatives would not create hazards or hazardous conditions. The proposed EWA alternatives, therefore, would not have an impact on hazards and hazardous materials, mineral resources, noise, transportation/traffic, or utilities and service systems, and these resources were not included in this document.

EWA actions are expected to change the flow regimes and storage patterns in rivers, creeks and other channels contained by levees. Typically, water would be released from reservoirs during the mid- to late-summer and fall, when rivers and channels are substantially below flood stage capacity (typically less than 25 percent of spring runoff flows). Releases of EWA assets would not exceed typical releases from the reservoirs. Therefore, geomorphological effects to riverbanks and levee systems due to EWA releases were not calculated, and this EIS/EIR does not include additional analysis of geomorphology. Because several of the reservoirs used to store EWA assets do have a flood control function, EWA asset storage effects on reservoir flood control capability were analyzed in this EIS/EIR.

Resources that have the potential to be affected by the EWA action alternatives include water supply, water quality, groundwater, geology, soils and seismicity, air quality, fisheries and aquatic ecosystems, vegetation and wildlife, agricultural economics, agricultural social issues, agricultural land use, recreation (including hunting and fishing), flood control, power, cultural resources, visual resources, environmental justice, and Indian Trust Assets. Chapters 4 through 22 evaluate these resources.

3.6 Related Actions

The scope of an EIS/EIR consists of the full range of EWA actions, alternatives, and impacts (40 CFR 1508.25). No connected actions have been identified for this EIS/EIR. Actions are connected if (1) they automatically trigger other actions which may require environmental impact statements; (2) they cannot or will not proceed unless other actions are taken previously or simultaneously; (3) are interdependent parts of a larger action and depend on the larger action for their justification. No similar actions have been identified for EWA. Similar actions are those which, when viewed with other reasonably foreseeable or proposed agency action, have similarities that provide a basis for evaluating their environmental consequences together.

Cumulative actions have been identified for the EWA. NEPA defines "cumulative impact" as the impact that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. Cumulative actions are those, which when viewed with the proposed EWA action, have cumulatively significant impacts and should therefore be discussed in the same impact statement. These cumulative actions, which include other water acquisition programs and other actions/programs creating similar impacts (e.g., legislated crop retirement), are described in Chapter 22, Cumulative Analysis Framework; the effects of these actions combined with the effects of the EWA are evaluated by individual resource in Chapters 4 through 20.

3.7 Environmental Documents Incorporated by Reference

This document tiers from the CALFED PEIS/EIR (July 2000) and the Record of Decision (CALFED ROD) issued August 2000, pursuant to CEQA Guidelines Section 15152 and NEPA CEQ guidelines in Section 1508.28 (Tiering). As discussed in Chapter 1 (Section 1.5.1), the CALFED PEIS/EIR is incorporated by reference into this document for the purpose of providing background information about the CALFED Plan and context for this EWA EIS/EIR:

- CALFED Final PEIS/EIR, main text Chapters 1, 2, and 4
- CALFED Final PEIS/EIR, Responses to Comments Volume 1, Common Responses 1, 5, and 21
- CALFED Final PEIS/EIR Technical Appendices (Phase II Report, Implementation Plan, Water Transfer Program Plan, and Multi-Species Conservation Strategy

Primary CALFED PEIS/EIR documents and supporting technical reports that were used to provide additional factual information include:

- Multi-Species Conservation Strategy, Technical Appendix (species lists, species accounts, and habitat types)
- CALFED Technical Report, Affected Environment, Vegetation and Wildlife. CALFED Bay-Delta Program, March 1998 (for vegetation and wildlife resource analysis).
- CALFED Technical Report, Affected Environment, Fisheries and Aquatic Resources. The CALFED Bay-Delta Program, March 1998 (for fisheries and aquatic resources analysis).
- CALFED Programmatic Record of Decision, Volume 1, August 28, 2000
  - Attachment 1 – California Environmental Quality Act Requirements
  - Attachment 2 – Environmental Water Account Operating Principles Agreement
  - Attachment 3 – Implementation Memorandum of Understanding
  - Attachment 4 – Clean Water Act Section 404 Memorandum of Understanding
- CALFED Programmatic Record of Decision, Volume 2, August 28, 2000
  - Attachment 5 – Conservation Agreement Regarding Multi-Species Conservation Strategy
  - Attachment 6 – Programmatic Endangered Species Act Section 7 Biological Opinions
- CALFED Programmatic Record of Decision, Volume 3, August 28, 2000
  - Attachment 7 – Natural Community Conservation Plan Determination
  - Attachment 8 – Clean Water Act Section 401 Memorandum of Understanding
  - Attachment 9 – Coastal Zone Management Act Programmatic Consistency Determination

- Attachment 10 – Common Acronyms

This EIS/EIR makes use of existing environmental documents prepared by DWR for acquisition of water assets under other programs from several water districts and agencies. In this regard, the following environmental documents are incorporated by reference:

- Acquisition of Water from the Western Canal Water District for Use in the 2001 Dry Year Water Purchase Program. The California Department of Water Resources, May 2001.
- Arvin-Edison Water Management Project Negative Declaration, May 1996 (expansion of groundwater bank).
- Final EIR for the Semitropic Groundwater Banking Project, July 1994 (construction and operation of groundwater bank).
- Kern Water Bank EIR, 1986 (operation of groundwater bank).
- Arvin-Edison Water Management Project Negative Declaration, May 1996 (contract between Arvin-Edison and the Metropolitan Water District (WD) to allow Metropolitan WD to make use of the additional storage in Arvin-Edison's groundwater basin).
- Semitropic Groundwater Banking Project Environmental Impact Report, July 1994 (construction and operation of groundwater bank).

3.8 Irreversible and Irretrievable Commitments of Resources

NEPA Section 102(C)(v) (CEQ Regulations Part 1502.16) requires Federal agencies to consider to the fullest extent possible any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. CEQA Guidelines Section 15126.2(c) echo this same intention. Nonrenewable resources committed during project initiation may be irreversible, since commitments of such resources may permanently remove resources from further use. CEQA requires evaluation of irretrievable resources to assure that consumption is justified. For example, cultural resources are nonrenewable; any destruction or loss is irreplaceable.

The EWA program is a water acquisition and management strategy that does not involve construction or the use of resources except water, with one exception. That exception is the use of fuel that is required to power generators for the extraction of groundwater. The acquisition strategies, thresholds, and avoidance actions incorporated into the design of the EWA program prevent the irreversible and irretrievable commitment of other nonrenewable resources. There is no other commitment of nonrenewable resources, and the EWA Program does not commit future generations to permanent use of natural resources.

3.9 Relationship Between Short-Term Uses of the Environment and Maintenance and Enhancement of Long-Term Productivity

NEPA Section 102(C)(iv) (CEQ Regulations 1502.16) requires all Federal agencies to disclose the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity. All EWA water acquisition and management processes in this EIS/EIR are temporary, and would not directly lead to long-term benefits to the sustainability and reliability of California's water supply, fish, and fish habitat. Therefore, this discussion will focus on the tradeoffs between short-term environmental and human health costs and long-term environmental benefits if EWA were to be continued beyond 2007.

Water acquisition through crop idling is a short-term acquisition option that could result in both long- and short-term effects. Crop idling under certain circumstances could produce windborne dust that could result in human health effects and a permanent loss of soil due to wind erosion. Crop idling under EWA water acquisitions would include mitigation measures to prevent these adverse effects. The temporary idling of productive farmland would also result in increased localized farm labor unemployment. Long-term productivity related to water supply reliability issues would be dependent on continuation of the EWA beyond the stage 1 period of CALFED. EWA actions could lead to improvements that address California's surface and groundwater supplies, water quality, fish protection and recovery and sustain agricultural economics and social issues if decisions were made to continue the EWA program indefinitely.

This EIS/EIR only analyzes EWA actions through the Stage 1 phase of CALFED (the year 2007). The EWA program would not provide for protection of the long-term productivity of urban and rural populations by increasing their water supply reliability unless it was continued beyond 2007. Through a continued EWA, farmers could sustain food production in the Central Valley through use of reliable sources of surface water instead of turning to over drafted groundwater basins during times when the surface water supply is interrupted. Enhanced management of groundwater would also ensure its long-term sustainability.

Chapter 4
Surface Water Supply and Management

This chapter discusses how and when surface water supplies are delivered to water users, the management of surface water, and how the EWA would benefit and/or affect water users in areas where EWA actions would take place. Section 4.1 below discusses existing water supplies, including source and management, for agencies that could take part in the EWA. Additionally, associated waterways or agencies not participating in the EWA, but which could be affected by program actions, are described. Section 4.2 analyzes effects of the No Action/No Project, Flexible Purchase, and Fixed Purchase Alternatives. Also included in Section 4.2 are a cumulative effects discussion and a comparative analysis of the alternatives.

4.1 Affected Environment/Existing Conditions

4.1.1 Area of Analysis

The evaluation of potential effects on surface water supply and management from the implementation of the EWA includes water users in the following area of analysis (Figure 4-1):

- Sacramento River from Lake Shasta downstream to the Delta;
- Feather River downstream from Little Grass Valley and Sly Creek Reservoirs;
- Yuba River downstream from New Bullards Bar Reservoir;
- American River downstream from French Meadows and Hell Hole Reservoirs;
- Merced River downstream from Lake McClure;
- San Joaquin River downstream from Merced River to the Delta;

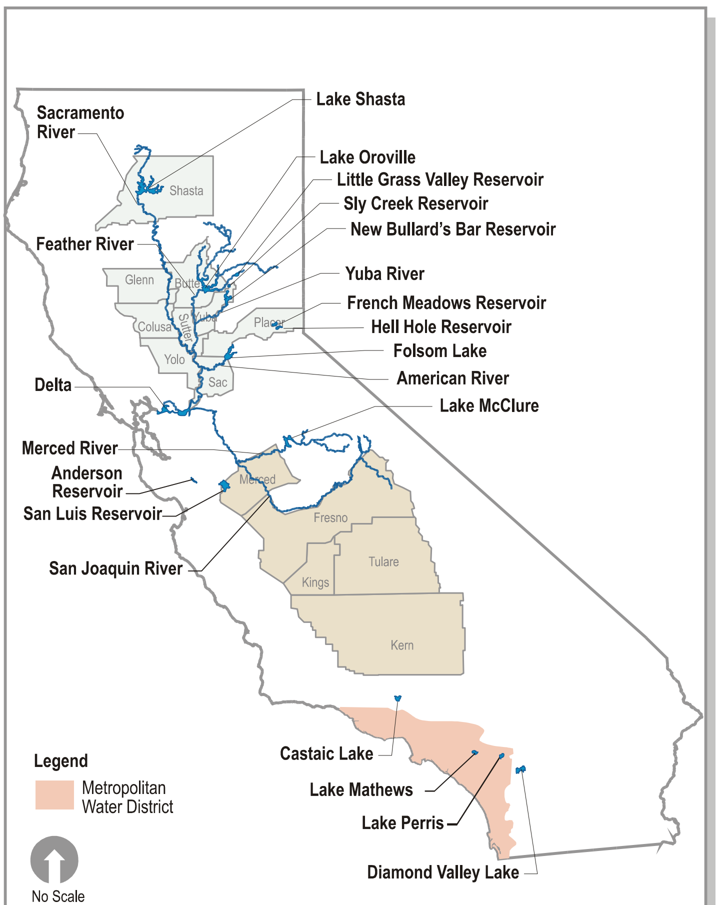

Figure 4-1
Water Supply Area of Analysis

- Delta;
- Water users with supply from Anderson Reservoir;
- Water users with supply from Metropolitan Water District; and
- Water users supplied by return flows from agencies that could sell to the EWA.

4.1.1.1 California Water Resources

Water supplies come from either groundwater or surface water. Because this chapter is entitled "Surface Water Supply and Management," the focus will be on the movement of surface water supplies from sources to their users. Within California, lakes, rivers, and reservoirs receive their water from precipitation and runoff, which is available during the rainy season (typically October through April). Water users need water year-round, with increased water needs during the summer because of increased temperatures and agricultural uses. This imbalance is exacerbated by the differences in precipitation and demand between northern California and southern California. More than 70 percent of runoff comes from northern California, but more than 75 percent of urban and agricultural demand is south of Sacramento. (DWR 1998)

Because of the uneven distribution of the location of water supply and water demand, aqueducts and canals are used to transport water to users. As discussed in Section 1.3, the Federal and State governments constructed the Central Valley Project (CVP) and State Water Project (SWP) to store and transport water to water users. All water that moves from the Upstream from the Delta Region to the Export Service Area must pass through the Delta and the Delta export pumps. The amount of water that can be transported south is dependent on Delta pump capacity[1].

Direct flows to the Delta drain over 40 percent of the State of California. The Sacramento River contributes roughly 75 to 80 percent of the Delta inflow in most years, while the San Joaquin River contributes about 10 to 15 percent. The Mokelumne, Cosumnes, and Calaveras Rivers, which enter into the eastern side of the Delta, contribute the remainder. Precipitation also contributes an annual average inflow of 990,000 acre-feet, approximately 5 percent of the annual inflow (Figure 4-2). The rivers flow through the Delta and into Suisun Bay.

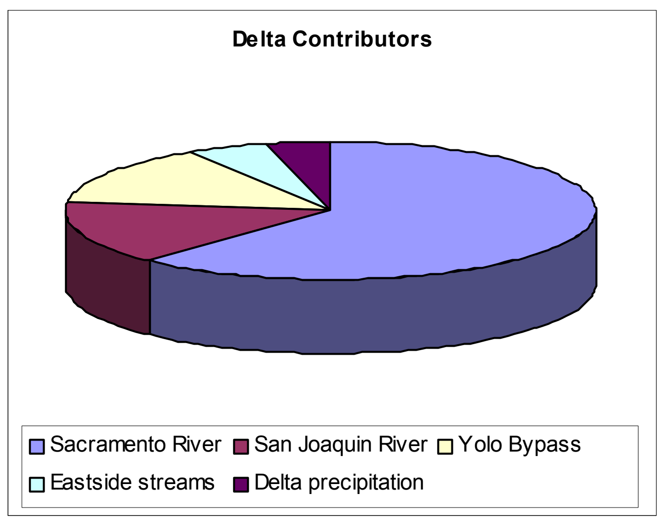

Figure 4-2
Contributors to Delta Inflow

1 Delta pumping capacity is not simply limited
on exports (e.g., fish protection requirements, and water quality requirements).

From Suisun Bay, water flows through the Carquinez Strait into San Pablo Bay, then south into San Francisco Bay, and then out to sea through the Golden Gate. On average, local users withdraw about 10 percent of the Delta inflow, and the CVP and SWP withdraw about 30 percent for export; 20 percent of the Delta inflow is required for salinity control, and the remaining 40 percent provides outflow to the San Francisco Bay ecosystem in excess of minimum identified requirements. Water that is not consumed or stored in northern California or pumped through the Delta to central and southern California flows out to the Bay and into the ocean.

4.1.2 Upstream from the Delta Region

Sections 4.1.2.1 through 4.1.2.5 are grouped by river and then further divided by agency. Included in the description of each agency is a discussion of the source of water supply, water supply facilities, and management practices. Preceding this description is an explanation of the type of water rights or entitlements the agencies may have.

As the Projects constructed dams and reservoirs, downstream flows became altered. Landowners and water agencies with either appropriative or riparian water rights[2] that diverted from the Sacramento and San Joaquin Rivers prior to construction of the CVP are guaranteed more reliable water supplies than other contractors (Water Education Foundation 1998). Likewise, water rights holders that diverted from the Feather River prior to the construction of the SWP are guaranteed a more reliable water supply. These “settlement contractors” negotiated agreements with the US Bureau of Reclamation (Reclamation) and the State of California to receive more reliable supplies during water shortages. CVP and SWP water service contracts differ, as compared to settlement contracts. During dry years, CVP and SWP contracts are subject to greater and more frequent deficiencies than settlement contracts.

“Exchange contractors” are those water users along the San Joaquin River who receive CVP water exported from the Delta in exchange for not using their water rights. Exchange contractors have the same water cutback agreement as the settlement contractors.

4.1.2.1 Sacramento River

Sacramento River agencies that may sell water to the EWA (Anderson-Cottonwood Irrigation District, Glenn-Colusa Irrigation District, Natomas Central Mutual Water Company, and Reclamation District 108) receive CVP water that is stored upstream from their service areas in Lake Shasta, a CVP facility. The CVP releases water from Lake Shasta as needed to meet downstream temperature requirements or the flow

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[2] An appropriative water right is based on physical control of water and since 1914, permit or license for its beneficial use. A riparian water right is based on ownership of land that physically touches the water source. Riparian rights are typically considered superior to appropriative rights (Water Education Foundation 1995).

requirement at Wilkins Slough. Lake Shasta is managed for flood control, water supply, recreation, fish and wildlife enhancement, power, and salinity control.

4.1.2.1.1 Anderson-Cottonwood Irrigation District

Anderson-Cottonwood Irrigation District (ID) has a CVP settlement contract. Anderson-Cottonwood ID diverts water from the Sacramento River near Redding. About 90 percent of Anderson-Cottonwood ID's customers irrigate pasture; Anderson-Cottonwood ID's service area accounts for two-thirds of all irrigated pasture in the Redding sub-basin. Although Anderson-Cottonwood ID does not have tailwater[3] available from outside its service area to use within the district, Anderson-Cottonwood ID operates five pumping plants to recapture return flows from lands within the district boundaries. The district reuses approximately 5,000 acre-feet annually. Although Anderson-Cottonwood ID's service area encompasses multiple municipal water purveyors, the District does not serve any major municipal and industrial (M&I) users (Reclamation et al. 2000).

4.1.2.1.2 Glenn-Colusa Irrigation District

Glenn-Colusa ID diverts water during the irrigation season under a CVP settlement contract from the Sacramento River and Stony Creek. Glenn Colusa ID may, according to its contract, also divert water for beneficial use November through March (typically for rice straw decomposition) to the extent authorized by California law, subject to Water Right Term 91 curtailments[4].

The Glenn-Colusa Canal is the principal conveyance mechanism for water delivery to the district. Glenn-Colusa ID also receives a portion of its water supply from the Tehama-Colusa Canal, on the west side of the Glenn-Colusa ID service area, at two connection points (Reclamation et al. 2000). The majority of the district's water supply is surface water; however, limitations on surface water deliveries because of environmental concerns and dry-year reductions have prompted farmers to rely more heavily on groundwater. The extent of groundwater use depends on the amount of available surface water; pumping ranges from 20,000 acre-feet during years of high surface supply to 95,000 acre-feet in dry years. Glenn-Colusa ID does not supply any M&I water.

Glenn-Colusa ID's water management program includes the recapturing of drainwater, including tailwater runoff and groundwater seepage. Glenn-Colusa ID recycles 155,000 acre-feet per year and delivers the water to either laterals or the main canal. Districts downstream of Glenn-Colusa ID, such as Provident Irrigation District, Princeton-Cordua-Glenn Irrigation District, and Maxwell Irrigation District, benefit from use of Glenn-Colusa ID's drainwater.

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3 Tailwater is applied irrigation water that runs off of a field. Tailwater is not necessarily lost; it can be collected and reused on the same or adjacent fields.

4 The SWRCB defined Term 91 in Water Rights Decision 1594: "Term 91 prohibits permittees from diverting water when stored Project water is being released to meet Delta water quality standards or other inbasin needs." Term 91 provisions are in permits issued after August 16, 1978.

4.1.2.1.3 *Natomas Central Mutual Water Company*

Natomas Central Mutual Water Company (MWC) diverts water from the Sacramento River during the irrigation season under a CVP settlement contract. Natomas Central MWC can also divert Sacramento River water during non-irrigation seasons for environmental water use (wetlands enhancement and rice straw decomposition). Such diversions outside the irrigation season are not a part of the Sacramento River Settlement Contracts. Natomas Central MWC has two main pump stations on the Sacramento River: Prichard Lake Pumping Plant and Elkhorn Pumping Plant. Natomas Central MWC also diverts water from the Natomas Cross Channel along the Natomas Central MWC's northern boundary. Although groundwater is used in conjunction with the surface water supply, especially in dry years, the majority of water use for irrigation is supplied by surface water. Natomas Central MWC owns two wells and has 61 privately owned wells.

Natomas Central MWC uses about 36,000 acre-feet of tailwater each year as an alternative supply to Sacramento River water. A recirculation system captures all tailwater and returns it either directly to the fields or into the main irrigation canals. During a normal irrigation season, Natomas Central MWC reuses agricultural drainage water until the end of the rice irrigation season (between August 15 and September 1) before it is released to the Sacramento River. Natomas Central MWC does not supply treated water for M&I, but does provide water for landscaping. Water demand is greatest during July and August due to agricultural needs and a hot, dry climate (Reclamation et al. 2000). Generally, all agencies have a greater water demand during July and August.

4.1.2.1.4 *Reclamation District 108*

Reclamation District 108 has a settlement contract with Reclamation to divert water from the Sacramento River as well as CVP Project water. Reclamation District 108 operates seven pumping plants that divert water from the Sacramento River for irrigation, and one that diverts water from the Colusa Basin Drain as a supplemental irrigation supply. Reclamation District 108's permit allows 75 cubic feet per second (cfs) to be pumped from the Colusa Basin Drain. The Sacramento River supplies the majority of the district's water; groundwater development is minimal. The district owns three wells that can supply groundwater in addition to the surface water supply. Reclamation District 108 does not serve any M&I users. For 15 years prior to 1997, Reclamation District 108 was recirculating all drainage water. This practice led to a buildup of salts in the soil that effected crop production; consequently in 1997, Reclamation District 108 reduced water reuse.

4.1.2.2 Feather River

Several Feather River agencies that may sell water to the EWA, including Western Canal Water District and the Joint Water Districts, receive water stored in Lake Oroville (an SWP facility). Lake Oroville is managed for flood control, water supply, recreation, fish and wildlife enhancement, power and salinity control too. Minimum flow requirements below the Thermalito Diversion Dam and the Thermalito Afterbay Outlet are 600 cfs and 1,000-1,700 cfs, respectively. Oroville-Wyandotte Irrigation

District, that may also sell water to the EWA, has water rights to water from the South Fork Feather River watershed.

4.1.2.2.1 Western Canal Water District

Western Canal Water District (WD) has a settlement contract with DWR. The District's allocation consists of natural flow from the Feather River (an amount subject to reduction during drought) and water stored upstream in the Feather River North Fork Project (an amount not subject to reduction) (Western Canal WD 1995). Western Canal WD's allocation is available from March through October of each year. The point of diversion is provided by two outlet structures on the northwest corner of the Thermalito Afterbay (PG&E Canal and Western Canal); maximum combined outlet flows are 1,250 cfs. Western Canal WD does not own any irrigation wells; any groundwater used is from individually owned wells. The primary water use is agricultural irrigation; some water is allocated for habitat production.

4.1.2.2.2 Joint Water Districts

The Joint Water Districts include the following districts: Biggs-West Gridley Water District, Butte Water District, Richvale Irrigation District, and Sutter Extension Water District. The Joint Water Districts have an SWP settlement contract for water from the Feather River. Points of diversion are provided by two outlet structures from Thermalito Afterbay (Main Canal and Richvale Canal). The Joint Water District Board is responsible for allocating water among their member agencies; however, the Board has no authority over how the agencies use their water. The Joint Water Districts have no production wells, but some landowners have backup wells to supplement water lost during droughts, or to provide all water during droughts so that the remaining surface water can be marketed. The primary water use is agricultural irrigation; some water is allocated for habitat production.

4.1.2.2.3 Oroville-Wyandotte Irrigation District

Oroville-Wyandotte ID can divert and store South Fork Feather River water between October 1 and July 1 according to Oroville-Wyandotte ID's water rights. A water right authorizes the diversion and storage of water from Lost Creek Reservoir between October 1 and June 1 (including diversion of up to 50 cfs between April 1 and June 1). The water received from both rights is used for irrigation and domestic purposes and for recreational purposes within Oroville-Wyandotte ID's reservoirs.

Oroville-Wyandotte ID owns and operates Little Grass Valley and Sly Creek Reservoirs as storage facilities on the South Fork Feather River. The reservoirs have a combined gross storage capacity of 160,400 acre-feet. These facilities are part of Oroville-Wyandotte ID's South Fork Project, which also includes Lost Creek and Ponderosa Reservoirs and the South Fork of the Feather River. The Lost Creek and Ponderosa facilities are not storage reservoirs; they act as regulating reservoirs for the Sly Creek Reservoir, the South Fork Feather River, and the South Fork Project. Oroville-Wyandotte ID operates the South Fork Project to supply water for consumptive uses and power generation.

4.1.2.3 Yuba River

The Yuba River agency that may sell water to the EWA is the Yuba County Water Agency, which has water rights to divert and store water on the Yuba River. The Yuba County Water Agency regulates releases from New Bullards Bar Reservoir into the Yuba River. The SWRCB D-1644/Order WR 2001-08 governs instream flow requirements in the lower Yuba River. The timing and quantity of allowable flow fluctuations are described in detail in Chapter 9, Fisheries and Aquatic Ecosystems.

4.1.2.3.1 Yuba County Water Agency

The primary water project in the lower Yuba River watershed is the Yuba River Development Project, operated by the Yuba County Water Agency (Yuba County WA). This multiple-use project provides for flood control, power generation, irrigation, recreation, and protection of fish and wildlife and includes the operation of New Bullards Bar Dam and Reservoir, Colgate Powerhouse, Englebright Reservoir, Narrows II Powerhouse, and lower Yuba River diversions and conveyance facilities. Englebright Dam and Daguerre Point Dam were not constructed by Yuba County WA as part of the Yuba River Development Project, but are used by Yuba County WA in delivering water.

Groundwater accounts for about 31 percent or 130,000 acre-feet of irrigation water use in Yuba County. The Yuba County WA service area has at least 385 wells, which provide water for irrigation. In recent years, Yuba County WA has provided surface water to areas previously served by groundwater, thereby decreasing demands on the groundwater basin.

Within Yuba County, the Yuba River supplies the majority of surface water supplies. Yuba County WA is a major water right holder on the Yuba River. Various water districts, irrigation districts, water companies, and individuals contract with Yuba County WA for delivery of water. Some of the parties that receive water from Yuba County WA have their own appropriative or riparian rights for diversion of water. Other agencies and districts providing surface water for irrigation in Yuba County include the Yuba County Water District, Browns Valley Irrigation District, Camp Far West Irrigation District, and Plumas Mutual Water Company.

Yuba County WA's water rights include diversion of water from the lower Yuba River for irrigation and other uses from September 1 to June 30 and diversion of water to storage in New Bullards Bar Reservoir from October 1 to June 30 for subsequent irrigation and other uses. Yuba County WA releases some for power generation at the Colgate Powerhouse and at the Narrows 1 and Narrows 2 Powerhouses. Hydroelectric power is generated at these locations under authorization from the Federal Energy Regulatory Commission and eight water right licenses issued by the State.

Water diverted under Yuba County WA's water right permits is delivered to Brophy Water District, Browns Valley Irrigation District, Cordua Irrigation District, Dry Creek Mutual Water Company, Hallwood Irrigation District, Ramirez Water District, the

South Yuba Water District, and other smaller contractors. Browns Valley receives water at the Pumpline Diversion Facility, 1 mile upstream from Daguerre Point Dam. Cordua, Hallwood, and Ramirez receive water via the Hallwood-Cordua Canal (North Canal) from the north side of the Yuba River just upstream from the north abutment of Daguerre Point Dam. Brophy and South Yuba receive water via the South Yuba Canal (South Canal) from the south side of the Yuba River just upstream from the south abutment of Daguerre Point Dam. Several private parties pump water from the lower Yuba River downstream from Daguerre Point Dam in an area known as the Datoni Area.

4.1.2.4 American River

The 1958 Water Right Decision 893 (D-893) regulates instream flow requirements in the lower American River (minimum of 250 cfs). However, in 1990, the State Water Resources Control Board stated that the flow requirements in D-893 were not sufficient for all uses of the river. Flows have not been held to D-893 levels for many years (DWR 2002). The Department of Fish and Game, National Marine Fisheries Service, US Fish and Wildlife Service, Reclamation, and other local stakeholders, are a part of the American River Operations Group. The group advises Reclamation on flow releases to protect the aquatic resources in the river.

Folsom Lake is the only CVP facility on the American River. Folsom Lake was built by the US Army Corps of Engineers, but is operated by Reclamation. Built as a multipurpose project, Folsom Lake (and Dam) functions primarily as a flood control structure; however, Folsom Lake also provides for irrigation and domestic water supply, electrical power generation, recreation, preservation of the American River fishery, and downstream control of saltwater intrusion in the Sacramento-San Joaquin Delta.

In addition to flood control operations, Folsom Lake (and Dam) is operated to meet the objectives of the San Francisco Bay-Sacramento-San Joaquin River Delta Estuary Water Quality Control Plan, the biological opinions for winter-run Chinook salmon, Delta smelt, and splittail, and the management of Central Valley Project Improvement Act Section 3406(b)(2) water.

American River agencies that may sell water to the EWA include the Placer County Water Agency and Sacramento Groundwater Authority.

4.1.2.4.1 Placer County Water Agency

The two major surface water sources for Placer County Water Agency (Placer County WA) are the Yuba and Bear Rivers, under contract from Pacific Gas & Electric (PG&E), and the American River, from water rights from the Middle Fork Project and under contract with the CVP (DWR 1997).

Surface water accounts for the majority of the water supplies for Placer County WA's municipal, industrial, and agricultural uses. Groundwater supplies only a small fraction of the total water supply. The Drum-Spaulding Project raw water supply, Middle Fork Project raw water supply, and CVP water supply comprise the water source allocations for western Placer County.

Placer County WA diverts water from the Yuba and Bear Rivers under contract with PG&E (Drum-Spaulding Project). The water supply is conveyed through the Drum, Bear River, and Upper Boardman canals. The Bear River Canal restricts the amount of water that can be conveyed, limiting Placer County WA to a diversion of 245 cfs (SWRI 2002).

Placer County WA's multi-purpose Middle Fork Project supplies water for irrigation, domestic and commercial uses, and power generation. Encompassing waters on the Middle Fork American River, the Rubicon River, and other tributaries, the Middle Fork Project includes two storage and five diversion dams, five powerplants, diversion and water transmission facilities, and five tunnels and related facilities. Permits from the State Water Resources Control Board allow for water diversions at Auburn, CA or at Folsom Dam. An agreement between Placer County WA and Reclamation facilitates delivery of Placer County WA's water rights water. Placer County WA has contracted transfers for a total of 25,000 acre-feet per year to San Juan Water District and 30,000 acre-feet per year to the City of Roseville. Placer County WA can also deliver up to 29,000 acre-feet per year to South Sutter Water District in years of surplus. In 1995, Placer County WA and Northridge Water District[5] entered into a 25-year water supply agreement. Placer County WA is currently providing 22,000 acre-feet per year and will increase supply by 1,000 acre-feet per year through 2009; during the last 10 years, Placer County WA supplies 29,000 acre-feet annually (DWR 1997).

The CVP supplies Placer County WA with 35,000 acre-feet per year. Placer County WA does not expect to use this allotment before using the full amount of the 120,000 acre-feet per year available from the American River (SWRI 2002). Placer County WA obtains 991 acre-feet per year from four groundwater wells.

4.1.2.4.2 Sacramento Groundwater Authority

The Sacramento Groundwater Authority (SGA) is a joint powers authority that was established in 1998 to manage and protect the north-area groundwater basin in Sacramento County. SGA is bounded by the Sacramento County line on the north and east, by the Sacramento River on the west, and by the American River on the south. SGA's 16-member board of directors is comprised of representatives from the overlying water purveyors in the basin along with an individual representative from agriculture and an individual representative from self-supplied groundwater users (mostly parks and recreational districts).

SGA member agencies serve the needs of over 500,000 people in the Sacramento area. Current water deliveries total about 300,000 acre-feet per year; about one-third of the deliveries come from groundwater pumping, and the remainder is supplied by

5 Northridge Water District and Arcade Water District have merged to form Sacramento Suburban Water District.

surface water deliveries from the American and Sacramento Rivers pursuant to water rights or contract entitlements. Over 70 percent of the deliveries are for M&I uses and 30 percent for agriculture in the western portion of the service area.

Water districts and agencies within the area generally use a combination of groundwater and surface water. The Sacramento Groundwater Authority funds conjunctive use programs through establishing regulatory fees among purveyors. The primary objectives of the Sacramento Groundwater Authority are to 1) facilitate implementation of regional conjunctive use, 2) mitigate conditions of regional groundwater overdraft, 3) replenish groundwater extractions; 4) mitigate groundwater contamination migration, 5) monitor groundwater elevations and quality, and 6) develop relationships with State and Federal Agencies.

4.1.2.5 Merced River

The Merced River agency that may sell water to the EWA is the Merced Irrigation District, which has water rights to divert and store water on the Merced River. Lake McClure and Lake McSwain are the major reservoirs on the Merced River. Lake McClure is operated for power, recreation, irrigation, and flood control purposes. Minimum flow requirements on the Merced River are a function of the Cowell Agreement (water rights adjudication), FERC requirements, and the Davis-Grunsky contract. The flow below the Crocker-Huffman Diversion Dam must equal the greater of the Davis-Grunsky and FERC flows plus the Cowell Agreement Entitlement. The flow requirements are listed in Table 4-1.

4.1.2.5.1 Merced Irrigation District

Merced ID's water right on the Merced River is an appropriative right which authorizes diversion and storage in Lake McClure and Lake McSwain during the period October 1 through July 1. The points of diversion for this license are at the New Exchequer (Lake McClure) and McSwain Dams. Surface water available to Merced ID depends on annual runoff, the district's diversion rights, and storage from Lake McClure.

Merced ID receives water from the Merced River based on Federal and State permits and water rights and uses groundwater to supplement surface water supplies. During wet years, Merced ID supplies irrigators outside its district boundaries, but along district canals, with surface water. Some individual properties that have riparian or adjudicated water rights divert water from the Merced River.

Table 4-1. Merced River Minimum Flow Requirements				
Month	**Davis-Grunsky**	**FERC**		**Cowell Agreement Entitlement**
	Crocker-Huffman Dam to Shaffer Bridge	**At Shaffer Bridge**		
		Normal Year[1]	**Dry Year[2]**	
Oct 1-15	0	25	15	50[3]
Oct 16-31	0	75	60	50[3]
Nov	180-220	100	75	50[3]
Dec	180-220	100	75	50[3]
Jan	180-220	75	60	50[3]
Feb	180-220	75	60	50[3]
Mar	180-220	75	60	100
Apr	0	75	60	175
May	0	75	60	225
Jun	0	25	15	250[4]
Jul	0	25	15	225[4]
Aug	0	25	15	175[4]
Sep	0	25	15	150[4]

Source: MBK 2001

[1] Normal year as defined by FERC license: Forecasted April through July inflow to Lake McClure is equal to or greater than 450,000 acre-feet, as published in DWR May 1 Bulletin 120.

[2] Dry year as defined by FERC license: Forecasted April through July inflow to Lake McClure is less than 450,000 acre-feet as published in DWR May 1 Bulletin 120.

[3] Entitlement is equal to 50 cfs or the natural flow of the Merced River (inflow to Lake McClure), whichever is less.

[4] If the natural flow of the Merced River falls below 1,200 cfs in the month of June, the entitlement flows are reduced accordingly from that day: 225 cfs flow for next 31 days; 175 cfs flow for next 31 days; 150 cfs for next 30 days; 50 cfs for the remainder of September.

4.1.3 Delta

Although there are no potential acquisitions identified from in-Delta water rights holders, Delta conditions are described at length because of the potential effects of EWA actions (changes in the rate and timing of CVP and SWP south Delta pumping) upon water levels in the south Delta.

The Sacramento and San Joaquin Rivers unite at the western end of the Sacramento-San Joaquin Delta. The Delta, which comprises a 738,000-acre area, forms the lowest part of the Central Valley and is interlaced with about 700 miles of waterways. The sloughs and channels form more than 60 islands and tracts, of which about 520,000 acres are devoted to farming. An approximate 1,110-mile network of levees protects the islands and tracts, almost all of which lie below sea level, from flooding. Prior to development, which began in the mid-l9th century, the Delta was mainly tule marsh and grassland, with some high spots rising to a maximum of about 10 to 15 feet above mean sea level.

On average, about 21 million acre-feet of water reaches the Delta annually, but actual inflow varies widely from year to year and within the year. In 1977, Delta inflow totaled only 5.9 million acre-feet, while inflow for 1983, an exceptionally wet year, was about 70 million acre-feet. On a seasonal basis, average natural flow to the Delta varies by a factor of more than 10 between the highest month in winter or spring and the lowest month in fall.

Hydraulics of the estuary system is complicated by tidal influences, a multitude of agricultural, industrial, and municipal diversions for use within the Delta itself, and by SWP and CVP exports. Tributary inflows, Delta outflows, and export pumping are the principal variables that define the range of hydrodynamic conditions in the Delta. The Tracy, Banks, and Contra Costa pumping plants' pump an average of approximately 3,300,000, 3,800,000, and 110,000 acre-feet annually, respectively. Excess outflow occurs almost entirely during the winter and spring months. Average winter outflow is about 32,000 cfs, while average summer outflow is about 6,000 cfs.

Tidal influence is important throughout the Delta. The influence of tide, combined with freshwater outflow, results in flow patterns that vary daily. The average tidal flow at Chipps Island, ebb or flood, is approximately 170,000 cfs. Historically, during summers when mountain runoff diminished, ocean water intruded into the Delta as far as Sacramento. During the winter and spring, freshwater from heavy rains pushed the saltwater back, sometimes past the mouth of San Francisco Bay.

Operations of the water facilities in the Sacramento River and San Joaquin basins and their tributaries influence the Delta greatly. With the addition of Shasta, Folsom, and Oroville Dams, saltwater intrusion into the Delta during summer months has been controlled by reservoir releases during what were the dry months under natural conditions (no dams). Flows from the East Side streams and San Joaquin River also contribute to controlling saltwater intrusion. Typically, peaks in winter and spring flows have been dampened, and summer and fall flows have been increased. The volume of runoff during very wet years, such as 1969, 1982, 1983, and 1986, has caused the upper bays to become fresh; even at the Golden Gate Bridge, the upper several feet of the water column sometimes consisted of freshwater.

The south Delta includes the San Joaquin River, Old River, Middle River, Woodward and North Victoria canals, Grant Line and Fabian Bell canals, Italian Slough, Indian Slough, Tom Paine Slough, and SWP and CVP canals. More than two-thirds of the land in the south Delta receives irrigation water from the Middle River, Old River, Grant Line Canal, and associated sloughs. The San Joaquin River is the major tributary flowing into the south Delta; however, due to flow depletions upstream from the Delta, San Joaquin River flows are often very low. At such times, water from the Sacramento River is drawn to the south Delta by a combination of SWP/CVP pumping and other diversions (Entrix 1996).

To facilitate movement of Sacramento River water to pumping facilities in the south Delta, Reclamation completed the Delta Cross Channel (DCC) near Walnut Grove in 1951. The DCC diverts water, by gravity, from the Sacramento River to Snodgrass Slough into the North and South Forks of the Mokelumne River. Sacramento River water moves down these channels through the central Delta and into the San Joaquin River. Flows in the DCC reverse as the tide changes and, at certain stages, there is considerable flow from the channel into the Sacramento River. Two radial gates operate in the open or closed position. The channel is closed for flood control when Sacramento River flows exceed about 25,000 cfs. The gates are also closed at times to protect fish.

The Contra Costa Water District (WD) supplies CVP water to the district's water users via a pumping plant at the end of Rock Slough. Contra Costa WD also has water rights at Mallard Slough. The district has constructed and operates the Los Vaqueros Project. This has a pumping plant on Old River for diverting surplus Delta flows to reservoir storage or to Contra Costa WD users. The Los Vaqueros Project's primary purpose is water quality improvement and was not developed to increase the district's total annual water use. The North Bay Aqueduct supplies SWP water to northeastern San Francisco Bay and Napa Valley, while the Banks and Tracy pumping plants facilitate the transport of water to the San Joaquin Valley, southern California, central coast, and south San Francisco Bay. SWP and CVP contractors receive water from the Delta as releases from San Luis Reservoir or directly from the California Aqueduct or the Delta Mendota Canal. Peak deliveries occur during spring and summer.

4.1.3.1 South Delta

Water conditions in the south Delta area are influenced in varying degrees by natural tidal fluctuation; San Joaquin River flow and quality; local agricultural drainage water; CVP and SWP export pumping; local diversions; inadequate channel capacity; and regulatory constraints. These factors affect water levels and availability at some local diversion points. When the CVP and SWP are exporting water, water levels in local channels can be drawn down, causing problems for landowners that need to divert from these areas. If local agricultural drainage water is pumped into the channels where circulation is poor, such as shallow, stagnant, or dead-end channels, water quality can be affected. Channels that are too shallow and narrow also restrict flow and the volume of water available for agricultural lands.

Problems associated with diverting water from south Delta channels prompted a series of actions and agreements to address the problems. The first action occurred during the 1976-77 drought, when DWR installed a temporary rock barrier in Old River to improve water conditions in the south Delta. Additional actions and agreements include a lawsuit filed by the South Delta Water Agency, modifications to Tom Paine Slough, a Joint Powers Agreement, a Framework Agreement, and a draft settlement agreement.

4.1.3.1.1 Draft Settlement Agreement

In 1990, DWR, Reclamation, and South Delta WA agreed to a draft settlement to a 1982 lawsuit by South Delta WA against DWR and Reclamation. The draft agreement focused on short-term and long-term actions to resolve the water supply problems in the south Delta. It included provisions to test and construct barrier facilities in certain south Delta channels. Barriers would lessen effects of Delta export pumping by raising water levels upstream from the barriers. The configuration of the barriers maintain circulation to minimize quality problems from stagnation.

The barriers testing program, referred to as the South Delta Temporary Barriers Project, involves the seasonal installation of four barriers: one in Middle River, two in Old River, and one in Grant Line Canal. Three of the barriers are designed to improve water levels and circulation for agricultural diversions; they are to be in place during the growing season. The fourth barrier, in Old River at the San Joaquin River, is designed to assist fish migration on the San Joaquin River. Water levels and water circulation in the south Delta improved with agricultural barrier installation (DWR 2000).

According to DWR's *Response Plan for Water Level Concerns in the South Delta Under D-1641* (DWR 2002),[6] prepared for the State Water Resources Control Board, south Delta water levels would be adequate for southern Delta diversions if they are forecasted to be 0.0 ft mean sea level (msl) or greater at Old River near Tracy Road Bridge, and Grant Line Canal near Tracy Road Bridge, and 0.3 ft above msl or greater at low tide at Middle River near the Undine Road Bridge. Additionally, the Response Plan recognized the potential for water levels at Coney Island/Channel 218, which is downstream from the temporary barriers, to be below those necessary for local diversions. An initial baseline water level of concern is not yet established for this location.

If it is determined by DWR, in coordination with the South Delta WA, that a landowner's ability to divert an adequate quantity of water is affected because of Project pumping, then DWR and the landowner work together to employ either temporary or permanent solutions. Temporary actions include the installation and operation of portable pumps at or near the diversion. Permanent actions include localized dredging near the affected diversion and/or modifying or relocating the diversion (DWR 2002a).

4.1.3.1.2 Joint Point of Diversion

The CVP and SWP have historically shared Delta export pumping facilities to assist with Project deliveries and to aid each Project during times of facility failures. In 1978, DWR agreed to, and the SWRCB permitted, the CVP to use SWP Banks Pumping Plant for replacement pumping (195,000 acre-feet annually) for pumping capacity lost at Tracy Pumping Plant because of striped bass pumping restrictions in D-1485. In 1986, Reclamation and DWR formally agreed that "either party may make use of its facilities available to the other party for pumping and conveyance of water by written agreement" and that the SWP would pump CVP water to make up for striped bass protection measures (Reclamation and DWR 1986). During this time frame (1970s and 1980s), the CVP regularly used SWP Banks Pumping Plant for CVP purposes (above the 195,000 acre-feet annually); however, there was some ambiguity

[6] The Response Plan only covers incremental impacts from Joint Point of Diversion/transfers.

as to whether the SWRCB had permitted such use. Reclamation filed a petition to cover such use in 1981.

After 1981, Reclamation usually filed ad hoc petitions to use Banks PP for purposes other than replacement pumping and CVP deliveries. Such uses included deliveries to the San Joaquin National Cemetery and Musco Olive Company. In 1999, the SWRCB addressed Reclamation's petition to permanently add Banks Pumping Plant and DWR's petition to permanently add Tracy Pumping Plant as a point of diversion under CVP water rights and SWP water rights, respectively. The points of diversion were added as part of the Bay Delta Hearings and included the completion of an SWRCB-directed EIR pursuant to CEQA. The hearing resulted in D-1641, which approved the Joint Point of Diversion (JPOD). D-1641 characterized the three types of JPOD use as Stage I, II, or III for the purposes of impact analysis. The stages are not sequential, but they vary as to magnitude and required mitigation (See Table 4-2).

Table 4-2 JPOD Stages

Stage	Purpose	Volume Limit	Mitigation
I	Cross Valley Canal Contractor, Musco Olive Co., SJ Nat'l Cemetery, and makeup pumping for fish protection actions	No increase to annual exports resulting from JPOD	Water Level Response Plan Water Quality Response Plan
II	Any authorized permitted purpose	Permitted pumping plant capacity	Operations Plan to protect aquatic resources and other legal users of water; or approval of minor exemptions
III	Any authorized permitted purpose	Physical pumping plant capacity	Operations Plan, and implementation of barriers or other water level protection

Stage I encompasses the historic use for those receiving CVP supplies via the SWP facilities and pumping "to make up export reductions taken to benefit fish" (Reclamation and DWR 1986). Because the SWRCB differentiated CVP JPOD according to likely environmental and economic impacts, D-1641 provides for differing mitigation requirements for the three stages.

The CALFED Record of Decision (CALFED ROD) described Delta operations for the acquisition of water for the EWA, and it described the sharing of CVP JPOD capacity between the CVP and the EWA. The EWA Operating Principles Agreement (Appendix C) stated that excess capacity for the EWA, CVP, and Level 4 refuge water has a higher priority than all non-project pumping, except for wheeling water for facility outages and for supply to CVP contractors for whom the SWP has wheeled water, specifically, San Joaquin National Cemetery, Musco Olive Co., and the users of the Cross Valley Canal. Banks Pumping Plant capacity available for Stage II and III is to be shared on a 50-50 basis (CVP receives 50 percent and the EWA and CVPIA Level 4 Refuge pumping share 50 percent).

4.1.4 Export Service Area

4.1.4.1 Santa Clara Valley Water District

Santa Clara Valley WD is responsible for water supply, flood protection, and watershed management in Santa Clara County, an area encompassing 1,300 square miles. Santa Clara Valley WD supplies water to local water retail agencies that provide water to customers in Santa Clara County. Local runoff, groundwater, and imported water comprise Santa Clara Valley WD's supplies. Local runoff is captured in ten reservoirs, with a combined capacity of 170,000 acre-feet. A total of 18 recharge ponds and three connected groundwater subbasins collect and store water for use during dry years. Both the CVP and SWP supply Santa Clara WD. Imported water is conveyed to the district through three main pipelines: the South Bay Aqueduct, which carries water from the SWP, and the Santa Clara Conduit and Pacheco Conduit, which bring water from the CVP.

Anderson Reservoir is an 89,073 acre-foot reservoir along Coyote Creek. Santa Clara Valley WD operates the reservoir for 1) impounding local surface runoff, 2) providing incidental flood control benefits, 3) providing controlled releases of reservoir water to the Almaden Valley Pipeline via the Cross Valley Pipeline and for groundwater recharge, and 4) providing source water to water treatment plants under emergency conditions. Storage space is also maintained in Anderson Reservoir for excess flows from Coyote Reservoir via Coyote Creek.

4.1.4.2 San Luis Reservoir

San Luis Reservoir is an off-stream storage reservoir operated jointly by the CVP and SWP. San Luis Reservoir has a capacity of 2,041,000 acre-feet and stores exports from the Delta to be used when the water is needed. Drawdown occurs each year; depending on hydrologic conditions and EWA actions, a low point of approximately 300,000 acre-feet could be reached in August or September. The reservoir is refilled as the Projects pump and export water from the Delta during the winter and spring.

4.1.4.3 Westlands Water District

Westlands WD supplies surface water and groundwater for agricultural irrigation as well as some M&I uses. Westlands WD comprises 604,000 acres on the west side of Fresno and King Counties. Westlands WD's primary water supply is its CVP water service contract. Water is pumped via the Delta-Mendota Canal to Westlands WD. Westlands WD's CVP supply has been unreliable; therefore, land retirement programs are ongoing because of lack of reliable water sources and drainage problems. Conjunctive use and supplemental purchases from State programs and other water agencies add to Westlands WD's supplies.

4.1.4.4 Tulare Lake Basin Water Storage District

Tulare Lake Basin Water Storage District (WSD) is located in the San Joaquin Valley; the majority of its 189,245 acres are in southeastern Kings County and the remainder in southwestern Tulare County. Tulare Lake Basin WSD supplies surface water deliveries for irrigation and groundwater recharge. Water supplies to the Tulare Lake

Basin WSD include SWP contract water; water rights on the King's, Kaweah, Kern, and Tule Rivers, as well as Deer Creek; and CVP Friant contract sources. Average annual total deliveries are about 150,000 acre-feet. Landowners supplement district surface supplies with groundwater pumping.

4.1.4.5 Kern County Water Agency

Kern County's water supply consists of both groundwater and surface water. Groundwater supplies about 43 percent of the county's water needed for domestic and agricultural purposes. Surface water supplies the remainder, delivered to the county from the California Aqueduct (SWP water), the Friant-Kern Canal (CVP water), surface flow from local streams (Poso, Cliente, Tehachapi, El Paso, and Emigdio), and from the Kern River. Potential transfers to the EWA would only involve SWP contract water or CVP floodflows. The county (Kern County WA) and the following agencies within the County are discussed in more detail in Chapter 6, Groundwater Resources.

4.1.4.5.1 Semitropic Water Storage District

Semitropic WSD is located in north central Kern County about 20 miles northwest of the City of Bakersfield, and covers an area of about 221,000 acres. Close to half the acreage within Semitropic WSD is irrigated; there are no incorporated cities within the District. Semitropic WSD receives water through an SWP allocation and groundwater for its supply. In 1995, Semitropic WSD's groundwater banking program was implemented; the storage program provides operational reliability and flexibility and promotes groundwater recharge (DWR 2001). Semitropic WSD's groundwater bank has a defined total storage capacity of 1,000,000 acre-feet. The pump back capacity of the facilities and Semitropic WSD's SWP entitlement restrict total program annual withdrawal amounts, which range from 90,000 to 290,000 acre-feet per year. The current banking partners are Metropolitan WD, Santa Clara Valley WD, Alameda County WD, Zone 7 Water Agency, and Vidler Water Company. Metropolitan WD and Santa Clara Valley WD have contracted for a total of 70% of the storage capacity.

Banking partners are able to store water in excess of their contracted limits; this excess storage is determined by the partner's withdrawal capacity. The size of the pumpback facility, scheduled SWP deliveries to Semitropic WSD, and the proportion of the total program capacity that has been contracted to other banking partners restrict total program annual withdrawal amounts. Metropolitan WD has contracted with Semitropic WSD for 350,000 acre-feet of storage space to store SWP allocated water. As of April 2000, Metropolitan WD had approximately 392,000 acre-feet stored in Semitropic WSD. The annual withdrawal capacity of Metropolitan WD's stored water similarly ranges from 31,500 acre-feet per year to 101,500 acre-feet (up to 35 percent of Semitropic WSD's overall withdrawal capacity).

Santa Clara Valley WD has contracted with Semitropic for 35 percent of the total storage capacity, or 350,000 acre-feet of storage space. As of September 2000, Santa

Clara WD had approximately 141,000 acre-feet of water in storage. The withdrawal capacity dedicated to Santa Clara Valley WD ranges from 31,500 to 101,500 acre-feet

4.1.4.5.2 Arvin-Edison Water Storage District

Arvin-Edison WSD manages the delivery of local groundwater and water imported into its service area from CVP's Millerton Reservoir via the Friant-Kern Canal. Arvin-Edison WSD is located in central Kern County and covers about 132,000 acres of primarily agricultural land. Arvin-Edison WSD operates its supplies conjunctively, storing water in the underlying aquifer when imported supplies are plentiful and withdrawing the water when the availability of imported supplies is reduced. In the 1970s, Arvin-Edison WSD entered into a number of agreements, jointly known as the Cross Valley Canal Exchange. This allows Arvin-Edison WSD to schedule water deliveries through the California Aqueduct.

The contract between Arvin-Edison WSD and Metropolitan WD extends current operations to allow Metropolitan WD to make use of the additional storage in Arvin-Edison WSD's groundwater basin. The amount of storage in Arvin-Edison WSD's groundwater basin that Metropolitan WD will use has yet to be determined. In years of plentiful supply, Metropolitan WD uses SWP supplies available above its current demands to deliver water to Arvin-Edison WSD through the California Aqueduct and Cross Valley Canal.

4.1.4.6 Metropolitan Water District of Southern California

Metropolitan WD receives water from at least five turnouts[7] from the SWP including turnouts at Castaic, Perris, and the Devil Canyon Afterbays. Metropolitan WD supplies drinking water as well as water for agriculture, M&I, and recreational purposes to parts of Los Angeles, Orange, San Diego, Riverside, San Bernardino and Ventura counties. Other water supplies include the Colorado River Aqueduct, local groundwater supplies, and water reclamation.

Castaic Lake, an SWP facility, receives SWP water from Pyramid Lake to the north and is the final reservoir on the West Branch of the SWP. It provides a major source of water to the Castaic Lake Water Agency and to the western part of the service area of Metropolitan WD. Water from Castaic Lake is used for municipal, industrial, and recreational uses. Castaic Lake is cycled annually, generally peaking in end-of-month storage in March, and then declining until a low is reached, usually in October. From this low point, the reservoir is filled to attain a high point again in March.

Lake Perris, also an SWP facility, is the southern terminus of the SWP's East Branch of the California Aqueduct. Lake Perris provides water supply for contracting users, recreation, and fish and wildlife enhancement. Maximum operating storage is 131,450 acre-feet.

Lake Mathews is in Riverside County between Interstate 15 and Interstate 215. Metropolitan Water District (WD) completed Lake Mathews in 1939 as the western

[7] Turnouts are areas where Metropolitan WD diverts from the SWP.

terminus for the Colorado River Aqueduct. Metropolitan WD operates Lake Mathews in conjunction with DWR reservoirs to meet emergency, dry-year supply, and seasonal needs (Metropolitan WD 2003).

Diamond Valley Lake, a Metropolitan WD facility, receives water from the California Aqueduct. Maximum operating storage is 800,000 acre-feet. An intertie between the Foothill Pipeline and a segment of Metropolitan WD's Inland Feeder allows Metropolitan WD to move SWP water from the East Branch of the California Aqueduct through the Foothill Pipeline and Inland Feeder into Diamond Valley Lake and the Colorado River Aqueduct. The intertie increases Metropolitan WD's ability to refill and maintain storage in Diamond Valley Lake by 260 cfs (Metropolitan WD 2003).

4.2 Environmental Consequences/Environmental Impacts

4.2.1 Assessment Methods

Under each alternative, the EWA Project Agencies would negotiate contracts with willing sellers based on a number of factors, including price, water availability, and location. These factors would change from year-to-year; therefore, the EWA Project Agencies may choose to vary their acquisition strategy in each year. To provide maximum flexibility, this analysis includes many potential transfers when the EWA Project Agencies would likely not need all transfers in a given year. Chapter 2 defines the transfers that are included in this analysis.

Effects on water supply are divided into potential effects on agencies and their users from transferring water to the EWA, water users receiving water from the EWA, and water users not selling water to the EWA.

Effects on agencies that would transfer water to the EWA are evaluated by comparing the agency's reduction in supply because of the transfer, and the demand after the transfer. Also, the evaluation compares the timing of the transfer to the timing of the demand.

Water users not selling water to the EWA are included in the analysis based on whether these users rely on supply from agencies that are selling water to the EWA. Users downstream from willing sellers and their water supply source are identified. Water budget data from the Butte County Water Inventory and Analysis (CDM 2001) is used to approximate the percentage of water that leaves an agency's boundaries and could be used downstream.

Modeling used for impact analysis accounts for all variable assets excluding relaxation of the Export/Inflow ratio.[8] (See Attachment 1 and Appendix H for modeling assumptions and the summary and technical appendix.) South Delta water

[8] See Section 2.4.2.2 for a discussion of variable assets.

level thresholds were taken from the *Response Plan for Water Level Concerns in the South Delta Under Water Rights Decision 1641*.

4.2.2 Significance Criteria

Effects on water supply and management due to program actions would be considered significant if the:

- Annual supply of water available to the CVP, SWP, or non-Project users would decrease as a result of:
  - A decrease in carryover storage[9];
  - A change in timing or rate of riverflows; or
  - A reduction in deliveries to Project contractors.
- Surface water elevations in the Delta were reduced below the following thresholds, which could adversely affect in-Delta water users:
  - Water levels at Old River near Tracy Road Bridge and Grant Line Canal near Tracy Road Bridge less than 0.0 feet msl; or
  - Water levels at Middle River near the Undine Road Bridge less than 0.3 feet msl.

Non-Project and Project contractors who participate as sellers to the EWA would receive lesser supplies. Because these sellers receive monetary compensation for their water, however, the reduction in their supply is not significant.

4.2.3 Environmental Measures Incorporated into the Project

Both the Flexible Purchase and Fixed Purchase Alternatives include refill criteria as part of the EWA project description to reduce environmental effects (as described in Section 2.4.2.1.1).

4.2.3.1 Refill Criteria

4.2.3.1.1 Feather River

The water released from Little Grass Valley and Sly Creek Reservoirs would be refilled from Feather River flows in the winter months following the transfer. Oroville-Wyandotte ID also has refill capability off of Slate Creek, a tributary to the Yuba River, via an upstream diversion operated by Oroville-Wyandotte ID.[10] The amount of storage reduction must be refilled at a time when downstream users would

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9 Carryover storage is the water that remains in a reservoir after demands on the reservoir have been met. Agencies typically maintain carryover storage as protection for low water availability during dry years.

10 Oroville-Wyandotte ID is a senior water rights holder to Yuba County WA. Oroville-Wyandotte ID diverts water from Slate Creek for power generation and would divert the same amount of water with the EWA for refill compared to diversions without the EWA. Therefore, during refill of Sly Creek and Little Grass Valley reservoirs, Oroville-Wyandotte ID would not reduce Yuba County WA water supplies (Peterson 2002).

not have otherwise captured the water, either in downstream Project reservoirs or by Project pumps in the Delta. Typically, refill could only occur during Delta excess conditions (when more water than the Projects can pump is available) and/or when the water could not be stored in Lake Oroville. Little Grass Valley and Sly Creek Reservoirs would refill from available runoff regardless of the conditions in the Delta. Oroville-Wyandotte ID would then pay back the Projects the following summer for any quantity of water taken at a time when the Projects could have pumped the water (when the Delta is in balanced conditions).

4.2.3.1.2 Yuba River

The water released from New Bullards Bar Reservoir would be refilled from Yuba River flows in the winter and spring months following the transfer. The amount of storage reduction must be refilled at a time when downstream users would not have otherwise captured the water by exporting water from the Delta. Typically, refill could only occur during Delta excess conditions (when more water than the Projects can pump is available). New Bullards Bar Reservoir would refill from available runoff regardless of the conditions in the Delta. Yuba County WA would then pay back the Projects the following summer for any quantity of water taken at a time when the Projects could have pumped the water (when the Delta is in balanced conditions).

4.2.3.1.3 American River

The water released from French Meadows and Hell Hole Reservoirs would be refilled from American/Rubicon riverflows during the winter months following the transfer. The amount of storage reduction must be refilled at a time when 1) downstream users would not have otherwise captured the water in downstream Project reservoirs (Folsom Lake) or 2) the Delta is in excess conditions. French Meadows and Hell Hole Reservoirs would refill from available runoff regardless of downstream conditions. Placer County WA would then pay back the Projects the following summer for any quantity of water taken at a time when the Projects could have stored the water downstream in Folsom Lake. Folsom Lake storage is limited by flood control protocols that require storage to stay below certain levels throughout the wet season. Placer County WA would need to pay back the CVP for any water that was captured in French Meadows and Hell Hole Reservoirs at a time that the water could have been stored in Folsom Lake or pumped from the Delta.

4.2.4 Environmental Consequences/Environmental Impacts of the No Action/No Project Alternative

If the EWA were not implemented, actions to protect fish would continue as described in the affected environment section; fish actions would occur only in response to ESA take limits. Compliance with the biological opinions, which represent the regulatory baseline, would result in pumping reductions, resulting in reduced deliveries. Reduced deliveries would be more likely in dry years because in wet years the Projects would be more likely to be able to recover from export reductions for fish protection. DWR and Reclamation would continue to attempt to re-operate the SWP and CVP, respectively, to avoid decreased deliveries to export users. These actions are described in Section 2.2.2.3.

Under the No Action Alternative, Stage 1 of the Joint Point of Diversion permitted the CVP/SWP to pump water using excess pump capacity to recover export reductions taken to protect fish. Stage 2 and Stage 3 would have authorized the Projects to divert water at the Tracy and Banks Pumping Plants for any purpose, provided the CVP/SWP complied with the terms of the agreement (Section 4.1.3.1.2). The operations plan required to divert water under Stage 2 and Stage 3 will have to be completed. It is likely, although not definite, that the Projects would prepare the elements necessary to divert additional water. Because it is uncertain if and when the Projects would move to Stage 2 and 3, and under what parameters, the effects cannot be stated conclusively. However, the likely outcome would be a beneficial effect on water supply because increased pumping would supply more water to the Export Service Area.

The existing conditions and the No Action/No Project Alternative are the same except for Joint Point of Diversion. The existing conditions and No Action/No Project Alternative (excluding the Joint Point of Diversion) are collectively referred to as the Baseline Condition in the following sections. The Joint Point of Diversion is evaluated compared to the existing conditions and the No Action/No Project Alternative.

4.2.5 Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative

The Flexible Purchase Alternative allows asset acquisition of up to 600,000 acre-feet[11] and does not specify transfer limits in the Upstream from the Delta Region or the Export Service Area. Total transfers made in the Upstream from the Delta Region would range from 50,000 to 600,000 acre-feet, limited by hydrologic year and conveyance capacity through the Delta. Although potential transfers would not all occur in one year, this section discusses maximum transfers to the EWA from all agencies (a transfer amount that would result in greater than 600,000 acre-feet) to provide an effect analysis of a maximum transfer scenario. Similarly, the evaluation includes an analysis of up to 540,000 acre-feet from the Export Service Area to cover a maximum transfer scenario for that region.

4.2.5.1 California Water Resources

With the EWA, the overall flow of rivers from mountainous areas down to the valley and out to the ocean through the Bay-Delta would not change. Projects would continue to move surface water from northern California to southern California. A larger amount of water would leave the Sacramento and San Joaquin River areas than under the Baseline Condition; at most this amount would equal 600,000 acre-feet. The increased flow from the Sacramento and San Joaquin Rivers would increase the amount of water passing through the Delta, reaching the Export Service Area, and

[11] Flexible Purchase Alternative acquisition amount includes variable assets.

flowing out into the Bay. Table 4-3 compares Delta inflows, outflows, and exports for the modeled Baseline Condition and the Flexible Purchase Alternative.

Table 4-3 illustrates several points of interest:

- Inflow from the Sacramento River basin increases in April, May, and June because crop idling water must be released from Lake Shasta to meet downstream standards although it cannot be pumped in the Delta;
- Increased inflow from the Sacramento River and decreased exports cause increased outflows from March through June (additional fish actions could occur in December through February, which would also cause decreased exports);
- Increased export in July through September requires carriage water and therefore an increase in Delta outflow; and
- The decreases in exports in March, April, May, and June are greater than the increases in July, August, and September because the EWA would acquire some assets from the Export Service Area that would not need to be pumped through the Delta. The combined assets acquired in the Upstream from the Delta Region and the Export Service Area would be used to pay back the Projects for the export decreases.

Table 4-3
Changes in Delta Inflows, Outflows, and Exports

Month	*Inflow from the Sacramento River (cfs)*		*Inflow from the San Joaquin River (cfs)*		*Delta Outflow (cfs)*		*Delta Exports (TAF)[1]*	
	Baseline	*Increase with Flexible Purchase*	*Baseline*	*Increase with Flexible Purchase*	*Baseline*	*Increase with Flexible Purchase*	*Baseline[2]*	*Change with Flexible Purchase*
Oct	12,029	88	3,016	203	6,430	291	506	0
Nov	14,866	15	1,980	210	8,913	225	456	0
Dec	26,703	5	3,038	0	21,387	5	554	0
Jan	39,355	3	4,505	0	36,739	2	606	0
Feb	48,222	1	6,392	0	48,088	1	512	0
Mar	40,247	2	6,361	0	40,025	1,829	490	-112
Apr	26,707	481	6,127	0	27,536	3,460	312	-177
May	19,808	352	5,482	0	20,030	2,411	259	-127
Jun	18,256	349	4,219	0	12,311	3,014	382	-159
Jul	17,824	3,142	2,314	0	7,319	592	498	157
Aug	13,839	2,167	1,696	0	3,993	358	520	111
Sep	13,847	644	1,909	0	4,953	97	546	33

All values are monthly means.
[1] Delta Exports are presented in thousands of acre-feet instead of cfs because the exports are not constant.
[2] Baseline Delta exports would be less than the following amounts because of pump reductions for ESA take limits. The reductions differ by year because of variability in fish populations; therefore, the baseline reductions could not be quantified.

The points of interest above describe trends regarding the movement of water in a big picture view under the Baseline Condition and with the Flexible Purchase Alternative. The effects of the trends are discussed in the following sections on a smaller scale; effects on the water supply for specific water agencies and users are evaluated.

4.2.5.2 Upstream from the Delta Region

Effects on water supply and management, beneficial or adverse, occur for the sellers as well as downstream users.

Water that is sold to the EWA agencies would be released as EWA assets and 1) stored in San Luis Reservoir, 2) delivered directly to the SWP, CVP, and/or water contractors, 3) stored in groundwater banks south of the Delta for later use, 4) delivered to one or more Export Service Area contractors in exchange for agreed return of the water at a future time, or 5) used directly for environmental purposes.

4.2.5.2.1 Sacramento River

EWA acquisition of water via groundwater substitution or crop idling could change the rate and timing of flows in the Sacramento River. The rate and timing of changes to flows in the Sacramento River would depend on the amount of water Glenn-Colusa ID, Reclamation District 108, Anderson-Cottonwood ID, and/or Natomas Central Mutual Water Company has sold to the EWA agencies and the scheduled release of that water. Because of flow and temperature requirements in the Sacramento River, Lake Shasta would not be able to store EWA water from groundwater substitution and crop idling in April and May. During these months, flows in the Sacramento River would increase by the amount of water purchased for crop idling[12]. In some years, (depending on hydrologic conditions) Lake Shasta would store EWA water from crop idling and groundwater substitution in June because users would not need the water released under the Baseline Condition for agricultural use. Sacramento River flows between Lake Shasta and the point of diversion would decrease in June. The decrease in flow corresponds only to the amount of water that the willing seller would have used under the Baseline Condition. The remaining river flow would supply other agencies' water needs as it would under the Baseline Condition because the timing and quantity of their water release would also be the same as under the Baseline Condition.

During July through September, water from Lake Shasta would be released into the Sacramento River; however, those agencies that have sold water to the EWA would divert less water off the river than they would under the Baseline Condition. The Sacramento River would therefore have increased flows below the point of diversion; above the point of diversion Sacramento River flows would be the same as under the

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12 Because water cannot be held in Lake Shasta in April and May, groundwater substitution would not begin until June/July when water can be held in Lake Shasta as EWA assets. If farmers were participating in crop idling, however, the water delivered under the Baseline Condition could be available as EWA assets beginning in April. Because Lake Shasta cannot hold the water during April and May, flows would increase below the point of diversion on the Sacramento River.

Baseline Condition. Also, releases from Lake Shasta would be timed to provide water when the export pumps are available, which would usually be in July and early August. Therefore, flows would also increase in July for the entire Sacramento River, and flows in August and September would vary depending on pump availability.

Although there would be a change in timing and rate of riverflows, the annual supply of water to Project or non-Project users would not decrease. Therefore, the EWA acquisition of water from groundwater substitution or crop idling would have no effect on water supply on the Sacramento River system.

EWA acquisition of water via crop idling would reduce the water supply for users not participating in the EWA who rely on return flows from fields that, under program conditions, would be idled. Glenn, Colusa, and Yolo Counties could idle up to 47,980 acres. The EWA would purchase approximately 3.3 acre-feet/acre (the amount of water consumed by the crop); however, under the Baseline Condition, water agencies divert additional water from the Sacramento River to account for system losses. System losses include conveyance losses (evaporation or percolation within the conveyance system), riparian evapotranspiration (water used by vegetation along the conveyance system), and on-farm losses (deep percolation to groundwater or tailwater runoff). The amount of diverted water varies depending on the amount of system losses.

If farmers idled their crops, their water agency would reduce diversions by the 3.3 acre-feet/acre plus the additional amount that goes to on-farm losses. Of this additional amount that is applied to fields in the Baseline Condition, a portion percolates into the groundwater aquifer below and a portion runs off the field back into the conveyance system. This "tailwater" that runs back into the conveyance system could then be used again by water users downstream on the conveyance system. Typically, downstream users within the same water agencies depend on tailwater to provide a portion of their water supply (see Figure 4-3). Some downstream water users that are outside of the agency service area also depend on tailwater supplies. If farmers idled land, tailwater would no longer be available to downstream users, both within and outside of the water agency.

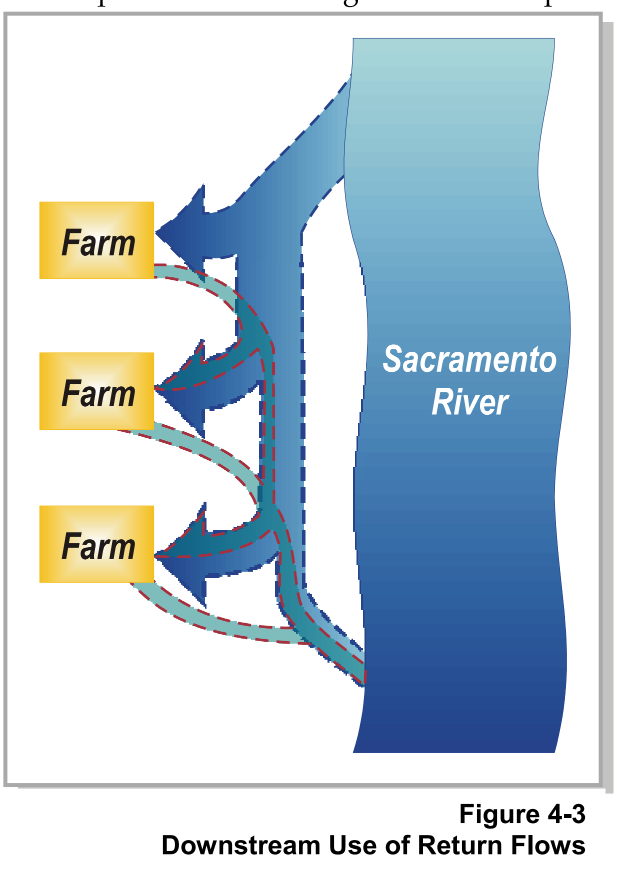

Figure 4-3
Downstream Use of Return Flows

Users within the willing seller's service boundaries would be able to contact the agency and request a water release if insufficient flows were reaching their property. However, users including farmers, refuges, duck clubs, and wetlands downstream and outside the willing seller's service boundaries would not be able to request additional water from the agency if flows below the Baseline Condition were reaching their property.[13] This effect would be potentially significant. The mitigation measure listed in Section 4.2.8.1 would protect downstream users from effects caused by reduced availability of return flows by requiring the selling agency to maintain flows through their system. Therefore, the potential effects of a reduction in water supply caused by crop idling are less than significant.

4.2.5.2.2 Feather River

EWA acquisition of water via groundwater substitution or crop idling could change the rate and timing of flows in the Feather River. The rate and timing of flow changes in the Feather River would depend on the amount of water Western Canal WD, Joint Water Districts, and/or Garden Highway Mutual Water Company have sold to the EWA agencies and the scheduled release of that water. During April through June, Lake Oroville would store EWA water. (Groundwater would replace surface water released from Lake Oroville for agricultural use under the Baseline Condition. Surface water would therefore not be released from Lake Oroville.) During July through September, water from Lake Oroville would be released into the Feather River; under the Baseline Condition, diversion is from Lake Oroville and irrigation supply to the farmer does not enter the river. The Feather River would therefore have increased flows below Lake Oroville from July through September.

Although there would be a change in timing and rate of riverflows, the annual supply of water to Project or non-Project users would not decrease. Therefore, the EWA acquisition of water from groundwater substitution or crop idling would have no effect on water supply on the Feather River system.

EWA acquisition of water via crop idling would reduce the water supply for users not participating in the EWA who rely on return flows from fields that, under program conditions, would be idled. Butte and Sutter Counties would idle up to 38,340 acres. As described above under the Sacramento River, idling these fields would reduce tailwater, which could reduce supplies to downstream users. This effect would be potentially significant. The mitigation measure listed in Section 4.2.8.1 would reduce the potential effects to downstream users to less than significant.

EWA acquisition of stored reservoir water from Oroville-Wyandotte ID could reduce carryover storage compared to the Baseline Condition. Oroville-Wyandotte ID would release more water from Little Grass Valley and Sly Creek Reservoirs than is released under the Baseline Condition. The water released from Little Grass Valley and Sly Creek Reservoirs would be refilled from Feather River flows in the winter months following the transfer. Oroville-Wyandotte ID also has refill capability off of Slate Creek, a tributary to the Yuba River, via an upstream diversion operated by Oroville-Wyandotte ID (see footnote 9 Section 4.2.3.1.1).

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13 Exceptions to this statement include private recreational refuges that are a part of the 1922 Agreement in which agencies have agreed to provide water for environmental purposes to lands outside their service area. If the amount of water via return flows that reached the refuges was less than the agreed upon amount, the refuges could request, and would receive, the difference.

Refill of the reservoirs would take place during the following winter and spring. Following the transfer, if insufficient water were available to refill the reservoirs (e.g., in a low runoff year), a decrease in available supply to users during the following summer could result. Oroville-Wyandotte ID would decide the amount of water to sell to the EWA (in agreement with the need of the EWA agencies). It is anticipated that Oroville-Wyandotte ID manages water effectively and would calculate the amount of carryover storage that could be released without adverse effects, factoring the potential for a dry year and less refill into the decision-making process. Oroville-Wyandotte ID would not sell water to the EWA that would be needed for its water users. Additionally, the State Water Resources Control Board would also review the reservoir release to be able to make a finding of no injury to other legal users. Therefore, EWA acquisition of stored reservoir water from Oroville-Wyandotte ID would have a less-than-significant effect on water supply.

4.2.5.2.3 Yuba River

EWA acquisition of water via groundwater substitution could change the rate and timing of flows in the Yuba River. The rate and timing of changes to flows in the Yuba River would depend on the amount of water Yuba County WA sold to the EWA agencies and the scheduled release of that water. During April through June, New Bullards Bar Reservoir would store EWA water. (Groundwater would replace surface water released from New Bullards Bar Reservoir for agricultural use under the Baseline Condition. Surface water would therefore not be released from New Bullards Bar Reservoir.) Yuba River flows would decrease between Englebright Dam (where the power facilities discharge water from New Bullards Bar Reservoir) and the usual point of diversion typically at Englebright of Daguerre Point Dams. The decrease in flow corresponds only to the amount of water that the willing seller would have used under the Baseline Condition. The remaining river flow would supply other agencies' water needs as it would under the Baseline Condition because the timing and quantity of their water release would also be the same as under the Baseline Condition.

During July through September, water from New Bullards Bar Reservoir would be released into the Yuba River; however, Yuba County WA would not divert as much water off the river, as would occur under the Baseline Condition. The releases on the Yuba River would remain relatively constant and would not vary as much as other rivers because constant flows help the fisheries on the Yuba system. The Yuba River would therefore have increased flows below the point of diversion; above the point of diversion, Yuba River flows would also be greater than under the Baseline Condition while the transfer was being delivered to the Delta because the water conserved over the entire irrigation season would be transferred in 2-3 months.

Although there would be a change in timing and rate of riverflows, the annual supply of water to Project or non-Project users would not decrease. Therefore, the EWA acquisition of water from groundwater substitution would have no effect on water supply on the Yuba River.

EWA acquisition of stored reservoir water from Yuba County WA could reduce carryover storage compared to the Baseline Condition. Yuba County WA would release more water from New Bullards Bar Reservoir than it releases under the Baseline Condition. Refill of the reservoir would take place during the following winter and spring. Following the transfer, if insufficient water were available to refill the reservoir (e.g., in a low runoff year), a decrease in available supply to users during the following summer could result. Yuba County WA would decide the amount of water to sell to the EWA (in agreement with the need of the EWA agencies). It is anticipated that Yuba County WA would calculate the amount of carryover storage that could be released without adverse effects, factoring the potential for a dry year and less refill into the decision-making process. Yuba County WA would not sell water to the EWA that would be needed for its water users. Additionally, the State Water Resources Control Board would also review the reservoir release to be able to make a finding of no significant effect to supply or to other legal users. Therefore, EWA acquisition of stored reservoir water from Yuba County WA would have a less-than-significant effect on water supply.

4.2.5.2.4 American River

EWA acquisition of water via crop idling could change the rate and timing of flows in the American River. The rate and timing of flow changes in the American River would depend on the amount of water Placer County WA sold to the EWA agencies and the scheduled release of that water. During April through June, Folsom Lake would store EWA water (water released under the Baseline Condition for agricultural use would not be needed because of crop idling and would therefore be held in Folsom Lake). American River flows would increase between the point of diversion and Folsom Lake. The increase in flow corresponds only to the amount of water that the willing seller would have used under the Baseline Condition. The flow would supply other agencies' water needs as it would under the Baseline Condition because the timing and quantity of their water release would also be the same as under the Baseline Condition.

During July through September, water from Folsom Lake would be released into the American River that, under the Baseline Condition, would have been used for rice crops. The American River would therefore have increased flows below Folsom Lake compared to the Baseline Condition.

Although there would be a change in timing and rate of riverflows, the annual supply of water to Project or non-Project users would not decrease. Therefore, the EWA acquisition of water from crop idling would have no effect on water supply on the American River.

EWA acquisition of stored reservoir water from Placer County WA could reduce carryover storage compared to the Baseline Condition. Placer County WA would release more water from French Meadows and Hell Hole Reservoirs than is released under the Baseline Condition. The reservoirs would refill during the following winter and spring. Following the transfer, if insufficient water were available to refill the reservoirs (e.g., in a low runoff year), a decrease in available supply to users during the following summer could result. Placer County WA would decide the amount of water to sell to the EWA (in agreement with the need of the EWA agencies). It is anticipated that Placer County WA and PG&E would calculate the amount of carryover storage that could be released without adverse effects, factoring the potential for a dry year and less refill into the decision-making process. Placer County WA would not sell water to the EWA that would be needed for their water users. Additionally, the State Water Resources Control Board would also review the reservoir release to be able to make a finding of no injury to other legal users. Therefore, EWA acquisition of stored reservoir water from Placer County WA would have a less-than-significant effect on water supply.

EWA acquisition of water via crop idling would reduce the water supply for users not participating in the EWA who rely on return flows from fields that, under program conditions, would be idled. Placer County could idle up to 3,280 acres. As described above under the Sacramento River, idling these fields would reduce tailwater, which could reduce supplies to downstream users. This would be a potentially significant effect. The mitigation measure listed in Section 4.2.8.1 would reduce the potential effects to downstream users to less than significant.

4.2.5.2.5 Merced River

EWA acquisition of water via groundwater substitution could change the rate and timing of flows in the Merced River. The rate and timing of flow changes in the Merced River would depend on the amount of water Merced ID sold to the EWA agencies and the scheduled release of that water. During April through September, Lake McClure would store EWA water (water released under the Baseline Condition for agricultural use would not be needed because of groundwater substitution and would therefore be held in Lake McClure). Merced River flows would decrease between New Exchequer Dam and the point of diversion, typically Lake McSwain. The decrease in flow corresponds only to the amount of water that the willing seller would have used under the Baseline Condition. The flow would supply other agencies' water needs as it would under the Baseline Condition because the timing and quantity of their water release would also be the same as under the Baseline Condition.

During October and November, water from Lake McClure would be released into the Merced River. Water released during this timeframe would increase Merced River flows compared to the Baseline Condition downstream from New Exchequer Dam.

Although there would be a change in timing and rate of riverflows, the annual supply of water to Project or non-Project users would not decrease. Therefore, the EWA acquisition of water from groundwater substitution would have no effect on water supply on the Merced River.

4.2.5.3 Delta

EWA acquisitions through stored reservoir water, groundwater substitution, crop idling, and stored groundwater purchase from sellers in the Upstream from the Delta Region would change the rate and timing of Delta inflows and the amount and timing of diversions from the

Delta for the EWA at the SWP or CVP pumps. Increased water transfers change the timing of diversions and alter the amounts of water diverted for agricultural, municipal, industrial, and ecosystem purposes. Export pumping compared to the Baseline Condition would increase July through October, although the majority of the water would be pumped July through September (as shown in Table 4-3). Under certain conditions where the incremental effects on fish would be negligible by the Management Agencies, EWA water could be transferred through the Delta as early as June or continue until November or December. Conversely, if the transfer could result in an adverse incremental effect on fish, transfer of EWA water through the Delta could be delayed in July, or discontinued temporarily if the effect developed after the transfer had started.

Poor circulation in the south Delta is an existing concern; increased export pumping would not exacerbate the situation above the Baseline Condition. An increase in pumping could affect water levels, however, which could affect water users. South Delta agricultural diverters would be affected if EWA actions resulted in lower water levels compared to the Baseline Condition in the south Delta that were also below the thresholds identified in Section 4.2.2. When water levels are too low, a sufficient pump draft cannot be maintained and diverters could experience an interruption to irrigation.

According to DWR's Response Plan for Water Level Concerns in the South Delta Under D-1641 (DWR 2002), prepared for the State Water Resources Control Board, South Delta water levels would be adequate for southern Delta diversions if they were 0.0 ft mean sea level (msl) or greater at Old River near Tracy Road Bridge and Grant Line Canal near Tracy Road Bridge, and 0.3 ft above msl or greater at Middle River near the Undine Road Bridge. The Coney Island/Channel 218 location also has water levels that fall below those necessary for local diversions. An initial baseline water level of concern is not yet established for the Coney Island/Channel 218 location.

Figures 4-4 through 4-7 show the water levels at four locations of concern identified in the Response Plan. The modeling data show the monthly mean of the daily averages with the operation of the temporary barriers. As the figures show:

- December through June, water levels with the EWA would be equal or higher than under the Baseline Condition;
- July through November, water levels would be equal or lower with the EWA than under the Baseline Condition).

Because daily averages include tidal influences (both high tide and low tide), the minimum daily water levels are not represented on Figures 4-4 through 4-7. It is important to consider the minimum daily water levels because the potential for effects would be greatest at these levels.

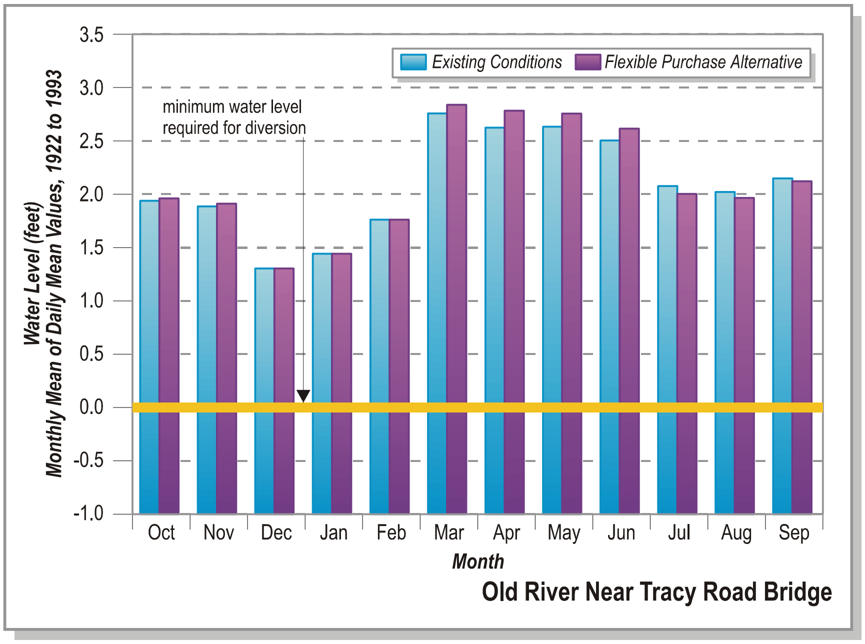

Figure 4-4
Water Levels at Old River Near Tracy Road Bridge

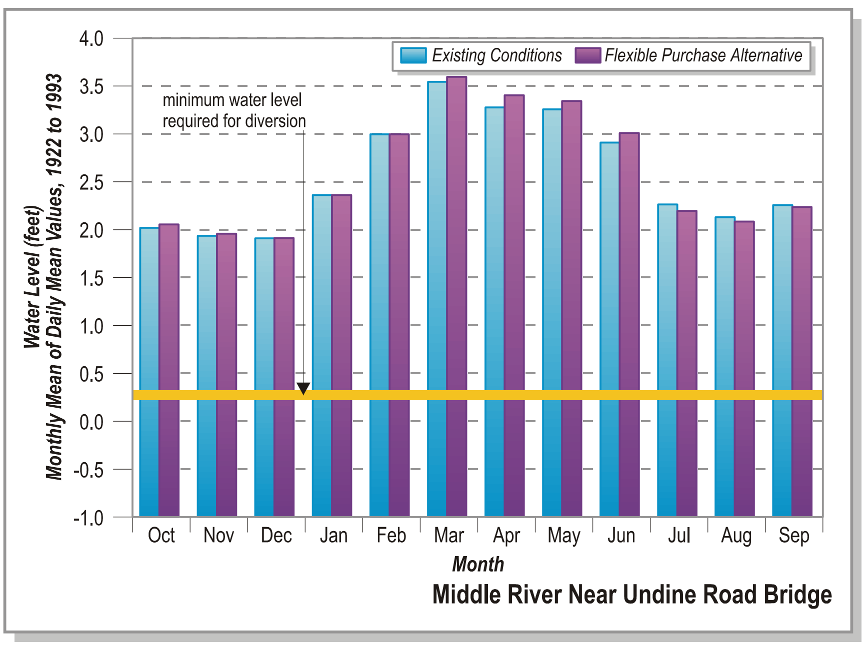

Figure 4-5
Water Levels at Middle River Near Undine Road Bridge

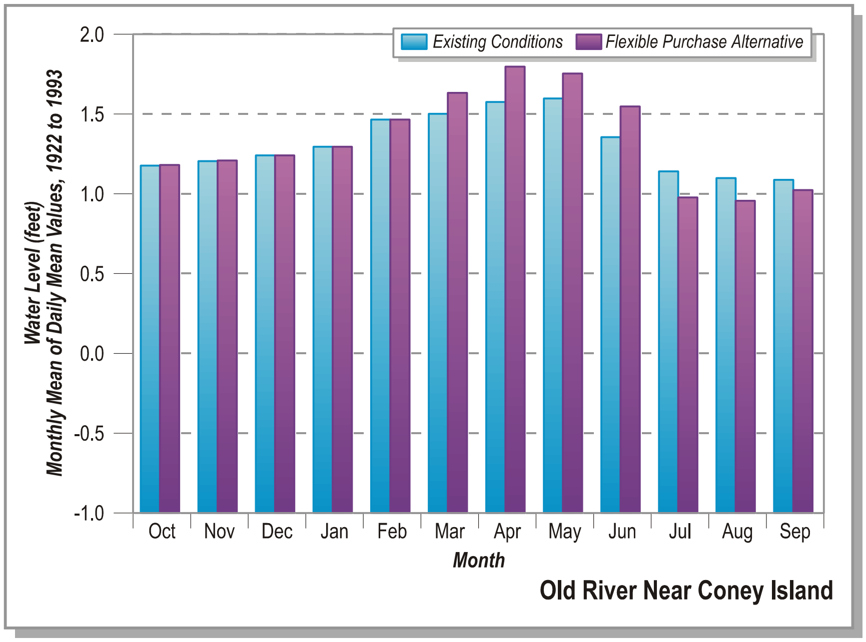

Figure 4-6
Water Levels at Old River Near Coney Island

Figures 4-8 and 4-9 show the monthly mean of the daily minimum values, representing the lowest water levels at the same locations as Figures 4-6 and 4-7. (Figures for the monthly mean of the daily minimum values are not shown for the locations shown in Figures 4-4 and 4-5. The temporary barriers at these locations maintain water levels above the threshold.) The data in Figures 4-8 and 4-9 show that under the Baseline Condition, water levels would be lower than the threshold (water levels are less than 0.0 msl).[14]

[14] As stated in Section 4.2.3.1, the initial baseline water level of concern for Coney Island/Channel 218 has not yet been determined.

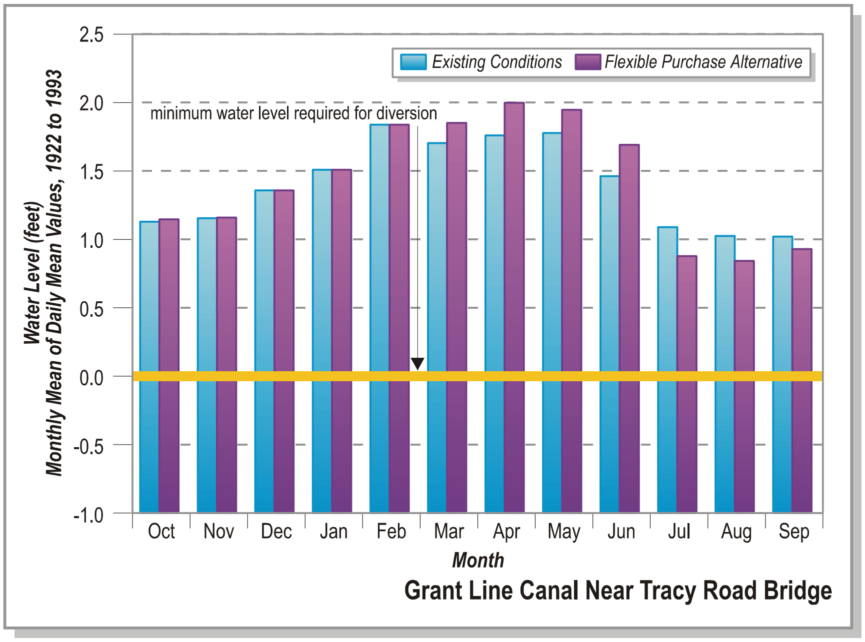

Figure 4-7
Water Levels at Grant Line Canal Near Tracy Road Bridge

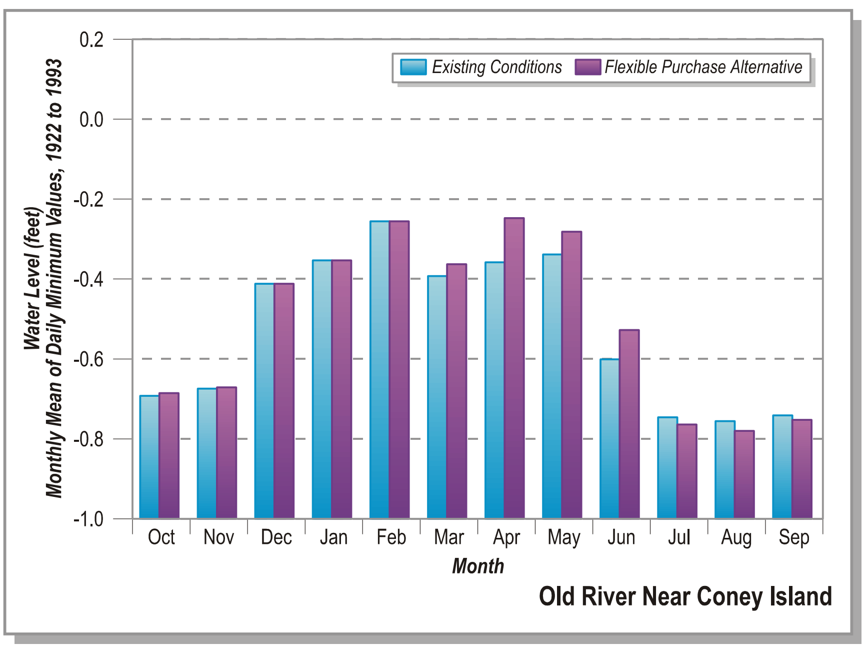

Figure 4-8
Minimum Water Levels at Old River Near Coney Island

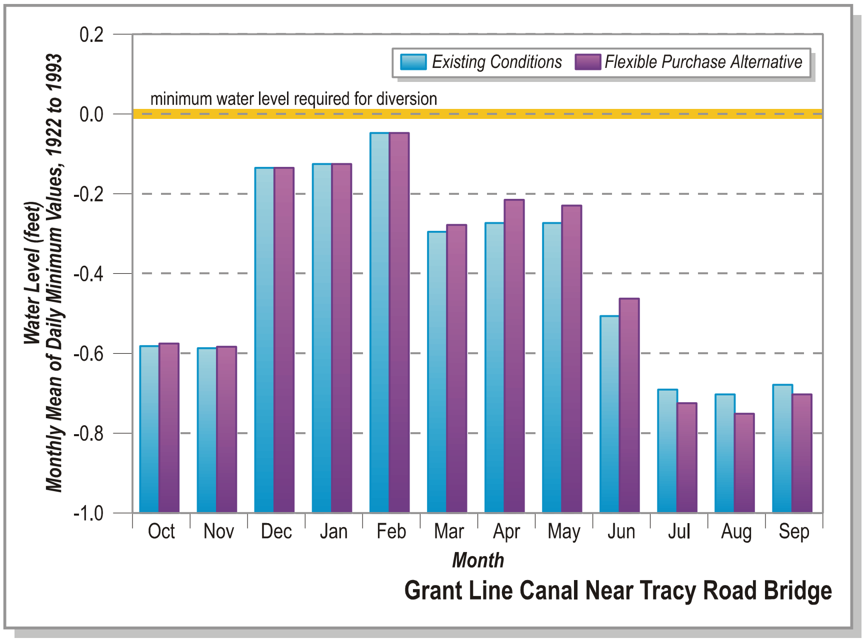

Figure 4-9
Minimum Water Levels at Grant Line Canal Near Tracy Road Bridge

During July through September, when the EWA would increase export pumping, south Delta water levels would be lower than under the Baseline Condition. As displayed in the figures, the difference between the Baseline Condition and the condition with EWA pumping would be slight; levels with the EWA could be less than 1 inch below the already low Delta water levels. This slight decrease could, however, affect water supplies to landowners and therefore would be a potentially significant effect. Because south Delta water levels are below the threshold even under the Baseline Condition, practices exist to reduce effects. As mentioned in Section 4.2.3.1, DWR installs temporary pumps to make irrigation possible at low water levels; permanent solutions, such as dredging, are also being considered. These practices would continue with the EWA such that the water supply would not be decreased to south Delta water users. The mitigation measure listed in Section 4.2.8, along with current DWR practices would reduce these potentially significant effects to less than significant.

EWA acquisition of water through variable assets, specifically Joint Point of Diversion, would change the available pump capacity for the CVP. Under the Flexible Purchase Alternative, the CVP and EWA could use SWP excess pump capacity (shared on a 50-50 basis). The EWA agencies would likely maximize use of available pumping capacity at Banks Pumping Plant because transfers originating in the Upstream from the Delta Region are typically less expensive. Under existing conditions, the CVP has used Stage 1 and Stage 2 of JPOD to pump water through Banks Pumping Plant to make up for pumping reductions that benefit fish and increase CVP supplies, respectively. Under the No Action/No Project Alternative, the CVP would have the potential to increase use of JPOD to reach the maximum volumes allowed in Stage 2. It is unclear to what extent the CVP would have implemented these stages of the JPOD and, if the CVP did reach these stages, if the CVP would use the full capacities of Banks Pumping Plant.

The CALFED ROD included sharing available capacity 50-50 between an EWA and CVP with an EWA program designed to acquire approximately 185,000 acre-feet (35,000 upstream from the Delta and 150,000 in the Export Service Area). The CALFED ROD also stated that the EWA has exclusive rights to 500 cfs of the Banks Pumping Plant capacity above the permitted capacity of 6,680 cfs for three months in the summer. Because the 500 cfs capacity can be used to export 50,000 to 60,000 acre-feet, the CALFED agencies did not identify any impacts to the CVP because of sharing available capacity with the EWA. The CALFED ROD acknowledged the 35,000 acre-feet purchase was a first-year purchase and higher amounts could be transferred in subsequent years, but the scope of upstream from the Delta transfers would still be smaller than the Flexible Purchase Alternative. Given there was additional capacity between 35,000 acre-feet and the 500 cfs capacity, it was anticipated that even if purchases increased, they would be covered under the 500 cfs capacity with a small amount of additional pumping using JPOD.

The incorporation of functional equivalence into the Flexible Purchase Alternative would increase the EWA's use of JPOD when capacity is available. The EWA pumping would represent an equal priority sharing of available excess capacity with the CVP, and so could change the CVP's current use of the JPOD and ultimately could affect the full implementation for the CVP's use of JPOD at the physical pumping plant capacity (Stage 3). Quantifying these lost opportunities is speculative, but given that the JPOD response plans will be in place and historically the CVP did utilize Banks Pumping Plant to meet water supply allocations, some lost opportunities would occur as a result of the sharing of excess capacity with EWA.

4.2.5.4 Export Service Area

The EWA program would likely result in increased reliability of water supplies to SWP/CVP contractors. Under the Baseline Condition, water users in the Export Service Area are subject to reductions in their water supply due to ESA take limits for Delta pumping reductions. The EWA agencies aim to assure that there would be no uncompensated water cost to the CVP or SWP relative to the baseline requirements. Furthermore, with the EWA, water supply would not be affected by pump reductions because EWA assets would repay the CVP and SWP for the loss of supply caused by reduced Project pumping. The Projects' annual supply would be equal to or greater than it would be without the EWA, therefore ensuring greater reliability. The amount of annual reductions under the Baseline Condition is difficult to predict because of variability in the system. The determination of pumping reductions is linked to fish, which are not a predictable resource. Because there is no quantitative baseline for pumping reductions, increased reliability is not discussed quantitatively.

The EWA would increase water supply reliability to the CVP and SWP.

The amount of assets the EWA has under the Flexible Purchase Alternative would help prevent moving to Tier 3.[15] If the EWA does move from Tiers 1 and 2 into Tier 3, the amount of assets the EWA would have under the Flexible Purchase Alternative would supply a greater assurance that the Projects would be compensated for fish actions.

Because the CVP and SWP would be repaid for water lost during pump reductions, additional reductions could be taken compared to the Baseline Condition with no consequence to the Projects, thereby increasing the benefits to fish. A more reliable water source would benefit all water users, including agricultural, environmental, and urban. The increased reliability in water supply to the Export Service Area, facilitated by the elimination of CVP and SWP water loss during ESA reductions, is a beneficial effect.

4.2.5.4.1 Santa Clara Valley Water District

EWA agencies' management of water via source shifting would change the pattern of reservoir level fluctuations. Santa Clara Valley WD could source shift a maximum of 20,000 acre-feet of water, using Anderson Reservoir for supply until water from San Luis Reservoir was delivered later in the year. Per District Resolution 605, the Santa Valley WD would not draw down the reservoir below its minimum summer pool of 20,000 acre-feet, which is necessary to maintain recreational opportunities. The source-shifting amount is within normal operations for the reservoir; therefore, there would be a less-than-significant effect on water supply.

EWA agencies' management of water via predelivery would change the pattern of reservoir level fluctuations. Water would be supplied to Santa Clara Valley WD prior to when it would be supplied under the Baseline Condition. Santa Clara Valley WD would store the water for use later in the year. Because Santa Clara Valley WD would be receiving the water earlier than it would under the Baseline Condition, the effect on water supply is beneficial.

4.2.5.4.2 Metropolitan Water District

EWA agencies' management of water via source shifting would change the pattern of reservoir level fluctuations. Metropolitan WD has adequate alternative supplies and storage to provide for the maximum 200,000 acre-feet of water that may be necessary for source shifting. It is anticipated that Metropolitan WD would not participate in source shifting if adequate supplies were not available for their water users. The 200,000 acre-feet represent about 10 percent of the Southern California storage capacity available to Metropolitan WD. Because of the relatively small quantity of water being deferred and the large variety of local sources for providing a temporary in-lieu supply during the period of deferment, the action would not affect the reliability of Metropolitan WD's water supplies. Therefore, the effect on water supply is less than significant.

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[15] See Section 2.1.3 for description of Tiers 1, 2, and 3.

EWA agencies' management of water via predelivery would change the pattern of reservoir level fluctuations. EWA water would be supplied to Metropolitan WD from San Luis Reservoir (to protect water from spilling from San Luis Reservoir) prior to when it would be supplied under the Baseline Condition. Metropolitan WD would store the water for use later in the year. Because Metropolitan WD would be receiving the water earlier than it would under the Baseline Condition, the effect on water supply is beneficial.

4.2.6 Environmental Consequences/Environmental Impacts of the Fixed Purchase Alternative

The Fixed Purchase Alternative specifies purchases of 35,000 acre-feet[16] in the Upstream from the Delta Region and 150,000 acre-feet in the Export Service Area. While the amounts in each region are fixed, the acquisition types and sources could vary. This section analyzes the effects on each potential transfer to allow the EWA Project Agencies maximum flexibility when negotiating purchases with willing sellers. These transfers are the same actions as those described for the Flexible Purchase Alternative, but the amounts are limited by the total acquisition amount in each region (35,000 acre-feet in the Upstream from the Delta Region and 150,000 acre-feet in the Export Service Area).

4.2.6.1 California Water Resources

Although the amounts listed in Table 4-3 apply only to the Flexible Purchase Alternative, the trends discussed in Section 4.2.5.1 for the Flexible Purchase Alternative would also occur under the Fixed Purchase Alternative. The effects of the trends on the water supply for specific water agencies and users are evaluated in the following sections.

4.2.6.2 Upstream from the Delta Region

4.2.6.2.1 Sacramento River

EWA acquisition of water via groundwater substitution or crop idling would change the rate and timing of flows in the Sacramento River. The changes in timing of flows in the Sacramento River would be the same for the Fixed Purchase Alternative as described in Section 4.2.5.2.1 for the Flexible Purchase Alternative. The amount of water acquired however, would be less under the Fixed Purchase Alternative. There were no effects on water supply on the Sacramento River system under the Flexible Purchase Alternative from groundwater substitution or crop idling; there would therefore be no effects under the Fixed Purchase Alternative.

EWA acquisition of water via crop idling would reduce the water supply for users not participating in the EWA who rely on return flows from fields that, under program conditions, would be idled. Glenn, Colusa, and Yolo Counties would idle up to 10,600 acres. As described in Section 4.2.5.2.1, idling these fields could reduce tailwater, which could reduce supplies to downstream users. This would be a potentially significant effect.

[16] The Fixed Purchase Alternative acquisition amount includes variable assets.

The mitigation measure listed in Section 4.2.8.1 would reduce the potential effects to downstream users to less than significant.

4.2.6.2.2 Feather River

EWA acquisition of water via groundwater substitution or crop idling would change the rate and timing of flows in the Feather River. The changes in timing of flows in the Feather River would be the same for the Fixed Purchase Alternative as described in Section 4.2.5.2.2 for the Flexible Purchase Alternative. The amount of water acquired however, would be less under the Fixed Purchase Alternative. There were no effects on water supply on the Feather River system under the Flexible Purchase Alternative from groundwater substitution or crop idling; there would therefore be no effects under the Fixed Purchase Alternative.

EWA acquisition of water via crop idling would reduce the water supply for users not participating in the EWA who rely on return flows from fields that, under program conditions, would be idled. Butte and Sutter Counties would idle up to 10,600 acres. As described above under the Sacramento River, idling these fields would reduce tailwater, which could reduce supplies to downstream users. This effect would be a potentially significant. The mitigation measure listed in Section 4.2.8.1 would reduce the potential effects to downstream users to less than significant.

EWA acquisition of stored reservoir water from Oroville-Wyandotte ID could reduce carryover storage compared to the Baseline Condition. Oroville-Wyandotte ID would release more water from Little Grass Valley and Sly Creek Reservoirs than is released under the Baseline Condition. The water released from Little Grass Valley and Sly Creek Reservoirs would be refilled from Feather River flows in the winter months following the transfer. Oroville-Wyandotte ID also has refill capability off of Slate Creek, a tributary to the Yuba River, via an upstream diversion operated by Oroville-Wyandotte ID (see footnote 9, Section 4.2.3.1.1).

Following the transfer, if insufficient water were available to refill the reservoirs (e.g., in a low runoff year), a decrease in available supply to users during the following summer could result. It is anticipated that Oroville-Wyandotte ID would calculate the amount of carryover storage that could be released without adverse effects, factoring the potential for a dry year and less refill into the decision-making process. Oroville-Wyandotte ID would not sell water to the EWA that would be needed for its water users. Additionally, the State Water Resources Control Board would also review the reservoir release to be able to make a finding of no significant effect to supply or to other legal users. Therefore, EWA acquisition of stored reservoir water from Oroville-Wyandotte ID would have a less than significant effect on water supply.

4.2.6.2.3 Yuba River

EWA acquisition of water via groundwater substitution would change the rate and timing of flows in the Yuba River. The changes in timing of flows in the Yuba River would be the same for the Fixed Purchase Alternative as described in Section 4.2.5.2.3 for the Flexible Purchase Alternative. The amount of water acquired however, would be less under the Fixed Purchase Alternative. There were no effects on water supply on the

Yuba River system under the Flexible Purchase Alternative from groundwater substitution; there would therefore be no effects under the Fixed Purchase Alternative.

4.2.6.2.4 American River

EWA acquisition of water via crop idling would change the rate and timing of flows in the American River. The changes in timing of flows in the American River would be the same for the Fixed Purchase Alternative as described in Section 4.2.5.2.4 for the Flexible Purchase Alternative. The amount of water acquired would be the same under both alternatives. There were no effects on water supply on the American River system under the Flexible Purchase Alternative from crop idling; there would therefore be no effects under the Fixed Purchase Alternative.

EWA acquisition of stored reservoir water from Placer County WA could reduce carryover storage compared to the Baseline Condition. Placer County WA would release more water from French Meadows and Hell Hole Reservoirs than is released under the Baseline Condition. Following the transfer, if insufficient water were available to refill the reservoirs (e.g., in a low runoff year), a decrease in available supply to users during the following summer could result. It is anticipated that Placer County WA and PG&E would calculate the amount of carryover storage that could be released without adverse effects, factoring the potential for a dry year and less refill into the decision-making process. Placer County WA would not sell water to the EWA that would be needed for its water users. Additionally, the State Water Resources Control Board would also review the reservoir release to be able to make a finding of no significant effect to supply or to other legal users. Therefore, EWA acquisition of stored reservoir water from Placer County WA would have a less-than-significant effect on water supply.

EWA acquisition of water via crop idling would reduce the water supply for users not participating in the EWA who rely on return flows from fields that, under program conditions, would be idled. Placer County could idle up to 3,280 acres. As described above under the Sacramento River, idling these fields would reduce tailwater, which could reduce supplies to downstream users. This would be a potentially significant effect. The mitigation measure listed in Section 4.2.8.1 would reduce the potential effects to downstream users to less than significant.

4.2.6.2.5 Merced River

EWA acquisition of water via groundwater substitution would change the rate and timing of flows in the Merced River. The changes in timing of flows in the Merced River would be the same for the Fixed Purchase Alternative as described in Section 4.2.5.2.5 for the Flexible Purchase Alternative. The amount of water acquired would be the same under both alternatives. There were no effects on water supply on the Merced River system under the Flexible Purchase Alternative from groundwater substitution; there would therefore be no effects under the Fixed Purchase Alternative.

4.2.6.3 Delta

EWA acquisitions through stored reservoir water, groundwater substitution, crop idling, and stored groundwater purchase would change the rate and timing of Delta inflows. Increased water transfers change the timing of diversions and alter the amounts of water diverted for agricultural, municipal, industrial, and ecosystem purposes.

Figures 4-4 through 4-9 show the effects of the Flexible Purchase Alternative on south Delta water levels. The Fixed Purchase Alternative would export less water than modeled under the Flexible Purchase Alternative. Although there are no modeling results for the Fixed Purchase Alternative, increased pumping over the Baseline Condition could lower south Delta water levels below the Baseline and below the thresholds identified in Section 4.2.2. This would be a potentially significant effect. Mitigation measures discussed in Section 4.2.8, such as installation of temporary pumps, would reduce any potentially significant effects to less than significant.

EWA acquisition of water through variable assets, specifically Joint Point of Diversion, could change the available Banks pump capacity for the CVP. Under the Fixed Purchase Alternative, the CVP and EWA could use SWP excess pump capacity (shared on a 50-50 basis). The CALFED ROD included sharing available capacity 50-50 between EWA and JPOD with an EWA program designed to acquire approximately 185,000 acre-feet (35,000 upstream from the Delta and 150,000 in the Export Service Area). The EWA program was described as having exclusive rights to 500 cfs of the Banks Pumping Plant capacity above the permitted capacity of 6,680 cfs for three months in the summer. If renewed, the 500 cfs capacity can be used to export 50,000 to 60,000 acre-feet (the maximum transfer in the Upstream from the Delta Region under the Fixed Purchase Alternative). Therefore, the Fixed Purchase Alternative would have no effects on other users of JPOD.

4.2.6.4 Export Service Area

The EWA program would likely result in increased reliability of water supplies to SWP/CVP contractors. Under the Baseline Condition, water users in the Export Service Area are subject to reductions in their water supply due to Endangered Species Act take limits for Delta pumping reductions. With the EWA, water supply would not be affected by these pump reductions. EWA assets would repay the CVP and SWP water for the loss of supply caused by reduced Project pumping. Furthermore, because the CVP and SWP would be repaid for water lost during pump reductions, additional reductions could be taken compared to the Baseline Condition with no consequence to the Projects, thereby increasing the benefits to fish. The increased reliability in water supply to the Export Service Area, facilitated by the elimination of CVP and SWP water loss during ESA reductions, is a beneficial effect.

If the EWA moves from Tiers 1 and 2 into Tier 3,[17] the cuts under Tier 3 would either be uncompensated or the Projects would be paid back for water lost during pump reduction. The water supply reliability under the Fixed Purchase Alternative would be greater than under the Baseline Condition.

[17] See Section 2.1.3 for description of Tiers 1, 2, and 3.

4.2.6.4.1 *Santa Clara Valley Water District*

EWA agencies' management of water via source shifting would change the pattern of reservoir level fluctuations. The same amount of water could be source shifted by Santa Clara Valley WD under the Fixed Purchase Alternative as was evaluated under the Flexible Purchase Alternative in Section 4.2.5.4.1. There was a less-than-significant effect on water supply under the Flexible Purchase Alternative; there would therefore be a less than significant effect on water supply under the Fixed Purchase Alternative.

EWA agencies' management of water via predelivery would change the pattern of reservoir level fluctuations. Water would be supplied to Santa Clara Valley WD prior to when it would be supplied under the Baseline Condition. Santa Clara Valley WD would store the water for use later in the year. Because Santa Clara Valley WD would be receiving the water earlier than it would under the Baseline Condition, the effect on water supply is beneficial.

4.2.6.4.2 *Metropolitan Water District*

EWA agencies' management of water via source shifting would change the pattern of reservoir level fluctuations. Metropolitan WD has adequate alternative supplies and storage to provide for the maximum 200,000 acre-feet of water that may be necessary for source shifting. It is anticipated that Metropolitan WD would not participate in source shifting if adequate supplies were not available for their water users. The 200,000 acre-feet represent about 10 percent of the Southern California storage capacity available to Metropolitan WD. Because of the relatively small quantity of water being deferred and the large variety of local sources for providing a temporary in-lieu supply during the period of deferment, the action would not affect the reliability of Metropolitan WD's water supplies. Therefore, the effect on water supply is less than significant.

EWA agencies' management of water via predelivery would change the pattern of reservoir level fluctuations. Water would be supplied to Metropolitan WD prior to when it would be supplied under the Baseline Condition. Metropolitan WD would store the water for use later in the year. Because Metropolitan WD would be receiving the water earlier than it would under the Baseline Condition, the effect on water supply is beneficial.

4.2.7 Comparative Analysis of Alternatives

This chapter has thus far analyzed the effects of many potential transfers, looking at the "worst-case scenario" that would occur if all acquisitions happened in the same year. This approach ensures that all effects of transfers are included and provides the EWA Project Agencies the flexibility to choose transfers that may be preferable in a given year. The EWA, however, would not actually purchase all this water in the same year. This section provides information about how EWA would more likely operate in different year types. A further comparison of the alternatives is listed in Table 4-4.

Acquisitions of water as EWA assets would enable the EWA agencies to repay the SWP/CVP for water not pumped during pump reductions. The Flexible Purchase Alternative would acquire more assets than the Fixed Purchase Alternative; therefore, the Flexible Purchase Alternative would be able to repay the Projects for a greater number of pump reductions for fish actions. If the Fixed Purchase Alternative used its assets and fish actions were still needed, Tier 3 would be implemented. Under Tier 3, either additional EWA assets could be acquired or pump reductions would continue uncompensated, resulting in less water supply reliability. Because there is an increased probability of reaching Tier 3 under the Fixed Purchase Alternative, the Fixed Purchase Alternative would provide less water supply reliability compared to the Flexible Purchase Alternative.

4.2.7.1 Upstream from the Delta Region

In the Upstream from the Delta Region, under the No Action/No Project Alternative, surface water supply would be greater in wet years than dry years. Less precipitation in dry years would result in lower reservoir and river levels, which would decrease available supplies to all water users.

The Fixed Purchase Alternative would be limited to a maximum acquisition of 35,000 acre-feet from all sources of water. The Flexible Purchase Alternative could involve purchase of up to 600,000 acre-feet of water from all sources upstream from the Delta in drier years.

The Flexible Purchase Alternative would acquire more assets through stored reservoir water than the Fixed Purchase Alternative, thus having a greater potential for effects on water supply due to lower non-Project reservoir levels. However, the project description includes refill criteria that would result in no adverse effects caused by either the Fixed Purchase or Flexible Purchase Alternatives.

The Flexible Purchase Alternative would acquire more assets through crop idling than the Fixed Purchase Alternative, especially in dry years. Crop idling would decrease return flows, potentially affecting downstream users. Mitigation measures listed in Section 4.2.8 would reduce the effects of both alternatives to less-than-significant levels.

4.2.7.2 Delta

During wet years, the Fixed and Flexible Purchase Alternatives would have no effects on the available Banks pumping capacity for the CVP. During dry years, the EWA would export more water and therefore there could be some lost pumping opportunities for the CVP under the Flexible Purchase Alternative. The Fixed Purchase Alternative would have no effect on CVP pumping capacity even in dry years.

The amount of variable assets the EWA could acquire would differ in different year types. For example, in wet years, the SWP pumps could have less excess capacity, and therefore, excess SWP pumping capacity to be shared by the CVP, EWA, and Level 4 refuge water under JPOD would be less than in dry years. The potential for acquiring variable assets is the same under the Flexible and Fixed Purchase Alternatives. However, the Flexible Purchase Alternative could take greater advantage of JPOD and the 500 cfs pumping capacity than the Fixed Purchase Alternative because these variable assets only supply the capacity; the EWA must move EWA water. Because the Flexible Purchase Alternative could acquire more water than the Fixed Purchase Alternative, the Flexible Purchase Alternative has the potential to move more water with the variable assets.

The amount of Delta export pumping affects south Delta water users. The Flexible and Fixed Purchase Alternatives would have similar effects on south Delta water levels during wet years. During dry years, the Flexible Purchase Alternative would export more water through the Delta than the Fixed Purchase Alternative, which could lower south Delta water levels further than the Fixed Purchase Alternative.

4.2.7.3 Export Service Area

Under the No Action/No Project Alternative, reduced deliveries would be more likely in dry years because in wet years the Projects would be more likely to be able to recover from export reductions for fish protection.

EWA asset acquisitions in the Export Service Area under the Fixed Purchase Alternative would be limited to 150,000 acre-feet. EWA asset acquisitions in the Export Service Area under the Flexible Purchase Alternative would be dependent on the water year type north of the Delta. Export pump capacity during wet years would limit the ability of the EWA Project Agencies to move assets through the Delta, requiring reliance on greater purchase amounts from Export Service Area sources.

Source shifting would occur under both the Flexible and Fixed Purchase Alternatives; however, source shifting would occur more often with the Fixed Purchase Alternative.

4.2.8 Mitigation Measures

4.2.8.1 Return Flows

Crop idling would reduce tailwater, which could reduce supplies to downstream users. The EWA agencies will require the willing seller of water for crop idling to maintain their drainage systems at a water level that would not reduce the supplies of downstream users.

4.2.8.2 Impacts to South Delta Water Levels:

Increased export pumping from the Delta in July through September compared to the Baseline Condition could lower south Delta water levels and affect irrigation supply for agricultural water users. Actions taken by DWR, such as installation of temporary pumps or dredging, would reduce effects to South Delta water users. If EWA pumping decreases south Delta water levels, the EWA agencies will pay their share for additional actions needed to increase south Delta water levels to the Baseline Condition.

4.2.9 Potentially Significant Unavoidable Impacts

There are no significant unavoidable impacts.

4.2.10 Cumulative Effects

The Sacramento Valley Water Management Agreement, Dry Year Purchase Program[18], Drought Risk Reduction Investment Program (DRRIP), Central Valley Project Improvement Act Water Acquisition Program, and Environmental Water Program could acquire water in the Upstream from the Delta Region. These programs all include stored reservoir water, and many include other acquisition types such as groundwater substitution, groundwater purchase, and crop idling.

Programs that acquire water through stored reservoir water could draw reservoirs down below the Baseline Condition, lessen the possibility of refill, and affect water supply for users the following year. However, as stated in Sections 4.2.5.2 – 4.2.5.4, it is anticipated that the agencies selling water to the EWA would manage their water responsibly, whether the water was sold for one program or for multiple programs. Therefore, these programs would cumulatively have a less-than-significant effect on water supply.

Programs in addition to the EWA that would acquire water through groundwater substitution and crop idling would create additional changes in the timing and quantity of water released from reservoirs, altering riverflows. However, the flow representing only the seller's supply would be altered. Groundwater substitution and crop idling would not cause a cumulatively significant effect because the associated flow changes would not affect nonparticipating users' water supply.

Crop idling would reduce the water supply for users not participating in the EWA who rely on return flows from fields that, with the EWA, would be idled. Crop idling under programs in addition to the EWA could further reduce return flows causing a cumulative impact. However, the EWA includes mitigation measures to maintain return flows; therefore, the EWA would not be contributing to a cumulative impact.

[18] Transfers negotiated between CVP and SWP contractors and other water users, such as the Forbearance Agreement with Westlands WD and the recent crop idling acquisition by Metropolitan WD from water agencies upstream from the Delta, are part of the Dry Year Program.

Table 4-4
Comparison of the Effects of the Flexible and Fixed Purchase Alternatives on Water Supply

Region	Asset Acquisition or Management	Result	Impacts	Flexible Purchase Alternative Change from Baseline Condition	Fixed Purchase Alternative Change from Baseline Condition	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta							
Sacramento River	Crop idling	Willing sellers do not divert water for irrigation.	Cropped fields that supplied tailwater under the Baseline Condition would be idled and would not supply tailwater for downstream use.	Farmers and other water users not participating in the EWA could receive less water because of reduced tailwater supplies.	Farmers and other water users not participating in the EWA could receive less water because of reduced tailwater supplies.	PS;[19] LTS[20] with mitigation measures.	PS; LTS with mitigation measures.
	Groundwater substitution/ Crop Idling	Water is released from Lake Shasta in July through September.	Water is not diverted for irrigation.	Sacramento River increases below point of diversion.	Sacramento River increases below point of diversion.	No effect	No effect
		Water held in Lake Shasta in June.	Slower decrease in water levels in Lake Shasta in June, compared to the Baseline Condition.	Sacramento River decreases from release to point of diversion.	Sacramento River decreases from release to point of diversion.	No Effect	No effect

[19] PS = Potentially Significant
[20] LTS = Less Than Significant

Table 4-4
Comparison of the Effects of the Flexible and Fixed Purchase Alternatives on Water Supply

Region	*Asset Acquisition or Management*	*Result*	*Impacts*	*Flexible Purchase Alternative Change from Baseline Condition*	*Fixed Purchase Alternative Change from Baseline Condition*	*Significance of Flexible Purchase Alternative*	*Significance of Fixed Purchase Alternative*
Upstream from the Delta							
Feather River	Stored reservoir water	Water is released from Sly Creek and Little Grass Valley Reservoirs.	Sly Creek and Little Grass Valley Reservoir levels decrease from December until refill.	Sly Creek and Little Grass Valley Reservoirs decrease in storage and elevation from December until refill compared to the Baseline Condition.	Sly Creek and Little Grass Valley Reservoirs decrease in storage and elevation from December until refill compared to the Baseline Condition.	LTS	LTS
			Increased flows in the Feather River upstream from Lake Oroville in November and December	Feather River increases below Little Grass Valley and Sly Creek Reservoirs downstream to Lake Oroville.	Feather River increases below Little Grass Valley and Sly Creek Reservoirs downstream to Lake Oroville.	No effect	No effect
			Lake Oroville levels increase in November and December compared to the Baseline Condition.	Lake Oroville storage and elevation increase by the amount released by Little Grass Valley and Sly Creek Reservoirs.	Lake Oroville storage and elevation increase by the amount released by Little Grass Valley and Sly Creek Reservoirs.	No effect	No effect
	Groundwater substitution/Crop Idling	Water is held in Lake Oroville	Slower decrease in water levels in Lake Oroville from April – June, compared to the Baseline Condition.	Lake Oroville storage and elevation is increased compared to the Baseline Condition.	Lake Oroville storage and elevation is increased compared to the Baseline Condition.	No effect	No effect
		Water is released from Lake Oroville	Feather River flows downstream from Lake Oroville increase July – September.	Feather River increases below Lake Oroville due to release of water held in April through June.	Feather River increases below Lake Oroville due to release of water held in April through June.	No effect	No effect

Table 4-4
Comparison of the Effects of the Flexible and Fixed Purchase Alternatives on Water Supply

Region	Asset Acquisition or Management	Result	Impacts	Flexible Purchase Alternative Change from Baseline Condition	Fixed Purchase Alternative Change from Baseline Condition	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta							
Feather River	Crop Idling	Willing sellers do not divert water for irrigation.	Cropped fields that supplied tailwater under the Baseline Condition would be idled and would not supply tailwater for downstream use.	Farmers and other water users not participating in the EWA could receive less water because of reduced tailwater supplies.	Farmers and other water users not participating in the EWA could receive less water because of reduced tailwater supplies.	PS; LTS with mitigation measures.	PS; LTS with mitigation measures.
Yuba River	Stored Reservoir Water	Water is released from New Bullards Bar Reservoir.	Yuba River flows increase July – September.	Yuba River flows increase below New Bullards Bar.	Yuba River flows increase below New Bullards Bar.	No effect	No effect
			New Bullards Bar water levels would be lower July – refill compared to the Baseline Condition.	New Bullards Bar storage and elevation are lower compared to the Baseline Condition.	New Bullards Bar storage and elevation are lower compared to the Baseline Condition.	LTS	LTS
	Groundwater Substitution	Water is held in New Bullards Bar Reservoir.	Slower decrease in water levels in New Bullards Bar Reservoir from April – June, compared to the Baseline Condition.	New Bullards Bar Reservoir storage and elevation are increased compare to the Baseline Condition.	New Bullards Bar Reservoir storage and elevation are increased compare to the Baseline Condition.	No effect	No effect
			Yuba River flows decrease April – June	Yuba River flow decreases because of water not released.	Yuba River flow decreases because of water not released.	No effect	No effect
		Water is released from New Bullards Bar Reservoir.	Yuba River flows increase July - September	Yuba River flow increases because of release of water held April through June.	Yuba River flow increases because of release of water held April through June.	No effect	No effect

Table 4-4
Comparison of the Effects of the Flexible and Fixed Purchase Alternatives on Water Supply

Region	***Asset Acquisition or Management***	***Result***	***Impacts***	***Flexible Purchase Alternative Change from Baseline Conditions***	***Fixed Purchase Alternative Change from Baseline Conditions***	***Significance of Flexible Purchase Alternative***	***Significance of Fixed Purchase Alternative***
Upstream from the Delta							
American River	Stored Reservoir Water	Water is released from French Meadows and Hell Hole Reservoirs	French Meadows and Hell Hole Reservoir water levels decrease June – refill	French Meadows and Hell Hole Reservoirs decrease in storage and elevation compared to the Baseline Condition.	French Meadows and Hell Hole Reservoirs decrease in storage and elevation compared to the Baseline Condition.	LTS	LTS
			Flows in the American River between French Meadows/Hell Hole Reservoirs and Folsom Lake are increased July – September	American River flow increases because of release of stored reservoir water.	American River flow increases because of release of stored reservoir water.	No effect	No effect
	Stored Reservoir Water and Groundwater Purchase	Water is held in Folsom Lake.	Folsom water levels increase in the summer due to slower release during groundwater purchase. Levels also increase because of stored water release from upstream reservoirs held temporarily in Folsom Lake.	Folsom Lake has increased storage compared to the Baseline Condition.	Folsom Lake has increased storage compared to the Baseline Condition.	No effect	No effect
		Water is released from Folsom Lake.	American River flows downstream from Folsom Lake increase June – December.	Folsom River flow increases compared to the Baseline Condition.	Folsom River flow increases compared to the Baseline Condition.	No effect	No effect
	Crop Idling	Willing sellers do not divert water for irrigation.	Cropped fields that supplied tailwater under the Baseline Condition would be idled and would not supply tailwater for downstream use.	Farmers and other water users not participating in the EWA could receive less water because of reduced tailwater supplies.	Farmers and other water users not participating in the EWA could receive less water because of reduced tailwater supplies.	PS; LTS with mitigation measures.	PS; LTS with mitigation measures.

Table 4-4
Comparison of the Effects of the Flexible and Fixed Purchase Alternatives on Water Supply

Region	Asset Acquisition or Management	Result	Impacts	Flexible Purchase Alternative Change from Baseline Conditions	Fixed Purchase Alternative Change from Baseline Conditions	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta							
Merced/San Joaquin River	Groundwater Substitution	Water is held in Lake McClure	Slower decrease in water levels in Lake McClure in April through October, compared to the Baseline Condition.	Lake McClure increases in storage and elevation compared to the Baseline Condition.	Lake McClure increases in storage and elevation compared to Baseline Condition.	No effect	No effect
			Merced River flows decrease April – October.	Merced River flow decreases below Lake McClure to the point of diversion.	Merced River flow decreases below Lake McClure to the point of diversion.	No effect	No effect
		Water is released from Lake McClure	Merced River flows increase in October.	Merced River flow increases below point of diversion.	Merced River flow increases below point of diversion.	No effect	No effect
Delta Region							
Delta	Crop idling, Groundwater substitution, Stored groundwater purchase, Stored reservoir water	Water released from reservoirs creates increased inflow for Delta export.	Increased Delta exports July – September.	South Delta water levels decrease compared to the Baseline Condition.	South Delta water levels decrease compared to the Baseline Condition.	PS; LTS with mitigation measures	PS; LTS with mitigation measures
	Management of variable assets	CVP and EWA could use SWP excess pump capacity shared on a 50-50 basis.	Change in available Banks pump capacity for the CVP.	Some lost CVP pumping opportunities will occur as a result of sharing excess capacity with the EWA.	No change in CVP available Banks pump capacity.	Loss of opportunity	No effect

Table 4-4
Comparison of the Effects of the Flexible and Fixed Purchase Alternatives on Water Supply

Region	Asset Acquisition or Management	Result	Impacts	Flexible Purchase Alternative Change from Baseline Conditions	Fixed Purchase Alternative Change from Baseline Conditions	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Export Service Area							
Export Service Area	Source Shifting	Water is drawn from Metropolitan or Santa Clara Valley WDs' alternate supply sources.	Metropolitan WD could draw water from Castaic Lake, Lake Perris, Diamond Valley Lake, or other supply sources. Santa Clara Valley WD would draw water from Anderson Reservoir.	Storage and elevation are reduced in reservoirs until water is paid back.	Storage and elevation are reduced in reservoirs until water is paid back.	LTS	LTS
	Predelivery	EWA water is moved to reservoirs for later return in same year; or water is moved to agricultural contractor for return in future wet year.	Water would increase reservoir levels until water returned; reduced groundwater pumping for agriculture in current year.	Storage and elevation are increased in reservoirs or groundwater pumping.	Storage and elevation are increased in reservoirs or groundwater pumping.	LTS	LTS
	Borrowed Project Water	Water is released from San Luis Reservoir	Decreased water levels in San Luis Reservoir	Decreased water levels in San Luis Reservoir would affect the low point problem in the same manner as under the Baseline Condition.	Decreased water levels in San Luis Reservoir would affect the low point problem in the same manner as under the Baseline Condition.	LTS	LTS

The Sacramento Valley Water Management Agreement, DRRIP, Central Valley Project Improvement Act Water Acquisition Program, and Environmental Water Program would acquire water in the Upstream from the Delta Region and would need Delta pump capacity to transfer water to the Export Service Area. Programs, in addition to the EWA, that transferred water to the Export Service Area would further increase water supply reliability to the region, creating a potentially beneficial cumulative effect. Conversely, a potentially adverse cumulative effect on south Delta water users could occur because of the increased export pumping. Although increased export pumping by many programs could cause a cumulative effect, the EWA's contribution is not cumulatively significant because the EWA would contribute to its share of mitigation costs to allow DWR to continue practices that alleviate water level concerns.

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Chapter 5
Water Quality

Maintaining water quality in California's waterbodies is important to ensure safe drinking water and to provide recreational, environmental, industrial and agricultural beneficial uses. This chapter describes the existing water quality of the water resources within the Environmental Water Account (EWA) Program area of analysis, and discusses potential effects to water quality in response to implementation of the EWA Program.

5.1 Affected Environment/Existing Conditions

This section provides an overview of the regulatory setting associated with water quality standards, outlines the constituents of concern, identifies designated beneficial uses, and provides a description of the waterbodies with the potential to be affected by the EWA Program.

5.1.1 Area of Analysis

The area of analysis for water quality includes the waterbodies with the potential to be affected by the EWA Program, including the Sacramento, Feather, Yuba, American, Merced, and San Joaquin River systems. The Sacramento-San Joaquin Delta Region encompasses the Delta, and the Export Service Area includes Central Valley Project (CVP)/State Water Project (SWP) facilities (Figure 5-1).

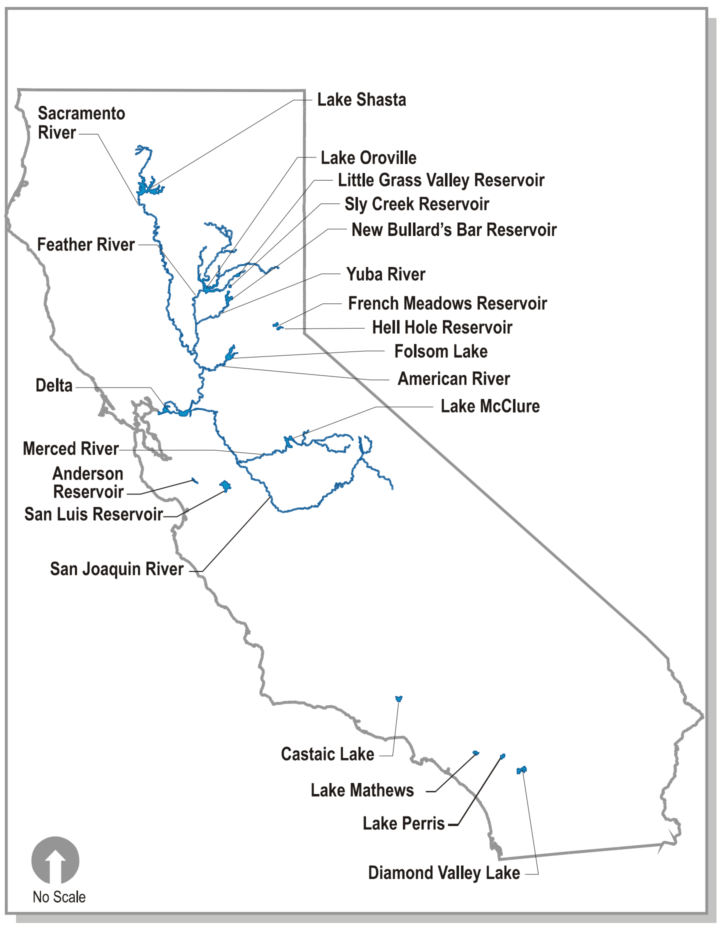


Figure 5-1
Water Quality Area of Analysis

The Sacramento River system includes Shasta Reservoir and the Sacramento River from Keswick Dam to the Delta (at approximately Chipps Island near Pittsburg). The Feather River system includes Little Grass Valley and Sly Creek Reservoirs on the South Fork Feather River; the Oroville Facilities, including Lake Oroville; and the lower Feather River extending from the Fish Barrier Dam to the confluence with the Sacramento River. The Yuba River system includes New Bullards Bar Reservoir and the lower Yuba River, extending from Englebright Dam to the confluence with the Feather River. The American River system includes French Meadows Reservoir on the Middle Fork American River and Hell Hole Reservoir on the Rubicon River; the Middle Fork American River, from Ralston Afterbay to the confluence with the North Fork American River; Folsom Reservoir; and the lower American River, extending from Nimbus Dam to the confluence with the Sacramento River. The San Joaquin River system includes Lake McClure on the Merced River; the Merced River, from Crocker-Huffman Dam to the confluence with the San Joaquin River; and the San Joaquin River from the mouth of the Merced River to Mossdale. Details regarding the facilities and waterbodies within the Upstream from the Delta Region and the water quality resources are provided in Section 5.1.5.1

The Sacramento-San Joaquin Delta Region includes the river channels and sloughs at the confluence of the Sacramento and San Joaquin rivers. Details regarding the facilities and waterbodies within the Delta Region area of analysis and the water quality resources are provided in Section 5.1.5.2. The area of analysis for the Export Service Area consists of the California Aqueduct, San Luis Reservoir, Anderson Reservoir, several SWP terminal reservoirs (Castaic Lake, Lake Perris), Lake Mathews, and Diamond Valley Lake. Details regarding the facilities and waterbodies within the Export Service Area and the water quality resources are provided in Section 5.1.5.3.

5.1.2 Regulatory Setting

5.1.2.1 Safe Drinking Water Act

The Federal Safe Drinking Water Act (SDWA) was established to protect the quality of drinking water in the United States (U.S.). This law focuses on all waters actually or potentially designated for drinking use, whether from above ground or underground sources. The SDWA authorized the Environmental Protection Agency (EPA) to establish safe standards of purity and required all owners or operators of public water systems to comply with primary (health-related) standards. State governments, which assume this power from the EPA, also encourage attainment of secondary standards (nuisance-related). Contaminants of concern in a domestic water supply are those that either pose a health threat or in some way alter the aesthetic acceptability of the water. These types of contaminants are currently regulated by the EPA as primary and secondary maximum contaminant levels (MCLs). As directed by the SDWA amendments of 1986, the EPA has been expanding its list of primary MCLs. MCLs have been proposed or established for approximately 100 contaminants.

5.1.2.2 Surface Water Treatment Rule

The Federal Surface Water Treatment Rule (SWTR) became effective on June 19, 1989. The California Surface Water Treatment Rule (California's SWTR), which implements the Federal SWTR within the State, became effective in June 1991. The California SWTR satisfies three specific requirements of the SDWA. First, it establishes criteria for determining when filtration is required for surface waters. Second, it defines minimum levels of disinfection for surface waters. Third, it addresses *Giardia lamblia*, viruses, *Legionella*, turbidity, and heterotrophic plate count by setting a treatment technique. It is appropriate to set a treatment technique in lieu of an MCL for a contaminant when it is not technologically or economically feasible to measure that contaminant. For example, methods to accurately detect *Giardia lamblia* are very time-consuming and costly, and may not be accurate. The SWTR is based on providing treatment to achieve a minimum theoretical percent removal/inactivation of 99.9 percent (3 logs) of *Giardia lamblia* and 99.99 percent (4 logs) of viruses. Treatment required includes the use of a filtration system, unless very stringent source water quality and site-specific conditions are met. The level of treatment needed to meet the 3- and 4-log removal must be achieved by disinfection.

The disinfectants used to treat *Giardia lamblia* and viruses can react with naturally-occurring materials in the water to form unintended byproducts. These byproducts may pose health risks. Amendments to the SDWA in 1996 require EPA to develop rules to balance the risks between microbial pathogens and disinfection byproducts (DBPs). The intent is to strengthen protection against microbial contaminants, and at the same time, reduce potential health risks of DBPs. The Stage 1 Disinfectants and Disinfection Byproducts Rule and Interim Enhanced Surface Water Treatment Rule, announced in December 1998, are the first of a set of rules under the 1996 SDWA Amendments.

5.1.2.2.1 Stage 1 Disinfectants and Disinfection Byproducts Rule (D/DBPR) and Long-Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR)

While disinfectants are effective in controlling many microorganisms, they react with natural organic and inorganic matter in source water and distribution systems to form DBPs.

The Stage 1 D/DBPR updates and supersedes the 1979 regulations for total trihalomethanes (TTHMs). In addition, it is intended to reduce exposure to three disinfectants and many disinfection byproducts. The D/DBPR establishes maximum residual disinfectant level goals (MRDLGs) and maximum residual disinfectant levels (MRDLs) for three chemical disinfectants – chlorine, chloramine and chlorine dioxide (Table 5-1). It also establishes maximum contaminant level goals (MCLGs) and maximum contaminant levels (MCLs) for total trihalomethanes, haloacetic acids, chlorite, and bromate (Table 5-1).

Water systems that use surface water (or groundwater under the direct influence (GWUDI) of surface water) and use conventional filtration treatment are required to remove specified percentages of organic materials, measured as total organic carbon (TOC), that may react with disinfectants to form DBPs (Table 5-2). Removal is to be achieved through a treatment technique (enhanced coagulation or enhanced softening), unless the system meets alternative criteria.

Table 5-1 *MRDLGs and MRDLs for Stage 1 Disinfectants and Disinfection Byproducts Rule*			
Disinfectant Residual	***MRDLG (mg/L)***	***MRDL (mg/L)***	***Compliance Based on***
Chlorine	4 (as Cl_2)	4.0 (as Cl_2)	Annual Average
Chloramine	4 (as Cl_2)	4.0 (as Cl_2)	Annual Average
Chlorine Dioxide	0.8 (as ClO_2)	0.8 (as ClO_2)	Daily samples
Total trihalomethanes (TTHM)(1)	N/A	0.080	Annual average
Chloroform	***		
Bromodichloromethane	0		
Dibromochloromethane	0.06		
Bromoform	0		
Haloacetic acids (five) (HAA5)(2)	N/A	0.060	Annual Average
Dichloroacetic acid	0		
Trichloroacetic acid	0.3		
Chlorite	0.8	1.0	Monthly average
Bromate	0	0.010	Annual average

N/A – Not applicable because there are individual MCLGs for TTHMs or HAAs.
(1) Total trihalomethanes is the sum of the concentrations of chloroform, bromodichloromethane, dibromochloromethane, and bromoform.
(2) Haloacetic acids (five) are the sum of the concentrations of the mono-, di-, and trichloroacetic acids and mono- and dibromoacetic acids.
***EPA removed the zero MCLG for chloroform from its National primary Drinking Water Regulations, effective May 30, 2000, in accordance with an order of the U.S. Court of Appeals for the District of Columbia circuit.
mg/L = milligrams/liter
Source: USEPA 1998a

Table 5-2 *Required Removal of Total Organic Carbon by Enhanced Coagulation and Enhanced Softening for Subpart H Systems Using Conventional Treatment (1)* *Recent Required Removal of TOC*			
Source Water TOC (mg/L)	***Source Water Alkalinity (mg/L as $CaCO_3$)***		
	0-60	***>60-120***	***>120 (2)***
>2.0-4.0	35	25	15
>4.0-8.0	45	35	25
>8.0	50	40	30

(1) Systems meeting at least one of the alternative compliance criteria in the rule are not required to meet the removals in this table.
(2) Systems practicing softening must meet these TOC removal requirements.
Source: USEPA 1998a

Large surface water systems were required to comply with the Stage 1 D/DBPR and the Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) by January 2002. Groundwater systems and small surface water systems must comply with the Stage 1 D/DBPR by January 2004.

The EPA's Science Advisory Board concluded in 1990 that exposure to microbial contaminants such as bacteria, viruses, and protozoa (e.g., *Giardia lamblia* and *Cryptosporidium*) was likely the greatest remaining health risk management challenge for drinking water suppliers. Acute health effects from exposure to microbial pathogens are documented and associated illness can range from mild to moderate cases lasting only a few days to more severe infections that can last several weeks and may result in death for those with weakened immune systems.

The primary purposes of LT1ESWTR are to improve microbial control, especially for *Cryptosporidium*, and guard against microbial risk because of the Stage 1 D/DBPR. The LT1ESWTR provisions include the following:

- MCLG of zero for *Cryptosporidium*;
- 2-log *Cryptosporidium* removal requirements for systems that filter;
- Strengthened performance standards and individual filter turbidity monitoring provisions;
- Disinfection benchmark provisions to assure continued levels of microbial protection while facilities take necessary steps to comply with new DBP standards;
- Inclusion of *Cryptosporidium* in the definition of GWUDI of surface water and additional avoidance criteria for unfiltered public water systems;
- Requirements for covers on new finished water reservoirs; and
- Sanitary surveys for all surface water and GWUDI systems regardless of size.

5.1.2.3 Federal Clean Water Act

Growing public awareness and concern for controlling water pollution led to enactment of the Federal Water Pollution Control Act Amendments of 1972. As amended in 1977, this law became commonly known as the Clean Water Act (CWA). The CWA established the basic structure for regulating discharges of pollutants into the waters of the U.S. It gave the EPA the authority to implement pollution control programs such as setting wastewater standards for industry. The CWA also continued requirements to set water quality standards for all contaminants in surface waters. The CWA made it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit was obtained under its provisions (USEPA 2002c).

Section 303(d) of the 1972 CWA requires states, territories and authorized tribes to develop a list of water quality-impaired segments of waterways. The list includes waters that do not meet water quality standards for the beneficial uses of that waterway, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for water on the lists and develop action plans, called Total Maximum Daily Loads (TMDLs), to improve water quality (USEPA 2002c).

A TMDL is a tool for implementing water quality standards and is based on the relationship between pollution sources and in-stream water quality conditions. The TMDL establishes the allowable loadings or other quantifiable parameters for a waterbody and thereby provides the basis for the establishment of water quality-based controls. These controls should provide the pollution reduction necessary for a waterbody to meet water quality standards. A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and nonpoint sources. The calculation for establishment of TMDLs for each waterbody must include a margin of safety to ensure that the waterbody can be used for the purposes the State has designated. Additionally, the calculation also must account for seasonal variation in water quality (USEPA 2002c).

TMDLs are intended to address all significant stressors which cause or threaten to cause waterbody use impairment, including point sources (e.g., sewage treatment plant discharges), nonpoint sources (e.g., runoff from fields, streets, range, or forest land), and naturally occurring sources (e.g., runoff from undisturbed lands). TMDLs are usually based on readily available information and studies. In some cases, complex studies or models are needed to understand how stressors are causing waterbody impairment. In many cases, simple analytical efforts provide an adequate basis for stressor assessment and implementation planning. TMDLs are developed to provide an analytical basis for planning and implementing pollution controls, land management practices, and restoration projects needed to protect water quality. States are required to include approved TMDLs and associated implementation measures in State water quality management plans or basin plans.

5.1.2.4 Porter-Cologne Act

The Porter-Cologne Act defines water quality objectives as the limits or levels of water constituents that are established for reasonable protection of beneficial uses. The Porter-Cologne Act requires the Regional Water Quality Control Board (RWQCB) to establish water quality objectives, while acknowledging that water quality may be changed to some degree without unreasonably affecting beneficial uses. Beneficial uses, together with the corresponding water quality objectives, are defined as standards, per Federal regulations. Therefore, the regional plans form the regulatory references for meeting State and Federal requirements for water quality control. Changes in water quality are only allowed if the change is consistent with the maximum beneficial use of the State, does not unreasonably affect the present or anticipated beneficial uses, and does not result in water quality less than that prescribed in the water quality control plans (RWQCBCV 1998).

5.1.2.5 Regional Water Quality Control Plans

The preparation and adoption of water quality control plans (Basin Plans) is required by the California Water Code (Section 13240) and supported by the Federal CWA. Section 303 of the CWA requires states to adopt water quality standards which "*consist of the designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses.*" According to Section 13050 of the California Water Code, Basin Plans consist of a designation or establishment for the waters within a specified area of beneficial uses to be protected, water quality objectives to protect those uses, and a program of implementation needed for achieving the objectives. State law also requires that Basin Plans conform to the policies set forth in the Water Code beginning with Section 13000 and any State policy for water quality control. Because beneficial uses, together with their corresponding water quality objectives, can be defined per Federal regulations as water quality standards, the Basin Plans are regulatory references for meeting the State and Federal requirements for water quality control (40 Code Federal Regulations [CFR] 131.20). One significant difference between the State and Federal programs is that California's basin plans establish standards for groundwater in addition to surface water.

Basin Plans are adopted and amended by regional water boards under a structured process involving full public participation and State environmental review. Basin Plans and amendments thereto, do not become effective until approved by the State Water Resources Control Board (SWRCB). Regulatory provisions must be approved by the Office of Administrative Law (OAL). Adoption or revision of surface water standards is subject to the approval of the EPA.

Basin Plans complement other water quality control plans adopted by the SWRCB, such as the Water Quality Control Plans for Temperature Control and Ocean Waters. It is the intent of the SWRCB and the regional water boards to maintain the Basin Plans in an updated and readily available edition that reflects the current water quality control program. The objectives of these plans also are set to protect beneficial uses of the waterbodies including municipal uses such as drinking water. Adherence to the basin plan objectives allows for the continued use of the waterbodies to meet criteria, including drinking water treatment standards.

Several different regional water quality control plans govern waterbodies within the EWA Program area of analysis. The Central Valley Water Quality Control Plan (WQCP) covers an area including the entire Sacramento and San Joaquin river basins, involving an area bound by the crests of the Sierra Nevada on the east and the Coast Range and Klamath Mountains on the west. The area covered in this WQCP extends some 400 miles, from the California – Oregon border southward to the headwaters of the San Joaquin River. The Tulare Lake Basin WQCP comprises the drainage area of the San Joaquin Valley south of the San Joaquin River. The San Francisco Bay Regional WQCP covers all or major portions of Alameda, Contra Costa, Marin, Napa, San Mateo, San Francisco, Santa Clara, Solano, and Sonoma counties. The Los Angeles Regional WQCP encompasses all coastal drainages flowing to the Pacific Ocean between Ricon Point (on the coast of western Ventura County) and the eastern Los Angeles County line, as well as the drainages of the five coastal islands (Anacapa, San Nicolas, Santa Barbara, Santa Catalina, and San Clemente). In addition, the Los Angeles Regional WCQP includes all coastal waters within three miles of the continental and island coastlines. The Santa Ana Regional WQCP covers the smallest area of the nine WQCPs in California (2,800 square miles) and covers southern California, roughly between Los Angeles and San Diego. In very broad terms, the Santa Ana Regional WQCP covers a group of connected inland basins and open coastal basins drained by surface streams flowing generally southwestward to the Pacific Ocean. The Pacific Ocean coast of the area covered by the Santa Ana Regional WQCP extends from just north of Laguna Beach up to Seal Beach and to the Los Angeles County line.

5.1.2.6 Water Quality Control Plan for the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary

The San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Bay-Delta Estuary or Estuary) is important to the natural environment and economy of California. The watershed of the Bay-Delta Estuary provides drinking water to two-thirds of California's population and water for a multitude of other urban uses. Additionally, it supplies some of California's most productive agricultural areas, both inside and outside of the Estuary. The Bay-Delta Estuary itself is one of the largest ecosystems for fish and wildlife habitat and production in the U.S. However, historical and current human activities (e.g., water development, land use, wastewater discharges, introduced species, and harvesting), exacerbated by variations in natural conditions, have degraded the beneficial uses of the Bay-Delta Estuary, as evidenced by the declines in the populations of many biological resources of the Estuary (RWQCBCV 1998).

The Bay-Delta Estuary Plan provides the component of a comprehensive management package for the protection of the Estuary's beneficial uses that involves salinity (from saltwater intrusion and agricultural drainage) and water project operations (flows and diversions), as well as a dissolved oxygen objective. This plan supplements other water quality control plans adopted by the SWRCB and RWQCBs, and State policies for water quality control adopted by the SWRCB, relevant to the Bay-Delta Estuary watershed. These other plans and policies establish water quality standards and requirements for parameters such as toxic chemicals, bacterial contamination, and other factors which have the potential to impair beneficial uses or cause nuisance.

5.1.2.7 State Water Resources Control Board Decision 1641

The WQCP for the Bay-Delta Estuary contains the current water quality objectives. D-1641 and Order WR 2001-05 contain the current water right requirements to implement the Bay-Delta flow dependent objectives. D-1641 includes both long-term and temporary requirements. Order WR 2001-05 requires partial implementation that will remain in effect up to 35 years. In D-1641 and in Order WR 2001-05, the SWRCB assigned responsibilities, for specified periods, to water users (including the U.S. Bureau of Reclamation (Reclamation) and the Department of Water Resources (DWR) in D-1641, and DWR in Order WR 2001-05) in the watersheds of the San Joaquin River upstream of Vernalis, the Mokelumne River, Putah Creek, Cache Creek, within the boundaries of the North Delta Water Agency, and within the Bear River watershed. These responsibilities require that the water users in these watersheds will contribute specified amounts of water to protect water quality, and that DWR and/or Reclamation will ensure that the objectives are met in the Delta (SWRCB 1997).

5.1.2.8 DWR Non-Project Water Acceptance Criteria

DWR has developed acceptance criteria to govern the water quality of non-Project water that may be conveyed through the California Aqueduct. DWR will consult with SWP contractors and the Department of Health Services (DHS) on drinking water quality issues relating to non-Project water as needed to assure the protection of SWP water quality. DWR will use a two-tier approach for accepting non-Project water pumped into the California Aqueduct. Tier 1 programs have a "no adverse impact" criteria and are tied to historical water quality levels in the California Aqueduct. Programs meeting Tier 1 criteria will be approved by DWR. Tier 2 programs have water quality levels that exceed the historical water quality levels in the California Aqueduct and have potential to cause adverse effects to State water contractors. Tier 2 programs will be referred to a State water contract facilitation group for review. The facilitation group will review the program and, if needed, make recommendations to DWR to use during consideration of the project. For additional information regarding DWR Non-Project Water Acceptance Criteria, see Section 5.2.5.3.

5.1.2.9 U.S. Bureau of Reclamation Groundwater Acceptance Criteria

Reclamation has developed a set of criteria for accepting groundwater into the Delta Mendota Canal (DMC). Different criteria are used for the portion of the DMC above check 13 at mile post 70 and below check 13. The criteria for acceptance of groundwater into the DMC above check 13 at mile post 70 are illustrated in Table 5-3. The criteria for this portion of the DMC are set for the following beneficial uses: drinking water, agriculture, and aquatic life. The criteria for acceptance of groundwater into the DMC below check 13 are illustrated in Table 5-4. The criteria for this portion of the DMC are set for protecting for the following beneficial uses: agriculture and aquatic life.

Table 5-3
Water Quality Standards For Acceptance Of Groundwater Into Delta Mendota Canal Above Check 13 (mg/L)

Constituent	Water Quality Standard	Reporting Limit
Aluminum	0.087	0.01
Antimony	0.006	0.001
Arsenic	0.01	0.002
Barium	1	0.1
Beryllium	0.004	0.001
Boron	0.8	0.1
Cadmium	0.00025*	0.0001
Chloride	106	10
Chromium	0.05	0.01
Copper	0.009*	0.001
Cyanide	0.0052	0.002
Fluoride	2	0.1
Iron	0.3	0.01
Lead	0.0025*	0.0005
Manganese	0.05	0.01
Mercury	0.00077	0.0001
Molybdenum	0.019	0.001
Nickel	0.052*	0.001
Nitrates, $N0_3$	45	10
Selenium	0.0008	0.0004
Silver	0.0032*	0.001
Sodium	185 (8 me/l)	10
Specific Conductance	700**/900*** uS/cm	1 uS/cm
Sulfate	250	20
Thallium	0.002	0.0005
TDS	450**/500***	1
Turbidity	5 NTU	0
Zinc	0.12*	0.01

* Values are based on a hardness of 100mg/L; ** Irrigation season(01Apr-31Aug); *** Drinking Water

Table 5-3 Water Quality Standards For Acceptance Of Groundwater Into Delta Mendota Canal Above Check 13 (mg/L)		
Constituent	**Water Quality Standard**	**Reporting Limit**
(01Sept-31Mar)		
Drinking Water Standards for Radioactivity (pCi/L)***		
Gross Alpha	15	3
Radium-226 + Radium-228	5	1
Tritium	20000	1000
Strontium-90	8	2
Gross Beta	50	4
Uranium	20	2
*** Analyze for Gross Alpha, if it exceeds criteria then analyze the other constituents.		
Water Quality Standards for Organic Chemicals (mg/L)		
Alachlor	0.002	0.0005
Atrazine	0.001	0.0005
Bentazon	0.018	0.001
Benzo(a)pyrene	0.0002	0.0005
Benzene	0.001	0.0005
Carbofuran	0.005	0.001
Carbon tetrachloride	0.0005	0.0005
Chlorobenzene	0.02	0.0005
Chlorpyrifos	0.000014	0.00005
Chlordane	0.000004	0.0001
2, 4-D	0.07	0.001
Dalapon	0.11	0.001
DDT	0.000001	0.00001
Diazinon	0.00005	0.0001
Dibrmochloropane	0.0002	0.0005
1,2,-Dibromo-3-chlorpropane	0.0002	0.0005
1,2-Dichlorobenzene	0.6	0.0005
1,4-Dichlorobenzene	0.005	0.001
1,1-Dichloroethane	0.005	0.001
1,1-Dichloroethylene	0.006	0.001
cis-1,1-Dichloroethylene	0.006	0.001
trans-1,2-Dichloroethylene	0.01	0.001
1,2-Dichloroethane	0.0005	0.0001
Dichlormethane	0.005	0.001
1,2-Dichloropropane	0.005	0.001
1,3-Dichloropropene	0.0005	0.0005
Di(2-ethyl)adipate	0.4	0.005
Di(2-ethylhexyl)phtalate	0.004	0.0006
Dieldrin	0.000056	0.00001
Dinoseb	0.007	0.001
Diquat	0.0005	0.0004
Endrin	0.000036	0.00001
Endothal	0.1	0.001
Ethylbenzene	0.3	0.001
Ethylene Dibromide	0.00005	0.00002
Glyphosate	0.7	0.01
Heptachlor	0.000004	0.00001
Heptachlor Epoxide	0.000004	0.00002
Hexachlrobeneze	0.001	0.0005
Hexachlorocyclopentadiene	0.001	0.0005
Lindane	0.00008	0.0002
Methoxychlor	0.00003	0.00005
MTBE	0.005	0.003
Molinate	0.013	0.001
Monochlorobenzene	0.02	0.001

Table 5-3 *Water Quality Standards For Acceptance Of Groundwater Into Delta Mendota Canal Above Check 13 (mg/L)*		
Constituent	**Water Quality Standard**	**Reporting Limit**
Oxamyl	0.05	0.002
Picloram	0.5	0.01
PCBs	0.000014	0.0001
Simazine	0.01	0.0005
Styrene	0.1	0.001
1,1,2,2-Tetrachlroethane	0.001	0.0005
Tetrachloroethylene (PCE)	0.005	0.0001
Thiobencarb	0.001	0.0005
Toluene	0.04	0.0005
Toxaphene	2 x10-7	0.0005
1,2,4-Trichlorobenzene	0.005	0.0005
1,1,1-Trichloroethane	0.2	0.0005
1,1,2-Trichloroethane	0.005	0.0005
Trichloroethylene (TCE)	0.005	0.0005
Freon 11	0.15	0.001
Freon 113	1.2	0.001
Vinyl chloride	0.0005	0.0001
Xylenes (total)	1.75	0.0005
2,4,5-T	0.05	0.0005

Source: B. Moore, USBR, pers. comm.

Table 5-4 *Water Quality Standards For Acceptance Of Groundwater Into Delta Mendota Canal Below Check 13 (mg/L)*		
Constituent	**Water Quality Standard**	**Reporting Limit**
Boron	0.8	0.1
Chromium	0.074*	0.001
Chlorpyrifos	0.000014	0.00005
Copper	0.009*	0.001
Diazinon	0.00005	0.0001
Lead	0.0025*	0.0005
Mercury	0.00077	0.00005
Molybdenum	0.019	0.001
Nickel	0.052*	0.001
Selenium	0.0008	0.0004
Specific Conductance	700** / 1,000 ***uS/cm	0
TDS	450 **/ 650***	10
Turbidity	5 NTU	0.1
Zinc	0.12*	0.001

* Values are based on a hardness of 100mg/L; ** Irrigation Season (1th April - 31th August); *** Non Irrigation Season (1th Sept -31th Mar).
Source: B. Moore, USBR, pers. comm.

5.1.3 Constituents of Concern

Various waterbodies within the area of analysis have been identified as impaired for certain constituents, as listed on the 303(d) list under the CWA. CWA Section 303(d) requires states to identify waters that do not meet applicable water quality standards after the application of certain technology-based controls. As defined in the CWA and Federal regulations, water quality standards include the designated uses of a waterbody, the adopted water quality criteria, and the State's anti-degradation policy.

As defined in the Porter-Cologne Water Quality Control Act, water quality standards are beneficial uses to be made of a waterbody, the established water quality objectives (both narrative and numeric), and the State's non-degradation policy (SWRCB Resolution No. 68-16). A further description of the CWA and the 303(d) listings is contained in Section 5.1.2.3.

Certain waterbodies in the EWA Program area of analysis are listed as water quality limited (impaired) for one or more of the constituents of concern. Table 5-5 includes the names of listed waterbodies, the constituent of concern, the potential sources for each constituent, the estimated area that is affected, and the proposed TMDL completion date. This information comes from the RWQCB plans for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (Region 2), the Central Valley Basin (Region 5), the Tulare Lake Basin (Region 5), the Los Angeles Basin (Region 4), and the Santa Ana River Basin (Region 8). In addition to constituents of concern with regard to 303 (d) listed waterbodies, there are water quality constituents of concern with respect to drinking water. Water quality constituents of concern for drinking water that are relevant to the EWA Program include total trihalomethanes (chloroform, bromodichloro-methane, bromoform, and chlorodibromomethane).

Appendix G contains a description of each water quality constituent of concern including those constituents of concern for the 303 (d) listed waterbodies and the constituents of concern for drinking water. The description of each constituent includes: 1) what the constituent is and what it is commonly used for; 2) what happens to the constituent when it enters the environment; 3) how a person may be exposed to the constituent; 4) the potential health effects of exposure; 5) and the human exposure standards (EPA, Occupational Safety and Health Administration, National Institute of Occupational Safety and Health, and the Food and Drug Administration).

5.1.4 Beneficial Uses

Beneficial uses are critical to water quality management in California. State law defines beneficial uses of California's waters that may be protected against quality degradation to include (but not limited to) "...domestic; municipal; agricultural and industrial supply; power generation; recreation; aesthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources or preserves" (Water Code Section 13050(f)). Protection and enhancement of existing and potential beneficial uses are primary goals of water quality planning. Significant points concerning the concept of beneficial uses are:

1. All water quality problems can be stated in terms of whether there is water of sufficient quantity or quality to protect or enhance beneficial uses (RWQCBCV 1998).

Table 5-5 Constituents of Concern for 303(d) Listed Waterbodies				
Name	***Constituent***	***Potential Sources***	***Estimated Area Affected***	***Proposed TMDL Completion Year***
Shasta Lake	Cadmium	Resource Extraction	27335 acres	2011
	Copper	Resource Extraction	27335 acres	2011
	Zinc	Resource Extraction	27335 acres	2011
Sacramento River	Diazinon	Agriculture	274 miles	2003
	Mercury	Resource Extraction	274 miles	2005
	Unknown toxicity	Source Unknown	274 miles	After 2015
Lower Feather River	Diazinon	Agriculture/Urban Runoff/Storm Sewers	86 miles	2005
	Group A Pesticides [1]	Agriculture	86 miles	After 2015
	Mercury	Resource Extraction	86 miles	2011
	Unknown Toxicity	Source Unknown	86 miles	After 2015
Lower American River	Mercury	Resource Extraction	27 miles	After 2015
	Unknown Toxicity	Source Unknown	27 miles	After 2015
Merced River	Chlorpyrifos	Agriculture	51 miles	2005
	Diazinon	Agriculture	51 miles	2005
	Group A Pesticides [1]	Agriculture	51 miles	After 2015
San Joaquin River	Boron	Agriculture	127 miles	2003
	Chlorpyrifos	Agriculture	127 miles	2003
	DDT	Agriculture	127 miles	After 2015
	Diazinon	Agriculture	127 miles	2003
	Group A Pesticides [1]	Agriculture	127 miles	After 2015
	Mercury	Resource Extraction	127 miles	2003
	Unknown Toxicity	Source Unknown	127 miles	After 2015
Sacramento-San Joaquin Delta	Chlorpyrifos	Agriculture/Urban Runoff/ Storm Sewers	577,089 acres	2004
	DDT	Agriculture	180,568 acres	2011
	Diazinon	Agriculture/Urban Runoff/ Storm Sewers	577,089 acres	2004
	Mercury	Industrial Point Sources/ Municipal Point Sources/ Resource Extraction/ Atmospheric Deposition/ Nonpoint Sources	577,089 acres	2004
	Electrical Conductivity	Agriculture	180,568 acres	2011
	Group A Pesticides	Agriculture	180,568 acres	2011
	Organic Enrichment/Low Dissolved Oxygen	Municipal Point Sources/ Urban Runoff/Storm Sewers	1,751 acres	2004
	Unknown Toxicity	Source Unknown	1,751 acres	2011

Group A Pesticides: aldrin, dieldrin, endrin, chlordane, heptachlor, heptachlor expoxid, hexachlorocyclohexane, endosulfan, and toxaphehe
Sources: RWQCBCV 1998, RWQCBSA 1995, RWQCBLA 1994, RWQCBSFB 1995, SWRCB 2003.

2. Beneficial uses do not include all of the reasonable uses of water. For example, disposal of wastewaters is not included as a beneficial use. This is not to say that disposal of wastewaters is a prohibited use of waters of the State; it is merely a use, which cannot be satisfied to the detriment of beneficial uses. Similarly, the use of water for the dilution of salts is not a beneficial use although it may, in some cases, be a reasonable and desirable use of water (RWQCBCV 1998).

3. The protection and enhancement of beneficial uses require that certain quality and quantity objectives be met for surface and ground waters (RWQCBCV 1998).

4. Fish, plants, and other wildlife, as well as humans, use water beneficially.

The beneficial uses designated for waters within the EWA Program area of analysis are presented in Table 5-6 (Upstream from the Delta Region), Table 5-7 (Sacramento-San Joaquin Delta Region), and Table 5-8 (Export Service Area). Appendix G contains of beneficial use definitions. The beneficial uses of any specifically identified waterbody generally apply to its tributary streams. In some cases, a beneficial use may not be applicable to the entire body of water. In these cases the RWQCB's judgment is applied. Waterbodies within the basins that do not have beneficial uses designated are assigned MUN designations in accordance with the provisions of SWRCB Resolution No. 88-63. These MUN designations in no way affect the presence or absence of other beneficial uses in these waterbodies.

Table 5-6
Beneficial Uses of Waterbodies in the Upstream from the Delta Region

Beneficial Use Designation	*Lake Shasta*	*Sacramento River*	*Little Grass Valley and Sly Creek*	*Lake Oroville*	*Lower Feather River*	*New Bullards Bar Reservoir*	*Lower Yuba River*	*French Meadows Reservoir*	*Hell Hole Reservoir*	*Middle Fork American River*	*Folsom Reservoir*	*Lower American River*	*Lake McClure*	*Merced River*	*San Joaquin River*
Municipal and Domestic Supply	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓		✓	
Irrigation Watering	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Stock Watering		✓				✓	✓	✓	✓	✓				✓	✓
Industrial Process Supply														✓	✓
Industrial Service Supply		✓										✓		✓	
Hydropower Generation	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Water Contact Recreation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Canoeing and Rafting[1]		✓			✓	✓	✓	✓	✓	✓		✓		✓	✓
Non-contact Water Recreation	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Warm Freshwater Habitat[2]	✓	✓	✓	✓	✓		✓				✓	✓	✓	✓	✓
Cold Freshwater Habitat[2]	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Warm[3] and Cold[4] Water Migration Areas		✓			✓		✓					✓		✓	✓
Warm[3] and Cold[4] Water Spawning Habitat	✓	✓	✓	✓	✓		✓					✓		✓	✓
Warm Water Spawning Habitat[3]	✓	✓		✓	✓		✓				✓	✓		✓	✓
Cold Water Spawning Habitat[4]	✓	✓		✓	✓	✓	✓	✓	✓	✓		✓		✓	
Navigation		✓													
Wildlife Habitat	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Source: RWQCBCV 1998
1. Shown for streams and rivers only with the implication that certain flows are required for this beneficial use.
2. Resident does not include anadromous. Any segments with both COLD and WARM beneficial use designations will be considered COLD waterbodies for the application of water quality objectives.
3. Striped bass, sturgeon, and shad.
4. Salmon and steelhead.

Table 5-7
Beneficial Uses of Waterbodies in the Sacramento-San Joaquin Delta Region

Beneficial Use Designation	Delta Inland Surface Waters	San Francisco Bay Estuary	Delta Coastal Waters
Municipal and Domestic Supply	✓	✓	
Irrigation Watering	✓	✓	
Stock Watering			
Industrial Process	✓	✓	✓
Service Supply			
Groundwater Recharge	✓	✓	
Power Generation			
Water Contact Recreation	✓	✓	✓
Non-contact Water Recreation	✓	✓	✓
Warm Freshwater Habitat	✓	✓	
Cold Freshwater Habitat	✓	✓	
Fish Migration	✓	✓	
Fish Spawning Habitat	✓		
Navigation		✓	✓
Wildlife Habitat	✓	✓	
Estuarine Habitat		✓	
Shellfish Harvesting			✓
Ocean, Commercial and Sport Fishing			✓
Preservation of Rare and Endangered Species			✓
Marine Habitat			✓

Source: RWQCBSFB 1995

Table 5-8
Beneficial Uses of Waterbodies in the Export Service Area

Beneficial Use Designation	California Aqueduct	San Luis Reservoir	Castaic Lake	Lake Perris
Municipal and Domestic Supply	✓	✓	✓	✓
Agricultural Watering	✓	✓	✓	✓
Irrigation Watering	✓	✓		
Stock Watering	✓	✓		
Industrial Process	✓		✓	✓
Service Supply	✓	✓	✓	✓
Groundwater Recharge			✓	✓
Power Generation	✓	✓	✓	
Water Contact Recreation	✓	✓	✓	✓
Non-contact Water Recreation	✓	✓	✓	✓
Cold Freshwater Habitat			✓	✓
Warm Freshwater Habitat		✓	✓	✓
Fish Migration				
Warm Water Spawning Habitat			✓	
Cold Water Spawning Habitat			✓	
Navigation				
Wildlife Habitat	✓	✓	✓	✓
Estuarine Habitat				
Shellfish Harvesting				
Ocean, Commercial and Sport Fishing				
Preservation of Rare and Endangered Species			✓	
Marine Habitat				

Source: RWQCBSA 1995, RWQCBLA 1994, RWQCBCV 1998

5.1.5 Environmental Settings

The general water quality for each of the waterbodies evaluated in the area of analysis is described in the following sections. Environmental setting information varies by geographic area because individual waterbodies have different water quality concerns. For waterbodies in the Upstream from the Delta Region, a description of the location of each waterbody is provided and land use around each of the waterbodies is briefly described. Land use is described for each waterbody because it can affect the quality of runoff that the waterbody receives and therefore, the water quality of the waterbody itself. In addition, where available, data describing general water quality parameters including pH, turbidity, dissolved oxygen, TOC, total suspended solids, nitrogen, phosphorus, and electrical conductivity or total dissolved solids are presented to provide information regarding the general water quality within each waterbody. Environmental settings information in the Delta Region and in the Export Service Area is more extensive due to the greater potential for the EWA Program to affect water quality in these areas. General background describing water quality in the Delta is provided, followed by a detailed discussion of salinity, organic carbon, and bromide, which are constituents of concern with respect to drinking water. Settings information for reservoirs in the Export Service Area focus on water quality concerns such as algal growth and also includes data describing the general water quality parameters listed above where such data is available.

5.1.5.1 Upstream from the Delta Region

5.1.5.1.1 Sacramento River Area of Analysis

The Sacramento River basin covers nearly 70,000 square kilometers (km^2) in the north-central part of California (USGS 2002a). The basin includes all or parts of six physiographic provinces – the Great Basin, the Middle Cascade Mountains, the Sierra Nevada, the Klamath Mountains, the Sacramento Valley, and the Coast Ranges. Land cover in the mountainous parts of the basin is primarily forest, except in parts of the Coast Ranges and the Great Basin where land cover is forestland and rangeland. Previous mining activities in the Klamath Mountains have resulted in acid mine drainage into Keswick Reservoir, along with the associated metals cadmium, copper, and zinc. Mercury, from previous mining activities in the Coast Ranges, enters the Sacramento Valley through Cache Creek and Putah Creek, which drain into the Yolo Bypass. The Yolo Bypass reenters the lower Sacramento River through Cache Slough and during low-flow and storm water runoff conditions, mercury can be transported downstream to receiving waters.

<u>Lake Shasta</u>
Lake Shasta is located on the upper Sacramento River in the Shasta Trinity National Forest and is used as a storage facility for water from snowmelt in the upper Sierra Nevada Mountains.

General water quality parameters for Lake Shasta are summarized in Table 5-9. Water quality in Lake Shasta generally is considered to be of good quality.

Table 5-9 **Water Quality Parameters Sampled at Lake Shasta**			
Water Quality Parameter	***Minimum***	***Maximum***	***Average***
pH[1] (standard units)	7.2	8.1	7.5
Turbidity[2] (NTU)	0.0	1.0	0.52
Dissolved Oxygen[2] (mg/L)	8.2	11.5	9.94
Total Organic Carbon[1] (mg/L)	N/A	N/A	N/A
Nitrogen[1](mg/L)	0.01	0.54	0.093
Phosphorus[1](mg/L)	0.0	0.129	0.030
Electrical Conductivity[1] (µS/cm)	105	131	116.9

Sources: [1-]USGS 1980; [2-]CDEC 2002
N/A – not available

Sacramento River

The Sacramento River is the largest river in California, providing water for municipal, agricultural, recreation, and environmental purposes throughout northern and southern California. Water users that have contracts with Reclamation to take delivery of CVP water from the Sacramento River system receive Sacramento River contractor water. General water quality data reported for several locations along the Sacramento River are presented below in the following sections and in Tables 5-10 through 5-12.

Sacramento River Above Bend Bridge Near Red Bluff

The Sacramento River sampling site above Bend Bridge near Red Bluff is located 83.7 km downstream of Shasta Dam. Streamflow is greatly influenced by managed releases from Lake Shasta and, during the rainy season, by storm water runoff. There are no artificial levees at this location; therefore, the stream channel is in a natural state. The drainage basin area at this site is 23,569 km^2 and includes parts or all of the Great Basin, Middle Cascade Mountains, Klamath Mountains, Coast Ranges, and Sacramento Valley physiographic provinces. Land cover in the area is mainly forestland; cropland, pasture and rangeland cover most of the remaining land area. Mining operations take place or have taken place in the Klamath Mountains and water quality effects from mining activities are likely to be detected at this location (USGS 2002a). Over a three-year period (1996-1998); 27 samples were taken. The data in Table 5-10 present the general water quality parameters.

Table 5-10 **Water Quality Parameters Sampled at Sacramento River Above Bend Bridge Near Red Bluff**			
Water Quality Parameter	***Minimum***	***Maximum***	***Average***
pH (standard units)	7.4	8.1	7.8
Turbidity (mg/L)	3	355	38.8
Dissolved Oxygen (mg/L)	8.2	12.1	10.7
Total Organic Carbon (mg/L) [1]	0.9	3.2	1.55
Nitrogen (mg/L) [1]	0.07	0.25	0.12
Phosphorus (mg/L) [1]	0.01	0.03	0.02
Electrical Conductivity[1] (µS/cm)	104	145	116.7

Sources: USGS 2002f, [1] USGS 2002e

Sacramento River at Freeport

The Sacramento River sampling site at Freeport is the furthest downstream monitoring site reported on the Sacramento River. Therefore, water-quality samples at this site integrate the effects of most land uses or land covers and physiographic provinces of the entire watershed. Forestland is the largest land use cover (USGS 2002a). The data in Table 5-11 present the general water quality parameters for samples collected over a three-year period (1996-1998); 31 samples were taken.

Table 5-11
Water Quality Parameters Sampled at Sacramento River at Freeport

Water Quality Parameter	Minimum	Maximum	Average
pH (standard units)	7	8.1	7.7
Turbidity (mg/L)	12	368	53.9
Dissolved Oxygen (mg/L)	6.5	12.2	9.7
Total Organic Carbon (mg/L) [1]	0.3	3.7	1.7
Nitrogen (mg/L) [1]	0.058	0.257	0.13
Phosphorus (mg/L) [1]	0.010	0.04	0.017
Electrical Conductivity[1] (µS/cm)	51	166	124.3

Sources: USGS 2002h; [1]USGS 2002g

For information regarding environmental settings for the Sacramento River at Greenes Landing/Hood, please see Section 5.1.5.2. Information regarding the Sacramento River's contribution to salinity, bromide and organic carbon loading to the Delta can be found in Section 5.1.5.2.1.

5.1.5.1.2 Feather River Area of Analysis

The Feather River is a large tributary to the Sacramento River. Flow in the lower Feather River is controlled mainly by releases from Lake Oroville, the second largest reservoir within the Sacramento River basin, and by flow from the Yuba River, a major tributary. Forestland is the major (about 78 percent of total) land use or land cover for the Feather River basin. Gold mining also was an important land use in the Sierra Nevada foothills that are part of the Feather River basin. The Yuba and the Bear rivers both flow into the lower Feather River. Both the Yuba River and the Bear River basins have been affected by past gold mining and contribute mercury to the lower Feather and Sacramento rivers (May et. al. 2000).

Little Grass Valley and Sly Creek Reservoirs
Little Grass Valley and Sly Creek reservoirs are upstream of Lake Oroville on the Feather River. Almost the entire surrounding watershed consists of the Plumas National Forest and managed forest lands; less than five percent of the watershed consists of rural residential and commercial areas. Evidence from a 1995 Watershed Sanitary Survey conducted on the watershed and current analytical data identify forest management practices and historic and active mining operations as potential sources of contaminants to the watershed. However, currently these waterbodies are not included on the CWA 303(d) list. Land uses surrounding the reservoirs are low impact, consisting of campgrounds, hiking trails, and access roads.

Both of these reservoirs are on the upper South Fork of the Feather River and receive their water from this source. Because data detailing concentrations of water quality constituents in Little Grass Valley and Sly Creek reservoirs were not available, water quality data from the South Fork of the Feather River downstream of both reservoirs is presented below. The minimum and maximum levels of pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and electrical conductivity or total dissolved solids that currently exist in the South Fork of the Feather River at Mining Ranch Canal are presented in Table 5-12.

Table 5-12
Water Quality Parameters Sampled on the South Fork Feather River at Miners Ranch Canal

Water Quality Parameter	***Minimum***	***Maximum***
pH (standard units)	7	7.3
Turbidity (mg/L)	0.5	14
Dissolved Oxygen (mg/L)	9.4	12.9
Total Organic Carbon (mg/L)	N/A	N/A
Nitrogen (mg/L)	less than 0.1	0.1
Phosphorus (mg/L)	less than 0.1	0.1
Electrical Conductivity (µS/cm)	34	54

Source: DWR 2001c
N/A – not available

<u>Lake Oroville</u>

Lake Oroville is primarily used for water supply, power generation, flood control, fish and wildlife enhancement, and recreational purposes (DWR 2001c). Water quality in Lake Oroville is influenced by tributary streams, of which the Middle, North, and South forks of the Feather River contribute the bulk of the inflow to the reservoir. The minimum and maximum levels of general water quality parameters: pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and electrical conductivity or total dissolved solids in Lake Oroville are presented in Table 5-13. All of the data were sampled near the dam at Lake Oroville and samples were taken bimonthly from January 1992 to May 1997.

Table 5-13
Water Quality Parameters Sampled at Lake Oroville

Water Quality Parameter	***Minimum***	***Maximum***
pH (standard units)	6.8	7.4
Turbidity (mg/L)	0.58	25
Dissolved Oxygen (mg/L)	7.8	12
Total Organic Carbon (mg/L)	N/A	N/A
Nitrogen (mg/L)	0.01	0.13
Phosphorus (mg/L)	0.01	0.57
Electrical Conductivity (µS/cm)	31	85

Source: DWR 2001c
N/A – not available

<u>Lower Feather River</u>

The minimum, maximum, and average levels of water quality constituents for the lower Feather River are presented in Table 5-14. All of the data were sampled on the Feather River near Nicolaus, California over a three-year period (1996-1998); 27 samples were taken.

Table 5-14 Water Quality Parameters Sampled on the Feather River Near Nicolaus			
Water Quality Parameter	**Minimum**	**Maximum**	**Average**
pH (standard units)	7.4	8.4	7.7
Turbidity (mg/L)	8	123	36.5
Dissolved Oxygen (mg/L)	9	15.7	10.1
Total Organic Carbon (mg/L)[1]	1.2	3.2	1.7
Nitrogen (mg/L)[1]	0.05	1.63	0.15
Phosphorus (mg/L) [1]	0.010	0.02	0.013
Electrical Conductivity (µS/cm)	56	122	84.7

Sources: USGS 2002a, [1] USGS 2002b

5.1.5.1.3 Yuba River Area of Analysis

The Yuba River is the largest tributary to the Feather River. Forestland is the primary land use and land cover for the Yuba River basin, comprising about 85 percent of the land cover (USGS 2002a). The forestland in the Yuba River Basin is located in the foothills of the Sierra Nevada, which also experienced a substantial amount of gold mining, including placer and hard rock mines. Mercury was used in the basin to recover gold from both placer deposits and ore-bearing minerals. Residual mercury from those operations has been detected in invertebrate and fish communities nearby and downstream from the gold mining operations (Slotton *et al.* 1997; May *et al*. 2000). According to Slotton *et al*., (1997), reservoirs constructed just downstream from the gold mining operations act as a sink for mercury. However, mercury transported to the lower Yuba drainage prior to reservoir construction probably is still in the streambed sediment.

New Bullards Bar Reservoir

New Bullards Bar Reservoir on the North Yuba River is approximately 21 miles north of Nevada City, in Yuba County. The average levels of pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and electrical conductivity or total dissolved solids for New Bullards Bar Reservoir are presented in Table 5-15. All of the data were collected on the North Fork of the Yuba River near New Bullards Bar Reservoir. The total organic carbon, nitrogen, and phosphorus samples all were taken during an eight-month period during 2001 and a total of seven samples were taken for each. The other parameters were sampled over a 12-month period during the course of one year and a total of seven samples were taken for each.

Table 5-15 Water Quality Parameters Sampled on the North Yuba River Near New Bullards Bar Reservoir			
Water Quality Parameter	**Minimum**	**Maximum**	**Average**
pH (standard units)	7.0	8.1	7.2
Turbidity (mg/L)	0	44.7	11.5
Dissolved Oxygen (mg/L)	8.3	12.3	9.9
Total Organic Carbon (mg/L)[1]	0.59	2.6	1.3
Nitrogen (mg/L) [1]	0.025	0.050	0.04
Phosphorus (mg/L)[1]	0.004	0.006	0.011
Electrical Conductivity (µS/cm)	20	30	23.8

Sources: SYRCL 2002; [1]USGS 2001

Lower Yuba River

The general water quality of the lower Yuba River is good and has improved in recent decades due to controls on hydraulic and dredge mining operations, and the establishment of minimum instream flows (Beak 1989 *in* SWRI 2000). Dissolved oxygen concentrations, total dissolved solids, pH, hardness, alkalinity, and turbidity are well within acceptable or preferred ranges for salmonids and other key freshwater biota.

The minimum, maximum, and average levels of pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and electrical conductivity for the lower Yuba River are presented in Table 5-16. All of the data were collected on the Yuba River near Marysville over a three-year period (1996-1998); 27 samples were taken.

Table 5-16
Water Quality Parameters Sampled on the Yuba River Near Marysville

Water Quality Parameter	Minimum	Maximum	Average
pH (standard units)	7	7.8	7.5
Turbidity (mg/L)	1	153	29.9
Dissolved Oxygen (mg/L)	8	12.4	11.4
Total Organic Carbon (mg/L)[1]	0.7	2.4	1.1
Nitrogen (mg/L)[1]	0.05	0.137	0.07
Phosphorus (mg/L)[1]	0.01	0.02	0.01
Electrical Conductivity (µS/cm)	44	105	72.8

Sources: USGS 2002c ; [1]USGS 2002d

5.1.5.1.4 *American River Area of Analysis*

The American River is a large tributary to the Sacramento River. Forestland constitutes the greatest percentage of land use or land cover (77 percent). Gold mining also occurred within the American River basin. Placer gold was first discovered in the American River in 1848, triggering the exploration and mining of gold that followed. The lower American River is listed as an impaired waterbody owing to mercury lost during gold recovery.

French Meadows Reservoir

French Meadows Reservoir is on the Middle Fork of the American River in Placer County. Water quality in French Meadows Reservoir is generally considered to be of good quality. The average levels of pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and electrical conductivity for French Meadows Reservoir are presented in Table 5-17.

Table 5-17
Water Quality Parameters Sampled at French Meadows Reservoir

Water Quality Parameter	Average
pH (standard units)	7.31
Turbidity (mg/L)	0.4
Dissolved Oxygen (mg/L)[1]	9.60
Total Organic Carbon (mg/L)	1.24
Nitrogen (mg/L) [1]	0.11
Phosphorus (mg/L)	1.1
Electrical Conductivity (µS/cm)	25.60

Sources: Storet 1985; [1] Storet 1981

Hell Hole Reservoir

Hell Hole Reservoir, in the El Dorado National Forest, receives flows from the Rubicon River, a tributary of the Middle Fork American River. Water quality in Hell Hole Reservoir is generally considered to be of good quality. The average levels of pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and electrical conductivity within Hell Hole Reservoir are presented in Table 5-18.

Table 5-18
Water Quality Parameters Sampled at Hell Hole Reservoir

Water Quality Parameter	***Average***
pH (standard units) [1]	7.10
Turbidity (mg/L)	N/A
Dissolved Oxygen (mg/L)	9.60
Total Organic Carbon (mg/L)	N/A
Nitrogen (mg/L)	0.11
Phosphorus (mg/L)	0.01
Electrical Conductivity (µS/cm) a	26.00

Sources: Storet 1985; [1]Storet 1969
N/A – not available

Middle Fork American River

Water quality in the Middle Fork American River is generally considered to be of good quality. The average levels of pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and electrical conductivity for the Middle Fork American River are presented in Table 5-19.

Table 5-19
Water Quality Parameters Sampled on the Middle Fork American River

Water Quality Parameter	***Average***
pH (standard units)	7.50
Turbidity (mg/L)	0.40
Dissolved Oxygen (mg/L)	9.60
Total Organic Carbon (mg/L)	N/A
Nitrogen (mg/L)	0.11
Phosphorus (mg/L)	0.01
Electrical Conductivity (µS/cm)	49.00

Source: Storet 1981
N/A – not available

Folsom Reservoir

Folsom Reservoir is about 25 miles east of the city of Sacramento on the American River. Folsom Reservoir regulates runoff from about 1,875 square miles of drainage area. The average levels of pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and total dissolved solids within Folsom Reservoir are presented in Table 5-20.

Table 5-20 Water Quality Parameters Sampled at Folsom Reservoir			
Water Quality Parameter	**Minimum**	**Maximum**	**Average**
PH (standard units)	5.82	8.46	7.09
Turbidity (mg/L)	1	68	1.2
Dissolved Oxygen (mg/L)	7.04	13.6	10.3
Total Organic Carbon (mg/L)	2	3.5	N/A
Nitrogen (mg/L)	N/A	N/A	N/A
Phosphorus (mg/L)	N/A	N/A	N/A
Electric Conductivity (µS/cm)	18.5	123	52.2

Source: Larry Walker Associates 1999

Lower American River

The lower American River is a tributary to the Sacramento River. Water quality in the lower American River is generally considered to be of good quality. The average levels of pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and total dissolved solids for the lower American River are presented in Table 5-21.

Table 5-21 Water Quality Parameters Sampled on the Lower American River			
Water Quality Parameter	**Minimum**	**Maximum**	**Average**
pH (standard units)	7.0	7.7	7.4
Turbidity (mg/L)	2	116	13.9
Dissolved Oxygen (mg/L)	8.2	12.8	5.1
Total Organic Carbon (mg/L) [1]	1.1	6.4	1.7
Nitrogen (mg/L)[1]	0.05	0.2	0.08
Phosphorus (mg/L) [1]	0.01	0.03	0.012
Total Dissolved Solids (mg/L)	40	68	51.1

Sources: USGS 2002i; [1] USGS 2002j

5.1.5.1.5 Merced River Area of Analysis

The Merced River is a tributary to the San Joaquin River; its watershed extends into the Sierra Nevada Mountains. Historical land uses within the basin include aggregate and mineral mining operations that eroded adjacent lands. Currently, much of the land within the basin is used for agriculture and the lower Merced River is known to receive a high volume of agricultural field inflows.

Lake McClure

Lake McClure is on the Merced River. No water quality data was available for Lake McClure. The average levels of pH, turbidity, dissolved oxygen, total organic carbon, nitrogen, phosphorus, and electrical conductivity presented in Table 5-22 were collected on the Merced River, which is just above Lake McClure. The samples were taken over a 22-year period from 1972 through 1990. The numbers of samples taken for each parameter are shown in the table.

Table 5-22 Water Quality Parameters Sampled on the Merced River Near Briceberg	
Water Quality Parameter	**Average**
pH (standard units)	7.2 (59 samples)
Turbidity (mg/L)	2 (7 samples)
Dissolved Oxygen (mg/L)	10.4 (40 samples)
Total Organic Carbon (mg/L)	1.6 (7 samples)
Nitrogen (mg/L)	0.16 (25 samples)
Phosphorus (mg/L)	0.02 (34 samples)
Electrical Conductivity (µS/cm)	43 (58 samples)

Source: Kratzer and Shelton 1998

<u>Merced River</u>
The minimum, maximum, and average levels of water quality constituents for the Merced River are presented in Table 5-23, as available. All the samples were taken on the Merced River near Stevinson (near the mouth of the Merced River) over a 22-year period from 1972 through 1990. The number of samples taken for each parameter is shown in the tables.

Table 5-23 Water Quality Parameters Sampled on the Merced River Near Stevinson			
Water Quality Parameter	**Minimum**	**Maximum**	**Average**
pH (standard units)	N/A	N/A	7.6 (60 samples)
Turbidity (mg/L)	7	30	21 (50 samples)
Dissolved Oxygen (mg/L)	N/A	N/A	8.4 (56 samples)
Total Organic Carbon (mg/L)	N/A	N/A	2.9 (42 samples)
Nitrogen (mg/L)	2.4	0.8	1.9 (57 samples)
Phosphorus (mg/L)	0.15	0.04	0.08 (57 samples)
Electrical Conductivity (µS/cm)	N/A	N/A	189 (60 samples)

Source: Kratzer and Shelton 1998
N/A – not available

5.1.5.1.6 San Joaquin River Area of Analysis

The primary land use in the valley area around the San Joaquin River is agricultural. Nutrient and suspended sediment concentrations in surface water are highest along the west side of the river. Most suspended sediment in the river comes from a variety of sources, including: agricultural drainage, wastewater treatment plants, and runoff from dairies. Flow-adjusted nitrate concentrations have increased steadily in the lower San Joaquin River since the 1950s (Kratzer and Shelton 1998). This can be attributed to many factors, including increases in subsurface agricultural drainage, fertilizer application, wastewater treatment plant effluent, and runoff from dairies. Since 1970, this increase has been due primarily to increases in mostly native soil nitrogen in sub-surface agricultural drainage. Flow-adjusted ammonia concentrations decreased during the 1980s and these decreases are probably related to improved regulation of domestic and dairy wastes (Kratzer and Shelton 1998).

The minimum, maximum, and average levels of water quality constituents for the San Joaquin River are presented in Tables 5-24 and 5-25. The number of samples taken for each parameter is presented in the tables. Samples were taken on the San Joaquin River near Newman (near the confluence of the San Joaquin and Merced rivers) over a 22-year period from 1972 through 1990 (Table 5-24).

Table 5-24 Water Quality Parameters Sampled on the San Joaquin River Near Newman			
Water Quality Parameter	***Minimum***	***Maximum***	***Average***
pH (standard units)	N/A	N/A	8.0 (57 samples)
Turbidity (mg/L)	35	500	103 (45 samples)
Dissolved Oxygen (mg/L)	N/A	N/A	9.2 (31 samples)
Total Organic Carbon (mg/L)	N/A	N/A	6.8 (41 samples)
Nitrogen (mg/L)	1.4	4.8	3.1 (53 samples)
Phosphorus (mg/L)	0.14	0.5	0.26 (54 samples)
Electrical Conductivity (µS/cm)	N/A	N/A	1,190 (57 samples)

Source: Kratzer and Shelton 1998.
N/A – not available

Samples taken on the San Joaquin River near Vernalis are presented in Table 5-25.

Table 5-25 Water Quality Parameters Sampled on the San Joaquin River Near Vernalis			
Water Quality Parameter	***Minimum***	***Maximum***	***Average***
pH (standard units)	7.0	9.0	8.2
Turbidity (mg/L) [1]	45	180	77 (3,503 samples)
Dissolved Oxygen (mg/L)	7.3	N/A 12.9	9.6
Total Organic Carbon (mg/L)	7.0	17	10.1
Nitrogen (mg/L) [1]	1.0	3.2	2.2 (501 samples)
Phosphorus (mg/L) [1]	0.14	0.38	0.24 (480 samples)
Electrical conductivity (µS/cm)	N/A	N/A	320

Source: USGS 2003 (samples taken monthly from 1995-2000); [1]Kratzer and Shelton 1998 (samples taken 22-year period from 1972 – 1990).
N/A – not available

For information regarding environmental settings for the portion of the San Joaquin River at Vernalis/Mossdale, please see 5.1.5.2 Information regarding the San Joaquin River's contribution to salinity, bromide and organic carbon loading to the Delta can be found in Section 5.1.5.2.1.

5.1.5.2 Sacramento-San Joaquin Delta Region

The Sacramento-San Joaquin Delta (Delta) Region forms the lowest part of the Central Valley, bordering and lying between the Sacramento and San Joaquin rivers, and extending from the confluence of these rivers inland as far as Sacramento and Stockton. The Delta is an important agricultural area, with more than 75 percent of the region's total production used for corn, grain, hay, and pasture. Although much of the Delta is used for agriculture, the land also provides habitat for wildlife. Many agricultural fields are flooded in the winter, providing foraging and roosting sites for migratory waterfowl. In addition to lands that are used seasonally, the California Department of Fish and Game (CDFG) manages thousands of acres specifically for wildlife including Lower Sherman Island and White Slough Wildlife Areas, Woodbridge Ecological Reserve, and Palm Tract Conservation Easement (SWRCB 1997).

Because water quality in the Delta Region is governed in part by Delta hydrodynamics, which are highly complex, the following paragraphs provide a brief description of the hydrodynamic conditions in the Delta. This description provides proper context for understanding potential effects to water quality that could result from implementation of the EWA Program. A discussion of general water quality in the Delta and water quality constituents of concern with respect to drinking water is provided following the description of Delta hydrodynamics.

The principal factors affecting Delta hydrodynamic conditions are: 1) river inflow from the San Joaquin and Sacramento River systems, 2) daily tidal inflow and outflow through the San Francisco Bay, and 3) export pumping from the south Delta through the Harvey O. Banks Pumping Plant and Tracy Pumping Plant. Because tidal inflows are approximately equivalent to tidal outflows during each daily tidal cycle, tributary inflows and export pumping are the principal variables that define the range of hydrodynamic conditions in the Delta. Freshwater flows into the Delta from three major sources: the Sacramento River, the San Joaquin River, and the eastside streams. The Sacramento River contributes about 77 percent of the freshwater flows, the San Joaquin River contributes roughly 15 percent, and streams on the east side provide the remainder. On average, 10 percent of the Delta inflow is withdrawn for local use, 30 percent is withdrawn for export by the CVP and SWP, 20 percent is required for salinity control, and the remaining 40 percent provides outflow to the San Francisco Bay ecosystem in excess of minimum identified requirements (CALFED 2000a).

Flow that enters the Delta via the Sacramento River flows by various routes to the export pumps in the southern Delta. Some of this flow is drawn to the SWP and CVP pumps through interior Delta channels, facilitated by the CVP's Delta Cross Channel. Water that does not travel into the Central Delta continues towards the San Francisco Bay. Under certain conditions, additional Sacramento River waters flow into the Central and South Delta. The Sacramento River waters flow through Threemile Slough, around the western end of Sherman Island and up the San Joaquin River towards the export pumps. When freshwater outflow is relatively low, water with a higher salt concentration enters the Central and South Delta as tidal inflow from the San Francisco Bay. When SWP and CVP exports cause flow from the Sacramento River to move toward the pumps, then "reverse flow" occurs in the lower San Joaquin River. Prolonged reverse flow has the potential to adversely affect water quality in the Delta and at the export pumps by increasing salinity (SWRCB 1997, Entrix 1996, CALFED 2002a).

5.1.5.2.1 Delta Drinking Water Quality Concerns

Appendix G describes the constituents of concern in the Delta. The existing water quality constituents of concern in the Delta can be categorized broadly as metals, pesticides, nutrient enrichment and associated eutrophication, constituents associated with suspended sediments and turbidity, salinity, bromide, and organic carbon. Water quality constituents that are of specific concern with respect to drinking water, including salinity, bromide, and organic carbon, are described below and further detailed in Appendix G. Table 5-26 presents water quality data for salinity, bromide, and organic carbon at selected stations within the Delta.

Salinity

Salinity is measures using a variety of methods. Salinity is a measure of the mass fraction of salts, measured in parts per thousand (ppt). Total dissolved solids (TDS) is a measure of the concentration of salt, as measured in mg/L (DWR 2001b). Electrical conductivity is a measure of the ability of a solution to carry a current and depends on the total concentration of ionized substances dissolved in the water. Because electrical conductivity (EC) of water generally changes proportionately to changes in dissolved salt concentrations, EC is a convenient surrogate measure for TDS.

Table 5-26 illustrates that mean TDS concentrations are highest in the west Delta and the south Delta channels which are affected by the San Joaquin River (CALFED 2000a). Salinity problems in the western Delta result primarily from the incursion of saline water from the San Francisco Bay system, and incursion of saline water to the western Delta may affect municipal and industrial uses (SWRCB 1997). The extent of seawater intrusion into the Delta is a function of daily tidal fluctuations, the freshwater inflow to the Delta from the Sacramento and San Joaquin rivers, the rate of export at the SWP and CVP intake pumps, and the operation of various control structures such as the Delta Cross-Channel Gates and Suisun Marsh Salinity Control System (DWR 2001b). In the southern Delta, salinity is largely associated with the high concentrations of salts carried by the San Joaquin River into the Delta (SWRCB 1997). The high mean concentration of TDS in the San Joaquin River at Vernalis reflects the accumulation of salts in agricultural soils and the effects of recirculation of salts via the Delta Mendota Canal (CALFED 2000a). Locations in the north portion of the Delta at Barker Slough, which is not substantially affected by seawater intrusion, and in the Sacramento River at Greene's Landing have lower mean concentrations of TDS. A similar pattern is seen using mean EC levels as a surrogate for TDS.

Table 5-26
Water Quality Data for Selected Stations Within the Delta

Location	***Mean TDS (mg/L)***	***Mean Electrical Conductivity (µS/cm)***	***Mean Bromide, Dissolved (mg/L)***	***Mean DOC (mg/L)***	***Mean Chloride, Dissolved (mg/L)***
Sacramento River at Greene's Landing	100	160	0.018	2.5	6.8
North Bay Aqueduct at Barker Slough	192	332	0.015	5.3	26
SWP Clifton Court Forebay	286	476	0.269	4.0	77
CVP Banks Pumping Plant	258	482	0.269	3.7	81
Contra Costa Intake at Rock Slough	305	553	0.455	3.4	109
San Joaquin River at Vernalis	459	749	0.313	3.9	102

Source: CALFED 2000a
mg/L = milligram per liter.
µS/cm = microsiemen per centimeter
Sampling period varies, depending on location and constituent, but generally is between 1990 and 1998.

Water quality data collected between 1996 and 1999 show that TDS levels at Banks Pumping Plant, in the Sacramento River at Hood, and in the western Delta at Old River at Station 9 never exceeded the secondary MCL for drinking water of 500 mg/L

(Table 5-27) (DWR 2001b). In the San Joaquin River near Vernalis, only 6 out of the 143 samples exceeded the secondary MCL for TDS. The secondary MCL for chloride is 250 mg/L, and the secondary MCL for electrical conductivity is 900 μS/cm. Because TDS is a measure of the total dissolved solids and does not measure the relative contribution of individual constituents such as chloride and bromide, it is possible to meet the secondary TDS MCL for (500 mg/L) but still exceed a standard for an individual salt constituent such as chloride (250 mg/L) (DWR 2001b). Because of this and because of their importance in formation of DBPs, chloride and bromide are addressed in detail in the following sections and Appendix G.

Table 5-27
Comparison of Total Dissolved Solids Concentrations at Selected Stations Within the Delta

TDS (mg/L)	***Sacramento River at Greenes/Hood***	***Old River at Station 9***	***Banks Pumping Plant***	***San Joaquin River Near Vernalis/Mossdale***
Mean	95	200	195	273
Median	92	173	182	261
Low	50	107	116	83
High	404	450	388	578
# of Detects/Samples	131/131	40/40	27/27	143/143

Source: DWR 2001b
TDS detection limit = 1.0 mg/L
Samples collected between 1996 and 1999

The seasonal changes in chloride concentrations at three locations are illustrated in Figure 5-2. The data represented in Figure 5-2 illustrate the median, 25th-percentile, and 75th-percentile chloride concentrations at the Banks Pumping Plant (Clifton Court), the Tracy Pumping Plant, and the Los Vaqueros Old River Intake for each month of the year. The lowest median concentrations of chloride typically occur in spring and early summer (March through July). The long-term monthly median concentrations of chloride for the period of record occurring under the Baseline Condition do not exceed the secondary MCL for chloride of 250 mg/L.

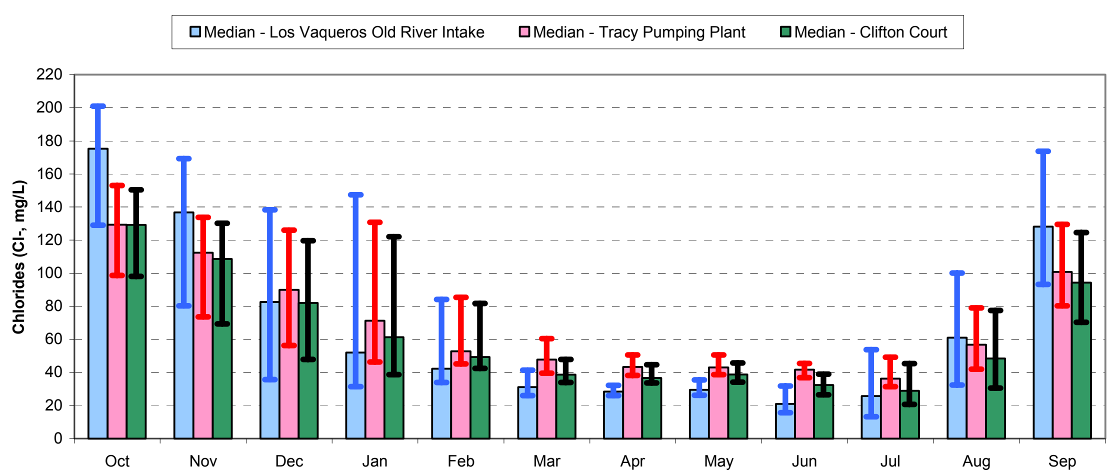
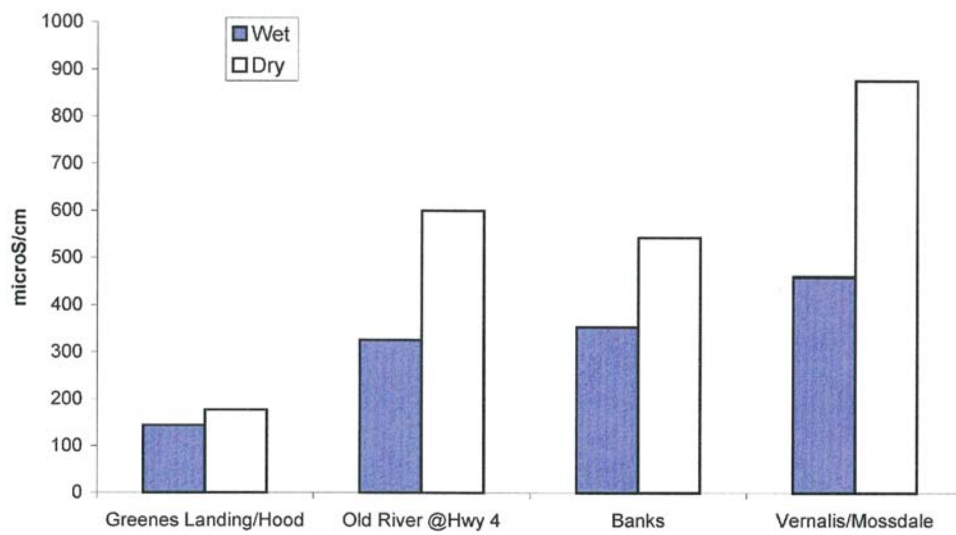


Figure 5-2
Long-term monthly median concentrations of chloride at Banks Pumping Plant (Clifton Court), Tracy Pumping Plant, and the Los Vaqueros Old River Intake under the Baseline Condition
Note: Bars represent the median and errors bars represent the 25th-percentile and 75th-percentile chloride concentrations.

Salinity patterns in the Delta also vary with water year type (DWR 2001b). As shown in Figure 5-3, salinity as measured by EC, a surrogate for TDS, is higher in dry years than in wet years (DWR 2001b). For the purpose of Figure 5-3, wet years are a combination of wet and above normal water year types and dry years are a combination of dry and critical water year types (DWR 2001b). In addition, a DWR project report (DWR 2000 *as cited in* DWR 2001b) found that EC levels generally were higher during low Delta outflows as compared to medium or high Delta outflows (DWR 2001b).



Source: DWR 2001b.

Figure 5-3
Average Electrical Conductivity (μS/cm) by Year Type at Selected Sites in the Sacramento-San Joaquin Delta (most samples collected monthly between 1990-1998)

<u>Bromide</u>

Bromides are formed by the reaction of bromine or a bromide with another substance and are widely distributed in nature (Columbia Encyclopedia 2003). For example, magnesium bromide, found in seawater, is a source of pure bromine (Columbia Encyclopedia 2003). Bromide is important from a drinking water perspective because during chlorination for disinfection of drinking water, bromide reacts with natural organic compounds in the water to form trihalomethanes. Four species of trihalomethanes (THMs) are regulated in drinking water including chloroform, bromodichloromethane, dibromochloromethane, and bromoform.

The recently announced requirements under the Stage 1 D/DBPR require lower levels of bromate in drinking water (0.010 mg/L) than previously required (see Table 5-1). The LT1ESWTR requires additional disinfection, primarily pathogens such as *Cryptosporidium* and *Giardia*, and the requirement for increased disinfection has the potential to increase the quantity of disinfection by-product formed during disinfection. In order to meet stringent EPA drinking water standards, CALFED has proposed that the concentration of bromide levels at export pumps not exceed 0.05 mg/L (DWR 2001b). However, this recommendation is a non-enforceable target level.

The primary source of bromide in Delta waters is sea-water intrusion (CALFED 2000a). Other sources of bromide include drainage returns in the San Joaquin River and within the Delta, connate water beneath some Delta Islands, and possibly agricultural applications of methyl bromide (CALFED 2000a). The San Joaquin River and agricultural irrigation sources are primarily a "recirculation" of bromide that originated from sea-water intrusion (CALFED 2000a). As shown in Table 5-26, TDS, EC, bromide and chloride data indicate that seawater intrusion is highest in the western and southern portions of the Delta, where the direct effects of seawater intrusion and the effects of recirculated bromide from the San Joaquin River exist (DWR 2001b).

In addition to varying geographically within the Delta, bromide varies seasonally, in a pattern similar to that exhibited by salinity. The data represented in Figure 5-4 illustrate the median, 25th-percentile, and 75th-percentile bromide concentrations at the Banks Pumping Plant (Clifton Court), the Tracy Pumping Plant, and the Los Vaqueros Old River Intake for each month of the year. The lowest median concentrations of bromide typically occur in spring and early summer (March through July).

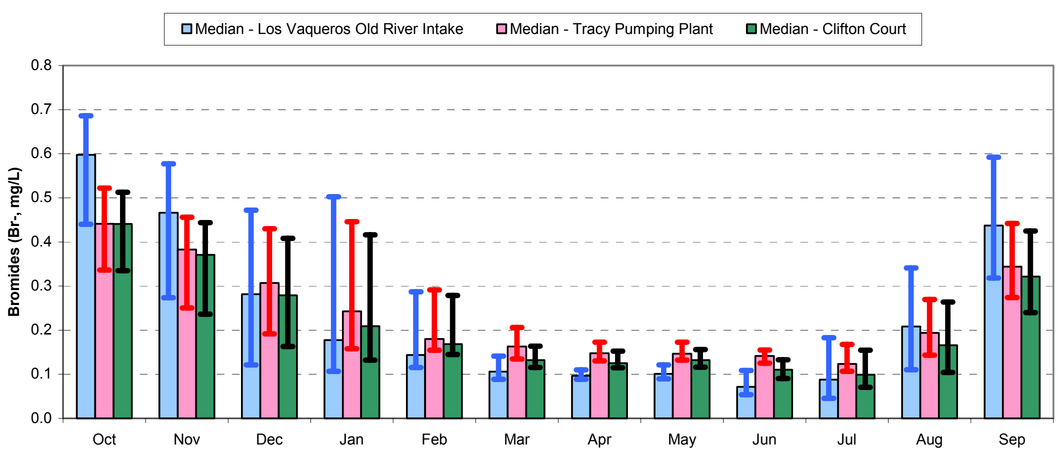
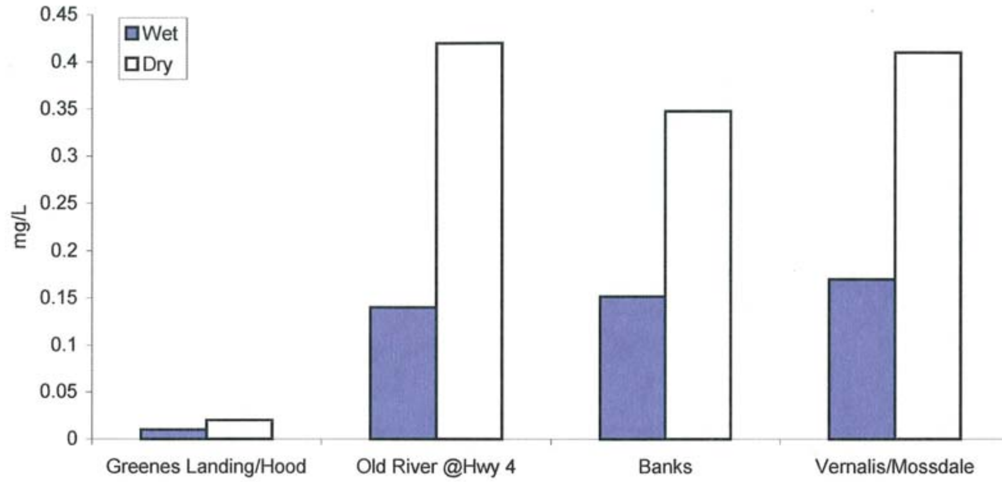


Figure 5-4
Long-term monthly median concentrations of bromide at Banks Pumping Plant (Clifton Court), Tracy Pumping Plant, and the Los Vaqueros Old River Intake under the Baseline Condition
Note: Bars represent the median and errors bars represent the 25th-percentile and 75th-percentile bromide concentrations.

In the Delta, water year has a strong influence on bromide concentration (DWR 2001b). Figure 5-5 illustrates that from 1990 to 1998, average bromide concentrations at four locations were higher in dry years than in wet years (DWR 2001b). For the purpose of Figure 5-5, wet years are a combination of wet and above normal water year types and dry years are a combination of dry and critical water year types (DWR 2001b).



Most samples collected monthly between 1990-1998.
Source: DWR 2001b.

Figure 5-5
Average Bromide Concentrations (mg/L) by Year Type at Selected Sites in the Sacramento/San Joaquin Delta

Organic Carbon

Naturally occurring organic compounds are present in surface waters as a result of degradation of aquatic vegetation and animal tissues. Scientists measure organic carbon using several methods. Dissolved organic carbon (DOC) is a measure of the dissolved organic carbon in the water, while TOC is a measure of all the organic carbon in the water, including organic carbon from particulate matter such as plant residues and DOC. Naturally occurring organic compounds, mainly humic and fulvic acids resulting from plant decay, are generally referred to as organic THM precursors. Organic carbon is important because of its role in the formation of DBPs, specifically THMs.

There is generally limited knowledge of the Baseline Condition of TOC at key Delta locations and tributaries, and limited understanding of TOC and DOC loads in the Delta system (DWR 2001b). With this caveat stated, there is some available data and information describing TOC and DOC concentrations in the Delta. Important sources of DOC and TOC to the Delta include the Sacramento River, the San Joaquin River, and in-Delta island drainage return flows (CALFED 2000a). Of the DOC loading contributed by tributary inflow, the Sacramento River is the major contributor to the Delta carbon load, contributing an estimated 71 percent of the total carbon load attributed to tributary inflow in the Delta (DWR 2001b). The Sacramento River is a major contributor because although its carbon concentrations are relatively low, approximately three-quarters of the inflow to the Delta comes from the Sacramento River (DWR 2001b). The San Joaquin River contributes approximately 20 percent of the total carbon load attributed to tributary inflow in the Delta (DWR 2001b). Drainage from Delta islands, particularly islands with highly organic peat soils, contributes significantly to the DOC load in the Delta (DWR 2001b). Studies conducted by DWR suggest that during the winter, 38 to 52 percent of the DBP-forming carbon in the Delta is contributed by Delta island drainage, while in the summer during irrigation, island drainage contributes to 40 to 45 percent of the DBP-forming carbon (DWR 2001b). In general, monitoring data suggests that most of the TOC in the Delta is in the form of DOC (CALFED 2000a).

As with salinity and bromide, organic carbon concentrations in the Delta vary both geographically and seasonally. Organic carbon patterns, however, in the Delta are somewhat different from salinity and bromide patterns in the Delta. Like salinity and bromide, organic carbon concentrations are higher in west and south Delta locations (Station 9, the San Joaquin River near Vernalis, and Banks Pumping Plant) than in the Sacramento River at Greenes Landing/Hood. Unlike salinity and bromide, organic carbon concentrations are typically lowest in the summer and higher during the rainy winter months. Appendix G further discusses organic carbon concentrations in the Delta.

5.1.5.3 Export Service Area

Water quality samples are routinely collected at 29 stations throughout the SWP. There also are 20 automated water quality monitoring stations that measure conventional parameters, including pH, EC, and turbidity.

5.1.5.3.1 California Aqueduct

The California Aqueduct is California's largest and longest water conveyance system, stretching 440 miles from the Sacramento-San Joaquin Delta in the north to Lake Perris in the south (DWR 2001b). The aqueduct and its branches supply water for two-thirds of California's population and irrigate approximately 1 million acres of farmland (DWR 2001b). Water quality data from the California Aqueduct were collected at four different sites: O'Neill Forebay Outlet (check 13), Kettleman City (check 21), near Highway 119 (check 29), and Tehachapi Afterbay (check 41). Data are generally collected monthly, although some parameters were not measured as frequently. The following figures present water quality data from January 1996 through December 1999 at each of the sampling sites (Figures 5-6 through 5-9).

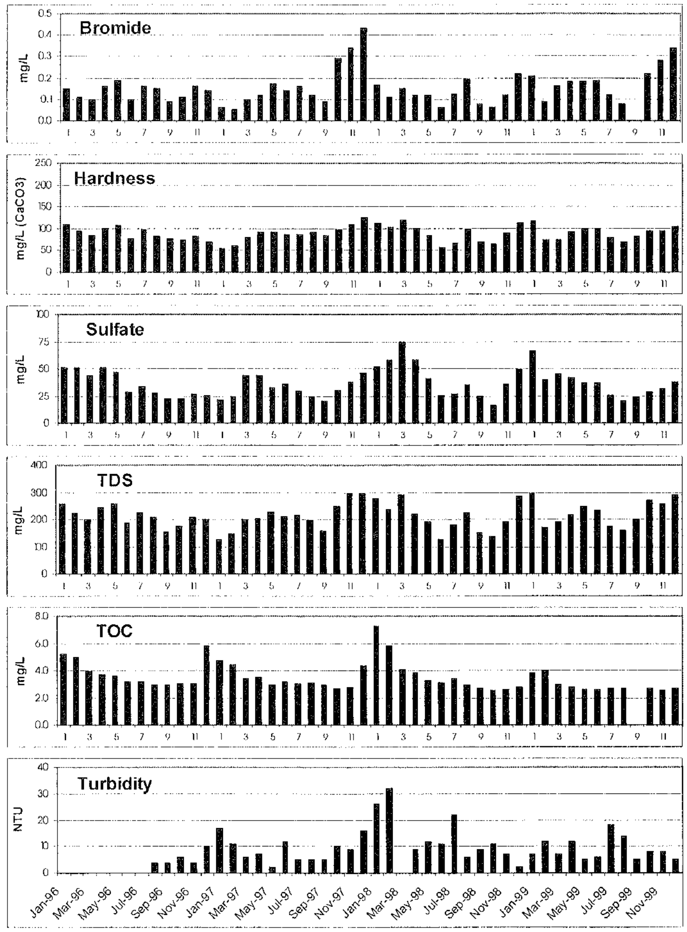


Figure 5-6
Water Quality on the California Aqueduct, Check 13

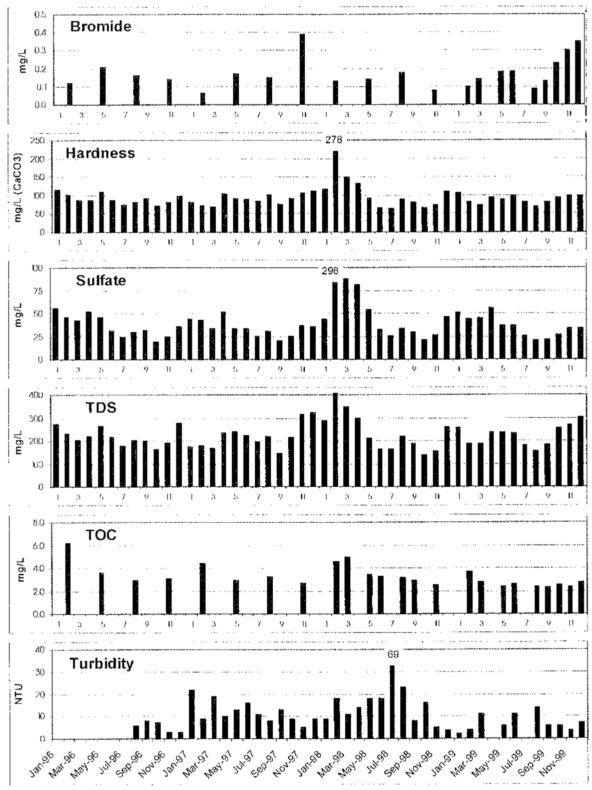


Figure 5-7
Water Quality on the California Aqueduct, Check 21

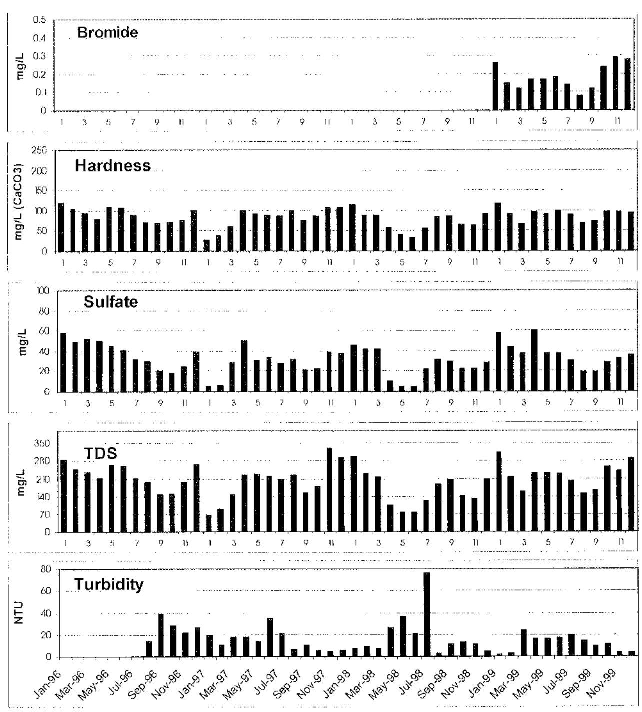


Figure 5-8
Water Quality on the California Aqueduct, Check 29

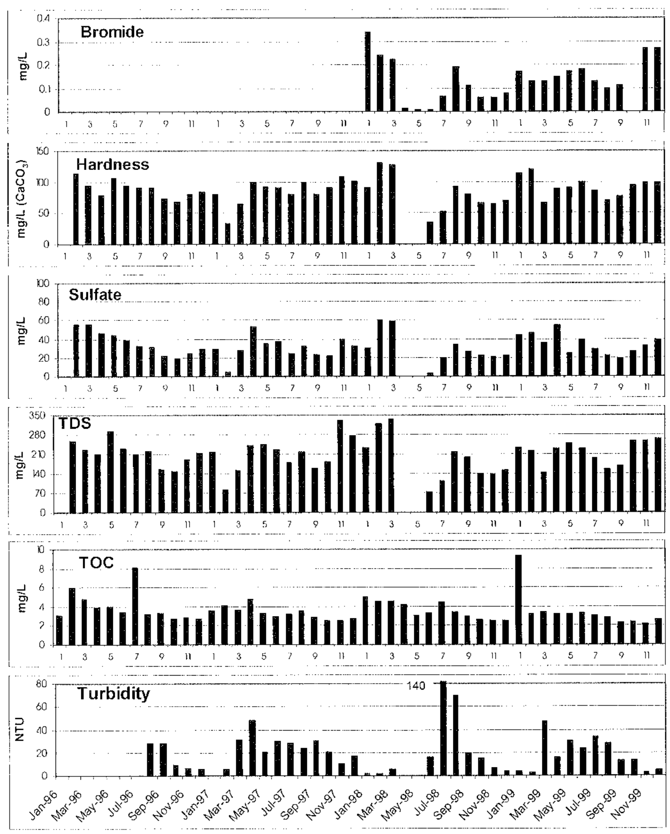


Figure 5-9
Water Quality on the California Aqueduct, Check 41

5.1.5.3.2 San Luis Reservoir

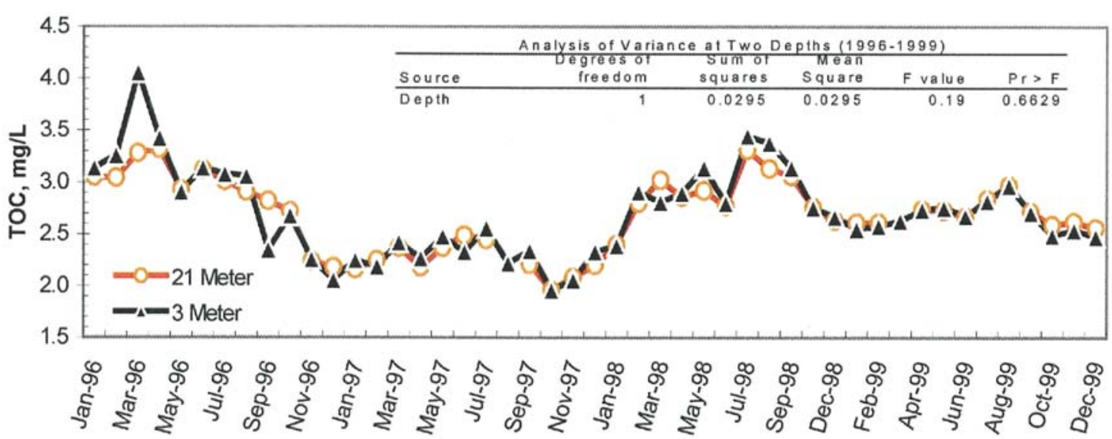
San Luis Reservoir is 12 miles west of the city of Los Banos on San Luis Creek, between the eastern foothills of the Diablo Range and the western foothills of the San Joaquin Valley in Merced County (DWR 2001b). This major off-stream reservoir of the joint-use San Luis Complex stores excess winter and spring flows from the Sacramento-San Joaquin Delta and supplies water to service areas for both the SWP and CVP (DWR 2001b). In general, the natural inflow from the San Luis Reservoir's watershed is insignificant relative to the reservoir's capacity (DWR 2001b). Most of the reservoir's water is pumped from the California Aqueduct and the Delta-Mendota Canal via the O'Neill Forebay through the Gianelli Pumping-Generating Plant during the winter and spring (DWR 2001b). Water enters and exits San Luis Reservoir from a common inlet/outlet tower (DWR 2001b). In addition, Reclamation pumps water out of San Luis Reservoir in a westerly direction to San Felipe Division Water contractors through the Pacheco Pumping Plant and the Santa Clara Tunnel (DWR 2001b). San Luis Reservoir water is delivered to the San Joaquin Valley, the Santa Clara Valley, and Southern California when water supply in the California Aqueduct and the Delta Mendota Canal is insufficient (DWR 2001b).

Table 5-28 presents data collected from 1996 to 1999 in San Luis Reservoir, including mean, median, low, and high concentrations for a variety of water quality parameters (DWR 2001b).

Table 5-28 San Luis Reservoir Water Quality Data, January 1996 to December 1999[1]							
Parameter	Mean[2]	Median[2]	Low[2]	High[2]	Percentile 10 to 90 Percent[2]	Reporting Limit	Detects/ Samples
pH (standard units)	7.7	7.7	7.2	8.6	7.3-8.2	0.1	22/22
Turbidity (NTU)	3	2	1	12	1-5	1	29/38
Total Organic Carbon (mg/L)[3]	2.7	2.7	2.0	4.1	2.2-3.1	0.1	92/92
Bromide (mg/L)	0.20	0.20	0.18	0.22	0.18-0.22	0.01	12/12
Chloride (mg/L)	65	64	48	78	56-76	1	48/48
Total Dissolved Solids (mg/L)	248	245	194	295	224-277	1	48/48
Conductivity (umhos/cm)	448	446	363	501	403-488	1	48/48
Nutrients							
Total Nitrogen[4] (mg/L)	1.0	1.1	0.7	1.4	0.8-1.0	0.1	27/27
Nitrate (as N) (mg/L)	0.6	0.6	0.1	0.9	0.3-0.8	0.1	45/47
Ammonia (dissolved) (mg/L)	0.03	0.02	0.01	0.10	0.01-0.06	0.01	22/47
Total Phosphorus (mg/L)	0.11	0.11	0.05	0.18	0.09-0.14	0.01	45/46
Orthophosphate (mg/L)	0.08	0.08	0.02	0.13	0.06-0.11	0.01	45/46

[1] Data were from DWR O&M Database, May 2000.
[2] Nondetects were not used for computation of these statistics.
[3] TOC data provided by Jeffrey Janik, DWR O&M, Feb 2001.
[4] Total nitrogen was the sum of Kjeldahl nitrogen and nitrate.
Source: DWR 2001b.

TOC samples were collected at the Pacheco Intake in San Luis Reservoir at two depths, 3 meters and 21 meters as shown in Figure 5-10 (DWR 2001b). An analysis of variance showed no significant difference between the carbon concentrations measured at the two depths during the same sampling day (DWR 2001b). TOC concentrations ranged from 2.0 to 4.1 mg/L, with an average concentration of 2.7 mg/L (DWR 2001b). These TOC levels are considered relatively high for source water, but were lower than the TOC measurements at the Banks Pumping Plant (DWR 2001b). There was no apparent seasonal trend in carbon levels within each year, except in 1996, when carbon levels appeared to be higher in January through March, and then declined (DWR 2001b).

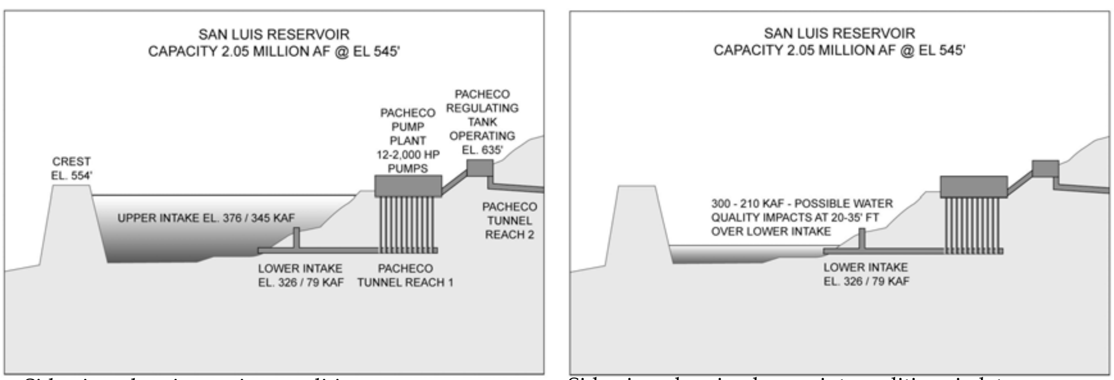


Source: DWR 2001b

Figure 5-10
Monthly Total Organic Carbon Measured at Two Depths

Bromide samples were collected monthly in 1999 and ranged from 0.18 to 0.22 mg/L, with a mean of 0.20 mg/L (DWR 2001b). Measured bromide values exceeded the recommended CALFED target of 0.05 mg/L (DWR 2001b). High bromide concentrations result from source water from both the California Aqueduct and the Delta Mendota Canal, which are affected by tidal inflows and seawater intrusion (DWR 2001b).

In San Luis Reservoir, the low-point problem and associated algal growth is the primary concern. In San Luis Reservoir, the low point refers to a range of minimum reservoir levels that occur in late summer and fall. The low-point problem is produced by a combination of warm-season algae growth and decreasing summer water levels. San Luis reservoir typically is at its high point in late winter and early spring, following the rainy season. During the spring and early summer, water is released from San Luis Reservoir into O'Neill Forebay. Additionally, some water is pumped through the Pacheco Pumping Plant for distribution to San Felipe Division contractors (including the Santa Clara Valley WD) via an upper intake located at approximately elevation 376 feet (Figure 5-11). As the summer progresses, algae begins to grow near the reservoir surface. At the same time, the reservoir water surface elevation decreases as water is withdrawn for the summer peak use season. The upper Pacheco intake at elevation 376 feet is closed when the reservoir water surface elevation reaches approximately 406 feet. For the remainder of the dry season, water is pumped through the Pacheco Pumping Plant via the lower intake, located at approximately 334 feet (Santa Clara Valley WD 2002).



Side view showing spring conditions

Side view showing low-point conditions in late summer

Source: Santa Clara Valley WD 2002.

Figure 5-11
San Luis Reservoir Low-Point Conditions

The low-point problem begins when the reservoir water surface elevation approaches 369 feet, corresponding to a storage capacity of 300,000 acre-feet. At this capacity, the water surface elevation in the reservoir is approximately 35 feet above the lower intake to the Pacheco Pumping Plant. Because the near-surface algae layer can be more than 30 feet thick in late summer, algae may be drawn into the lower intake. High algae content reduces the effectiveness of water treatment and can affect the quality and taste of treated water. As the reservoir is progressively drawn down below 300,000 acre-feet, increasing amounts of algae may enter the intake, and water quality problems can worsen. When the water surface elevation reaches approximately 354 feet (209,000 acre-feet), algae concentrations may be so high that the water delivered to the Pacheco Pumping Plant is untreatable (Santa Clara Valley Water District 2002).

Historical data suggest that algal blooms caused taste and odor problems for the Santa Clara Valley Water District (WD) during the drought years from 1992 to 1993 (DWR 2001b). From 1996 to 1999, the Santa Clara Valley WD did not report any serious algal blooms and taste and odor were not serious water quality concerns during this period (DWR 2001b). There were no drought years during this period, and precipitation records show that rainfall was heavy in 1995 and 1996, reaching a record high of 24.1 inches in the reservoir watershed during 1998 (DWR 2001b). Strong winds mix the surface water with water at greater depths, making it less likely that a thermocline will become established in the reservoir (DWR 2001b). Wind disturbances and the lack of thermocline establishment apparently limited growth of blue-green algae during this period (DWR 2001b).

Typically, taste and odor concerns associated with algal growth in the reservoir are more serious water quality concerns during drought years (DWR 2001b). In the fall, especially during drought years, a greater demand by SWP contractors creates lower water levels in the reservoir (DWR 2001b). Because of the improved light penetration and greater likelihood of establishment of a thermocline in the reservoir, algal blooms, consisting primarily of the blue-green algae *Aphanizomenon flosaquae*, are more likely to occur (DWR 2001b). During fall months, winds blow accumulated blue-green algae toward the intake, and taste and odor concerns may result (DWR 2001b).

5.1.5.3.3 Anderson Reservoir

Anderson Dam and Reservoir was built in 1950 and is the largest man-made lake in Santa Clara County (Santa Clara Valley WD 2002). Anderson Reservoir is in the Coyote Creek watershed of central Santa Clara County. Coyote Creek is a south-to-north trending drainage that discharges into the southern end of South San Francisco Bay. Anderson Reservoir is managed by the Santa Clara Valley WD for water supply and flood control purposes. The reservoir is filled in the winter and spring using runoff collected from within the watershed and from San Luis Reservoir. When full, the reservoir holds 111,198 acre-feet. At present, the Santa Clara Valley WD maintains a minimum pool amount of 20,000 acre-feet for summer recreation and emergency storage[1].

Since late 1996, the Santa Clara Valley WD has found low levels of a gasoline additive known as MTBE present in Anderson Reservoir. At very low levels, this substance can foul the taste and odor of drinking water. To help control the amount of MTBE entering the reservoir, county parks have reduced the number of boats, allowing access only to vessels fueled with MTBE-free fuel. They have also relocated personal watercraft to Calero Lake, instituted controls on refueling, and are providing boating safety education through park rangers (Santa Clara Valley WD 2002a).

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1 Coyote Creek, Stevens Creek, and Guadalupe River Watersheds – Fisheries and Aquatic Habitat Collaborative Effort: Summary Report. February 26, 2003. (Akin, et al.)

The reservoir is filled with water from San Luis Reservoir, so the water quality within Anderson Reservoir is would be similar to that for San Luis Reservoir. For information on the water quality within San Luis Reservoir, please refer to Section 5.1.5.3.2.

5.1.5.3.4 Castaic Lake

Castaic Lake is two miles north of the community of Castaic, 45 miles northwest of downtown Los Angeles, in the southeast portion of the Angeles National Forest. The lake is the terminus of the West Branch of the California Aqueduct and is used to supply water to southern California users. The watershed and the lake combined encompass a total of 154 square miles, with the surface area of Castaic Lake covering approximately 2,240 acres (approximately 3.5 miles). Castaic Lake is fed by natural and SWP sources. Along with the California Aqueduct (via Pyramid Lake and the Elderberry Forebay), the two main sources of natural inflow are Castaic Creek on the northwest arm and Elizabeth Lake Canyon Creek on the northeast arm of the lake. Historic average annual natural inflows from the watershed have been estimated to be about 23,000 acre-feet (Brown and Caldwell 1990 *cited in* DWR 2001b). Average SWP inflows from 1996 to 1998 were approximately 307,500 acre-feet (DWR 2001b). SWP water is withdrawn from Castaic Lake at West Branch mile 31.55 via the Castaic Tunnel and distributed to three agencies, the Metropolitan Water District of Southern California (Metropolitan WD), the Castaic Lake Water Agency, and the Ventura County Flood Control and Water Conservation District.

Primary land uses in the Castaic Lake watershed include recreation and related activities, livestock grazing, limited residential development and some historic mining (DWR 2001b). Each of these represents a potential source of contamination to the lake by the direct addition of contaminants or by increasing potential runoff into the lake. Wastewater treatment facilities such as septic systems, algal blooms, crude oil pipelines, spills from traffic accidents, geologic hazards, fires, and future construction within the watershed represent additional potential sources of contamination to the lake.

Castaic Lake water quality is affected by outflow from Pyramid Lake and the Elderberry Forebay as well as the small natural streams feeding the lake, particularly Castaic Creek. Table 5-29 presents data collected by DWR's Division of Operation and Maintenance Castaic Lake outlet. All parameters in Table 5-29 were below drinking water MCLs for the monitoring period (DWR 2001b). The data were taken from February 1996 through November 1999 with the exception of bromide and pH data. Bromide data were collected from November 1998 to August 1999. Alkalinity data expressed as pH were collected from February 1998 to November 1999.

Table 5-29 Water Quality Parameters Sampled at Castaic Lake			
Parameter	**Minimum**	**Maximum**	**Average**
pH (standard units)	7.4	9.1	8.3
Turbidity (NTU)	<1	3	2
Dissolved Oxygen (mg/L)	N/A	N/A	N/A
Total Organic Carbon (mg/L)	2.5	7.7	4.0
Nitrogen (mg/L)	0.2	0.8	0.4
Phosphorus (mg/L)	0.01	0.09	0.03
Electrical Conductivity (µS/cm)	479	627	535
Chloride (mg/L)	41	54	46
Bromide (mg/L)	0.12	0.15	0.13

Source: DWR 2001b
N/A – Not Available

5.1.5.3.5 Lake Perris

Lake Perris is the terminal reservoir of the East Branch of the California Aqueduct and is approximately 13 miles southeast of the City of Riverside and approximately 65 miles from downtown Los Angeles within Riverside County. The lake is a multiuse facility providing water storage, recreation, and fish and wildlife habitat. The Lake Perris watershed encompasses approximately 16 square miles and is fed almost exclusively by the California Aqueduct with no significant natural inflow. SWP water flows into Lake Perris from the Devil Canyon Afterbay, through the Santa Ana Pipeline. The Metropolitan WD is the only agency contracting water deliveries from Lake Perris. Ultimately, approximately 17 million people receive part of their drinking water from Lake Perris each year (DWR 2001b).

Lake Perris becomes thermally stratified in the summer months presenting some significant water quality concerns that limit the use of lake water. High nutrient levels in the epilimnion (upper level) stimulate nuisance algae growth that degrades the odor and taste of the water and causes treatment difficulties by clogging filters. In addition, microbial respiration fueled by periodic algae die-offs cause anoxic conditions in the hypolimnion (lower layer). Anoxic water decreases aesthetic values and is difficult and expensive to treat. In addition to nutrient enrichment, recreation, wastewater treatment and facilities, urban runoff, animal populations, and leaking storage tanks have contributed contaminants to the lake in the past (DWR 2001b).

Table 5-30 presents data collected by DWR's Division of Operation and Maintenance at the Lake Perris outlet. All parameters were below drinking water MCLs for the monitoring period (DWR 2001b). The data were taken from February 1996 through November 1999 with the exception of bromide data. Bromide data were collected from February 1999 to August 1999.

Table 5-30 Water Quality Parameters Sampled at Lake Perris			
Parameter	**Minimum**	**Maximum**	**Average**
pH (standard units)	7.4	8.9	8.2
Turbidity (NTU)	<1	8	1
Dissolved Oxygen (mg/L)	N/A	N/A	N/A
Total Organic Carbon (mg/L)	N/A	N/A	N/A
Nitrogen (mg/L)	0.3	1.2	.5
Phosphorus (mg/L)	<0.01	0.15	0.04
Electrical Conductivity (µS/cm)	483	712	591
Chloride (mg/L)	65	121	89
Bromide (mg/L)	0.20	0.22	0.21

Source: DWR 2001b
N/A – Not Available

5.1.5.3.6 Diamond Valley Lake

Diamond Valley Lake is the largest drinking water reservoir in southern California. It is in southwestern Riverside County, approximately four miles southwest of the City of Hemet and approximately 90 miles southeast of Los Angeles. The reservoir has a capacity of approximately 800,000 acre-feet and a surface area of approximately 4,400 acres. The Diamond Valley Lake watershed encompasses approximately 17.4 square miles and is primarily fed by the SWP and the Colorado River (Metropolitan WD 1991). Warm Spring and Goodhart Canyon creeks also contribute a small amount of water to the lake. The Metropolitan WD owns and operates the reservoir as a multi-use facility providing water storage, drinking water, hydroelectric power generation and recreational uses to southern California users (Metropolitan WD 1991).

Construction of the three dams holding Diamond Valley Lake water was completed in 1999 (Water Technology 2003). The reservoir was dedicated March in 2000 and began generating electricity in May 2001 (Metropolitan WD 2001a; Metropolitan WD 2001b). Due to the lack of publicly available data and the short operating time of the reservoir, water quality data were not available for Diamond Valley Lake.

5.1.5.3.7 Lake Mathews

Lake Mathews Reservoir was completed in 1939 by the Metropolitan WD of Southern California as the western terminus for the Colorado River Aqueduct. Lake Mathews is within Riverside County approximately five miles southeast of Corona and three miles south of Riverside. Before the construction of Diamond Valley Reservoir, Lake Mathews was the largest reservoir operated by Metropolitan WD, and it remains the oldest. Lake Mathews holds up to 182,000 acre-feet.

The lands immediately surrounding the lake have been held by the Metropolitan WD, and human intrusions have been few. As Riverside continued to grow during the latter part of the century, surrounding areas began to be developed primarily as custom built homes on small ranchettes. Additionally, since the 1930s, many of the surrounding lands were and continue to be used for citrus agriculture. In July 1997, the SWRCB approved a resolution project for the Drainage Water Quality Management Plan (DWQMP) for the Lake Mathews Watershed Project. The project is designed to protect Lake Mathews from nonpoint source and storm water pollution originating in the upstream watershed. The facilities include natural wetlands, ponds and a dam to purify the contaminated runoff (SWRCB 1998). In October 2002, Metropolitan WD was awarded the Outstanding Civil Engineering Project of the Year for their DWQMP project. In addition, as part of a mitigation plan for its water projects, and recognizing the value to wildlife of such a large, open source of water, the Metropolitan WD lands (approximately 4,000 acres) surrounding the lake were formally designated as a State Ecological Reserve in 1982.

Public access within the Lake Mathews Reserve is limited to non-Metropolitan WD lands only, and the lake is not open for public recreation. The Reserve is open daily from dawn to dusk, but since motorized vehicles are not allowed on Reserve lands, access to these non-Metropolitan WD lands is by foot or horse travel only (Center for Natural Lands Management 2003).

In July 2002, Metropolitan WD officials announced that the musty taste and odor in their tap water was not a health hazard, but an aesthetic problem. The earthy taste and odor came from an especially large persistent algal bloom within the California Aqueduct and Lake Mathews. The cause was identified as 2-methylisoborneal (MIB) and geosmin, whose growth tends to increase in the summer months with the warmer temperatures. DWR applied copper sulfate to the east end of the California Aqueduct to control the algal bloom. Investigations took place at Lake Mathews to determine if a similar treatment was needed at this location (Metropolitan WD 2002).

Lake Mathews receives its water from the Colorado River Aqueduct, but water supplies from this source are much higher in salinity than those from the SWP, so the water is blended at the Robert A. Skinner Filtration Plant at Lake Skinner before it is delivered. Table 5-31 presents data collected for the 2001 Consumer Confidence Report at the Robert A. Skinner Filtration Plant for a variety of water quality parameters. As illustrated in Table 5-31, pH ranged from 8.03 to 8.10, with an average of 8.06 (Rincon 2003). TDS concentrations ranged from 480 mg/L to 521 mg/L and averaged 500 mg/L, which is lower than the State MCL of 1000 mg/L (Rincon 2003). Conductivity was not high in the reservoir, with values ranging from 813 µmhos/cm to 876 µmhos/cm, falling well within the State MCL range of 900 to 1600 µmhos/cm (Rincon 2003).

Table 5-31
Water Quality Parameters Sampled at the Robert A. Skinner Filtration Plant

Water Quality Parameter	*Minimum*	*Maximum*	*Average*
pH (standard units)	8.03	8.10	8.06
Turbidity (mg/L)	0.05	0.07	0.06
Dissolved Oxygen (mg/L)	N/A	N/A	N/A
Total Dissolved Solids (mg/L)	480	521	500
Nitrogen (mg/L)	N/A	N/A	N/A
Phosphorus (mg/L)	N/A	N/A	N/A
Electrical Conductivity (µS/cm)	813	876	836

Source: Rincon 2003.
N/A – not available

5.2 Environmental Consequences/Environmental Impacts

5.2.1 Assessment Methods

The assessment methods and effects evaluation for water quality were organized by EWA acquisition type because each acquisition type required a different assessment method and effects analysis. Additionally, for some acquisition types, the assessment methods and effects evaluations were similar for several geographic regions and therefore several geographic regions were grouped together under various acquisition types. Because the grouping of geographic regions varied by acquisition type, structuring the entire analysis by geographic area within acquisition type allowed for the most condensed and least redundant presentation of the assessment methods and effects analysis.

The assessment methods and effects analysis are presented in the following order:

- Stored Reservoir Water (Including Stored Water Acquired From Crop Idling and Groundwater Substitution);
- Crop Idling;
- Stored Groundwater Purchase;
- Groundwater Substitution; and
- Source Shifting.

5.2.1.1 Stored Reservoir Water (Including Stored Water Acquired from Crop Idling and Groundwater Substitution)

This analysis uses changes in reservoir storage and water surface elevation to determine potential water quality effects under the Flexible Purchase Alternative. When a reservoir has a higher water surface elevation, there would be an improvement in water quality (greater dilution of constituents of concern). Conversely, when water surface elevations were shown to be lower than the baseline condition, it was expected that there would be a potential for impaired water quality (less stratification, warmer water, concentration of pollutants, and greater sediment exposure around the shoreline).

Storage volumes are an important analytical component for water quality because they provide an indication of dilution factors for constituents of concern. The volume of the cold water pool also provides an indication of water quality available to coldwater fisheries, and may indirectly provide an indication that there is a sufficient quantity of dissolved oxygen available to support aquatic life and natural benthic processes. In addition, the cold water pool is often relied upon to ensure the health and protection of downstream riverine fish, particularly with respect to anadromous salmonid spawning and rearing activities.

Water temperature-related effects are also important to consider because such changes may result in direct effects to water quality. With regard to aquatic pollution and water quality in the project reservoirs, a greater volume of water present in a particular waterbody equates to a greater amount of dilution regarding any constituent of concern that may be present in the water. Hence, greater dilution results in exposure to a lower concentration of any substance that is present in the water and also will result in less stress to aquatic organisms. Metals and other constituents of concern that normally settle out of suspension and concentrate in the sediments most likely would remain within the sediments and would not be disturbed by fluctuations in surface water elevation. Temperature also plays a role in how quickly certain physical, chemical and biological reactions occur. For instance, the respiration and metabolic rates of most aquatic organisms tend to increase in warmer water. Increased water temperature also can accelerate oxygen demand and bacterial respiration associated with decomposition of organic matter. Water temperature effects to water quality were only quantitatively evaluated in the water quality analysis for rivers, because current modeling simulations cannot predict water temperature variations within the project reservoirs. However, it was expected that if surface water elevations and storage volumes do not fluctuate beyond the range of normal operating conditions, reservoir water temperatures also would remain within normal operational ranges.

5.2.1.1.1 Reservoirs within the Upstream from the Delta Region

EWA acquisitions could result in alterations to storage and water surface elevations for CVP/SWP and non-Project reservoirs within the area of analysis. The following reservoirs potentially could be affected by EWA acquisitions:

- Shasta
- Little Grass Valley
- Sly Creek
- French Meadows
- Hell Hole
- Folsom
- Oroville
- New Bullards Bar
- McClure

In response to day-to-day operations and changes in runoff patterns, fluctuations in storage and water release patterns in these reservoirs potentially could affect reservoir water quality due to alterations in the timing and magnitude of reservoir drawdown activities. Methods used to determine potential effects to water quality within CVP/SWP project reservoirs and non-Project reservoirs are discussed below.

<u>Central Valley Project/State Water Project Reservoirs</u>
For reservoirs within the CVP/SWP system, modeling was conducted to characterize CVP/SWP reservoirs and their associated rivers. Modeling of reservoirs within the CVP/SWP system in the Upstream from the Delta Region is described in Attachment 1. Attachment 1 describes in detail the EWA water purchase assumptions and assumptions regarding total available EWA assets for water purchased in the Upstream from the Delta Region.

For each of the CVP/SWP reservoirs, the analysis looked at the end of month reservoir water surface elevation and end of month reservoir storage for each month of the year to determine potential water quality effects that may result from implementation of the EWA Program. Modeling output was used to evaluate changes in water surface elevation and reservoir storage for each month of the year. These parameters were selected as effect indicators because of the interrelationships that exist between physiochemical and biological processes, and water quality. Modeled temperate changes within 0.3ºF (for rivers only), river flows and reservoir storage changes within one percent, and reservoir elevation changes within one foot between modeled simulations were considered to represent no measurable change (were considered "essentially equivalent”).

CVP/SWP reservoirs were additionally analyzed with respect to water year type. The data developed and used for the critical, dry, and below normal years types was based on the model output described in Attachment 1. The analysis for each water year type analyzed the same metric used in the analysis of the entire 72-year period of record. Critical years, dry years, and below normal years were analyzed as three separate groups with respect to end-of-month water surface elevation and end-of-month storage. For each water year type, the long-term average end-of-month water surface elevation and end-of-month storage was examined for each month of the year.

Non-Project Reservoirs

There are several non-Project reservoirs that could serve as potential water sources for EWA acquisitions. Because these non-Project reservoirs are not managed under the operations of either the CVP or SWP, they are not included in the CALSIM modeling simulations. Non-Project reservoirs evaluated include:

- Hell Hole
- Little Grass Valley
- French Meadows
- Sly Creek
- New Bullards Bar
- Lake McClure

The following method of evaluating potential effects from EWA actions was used to analyze possible project-related effects on non-Project reservoirs. The evaluation assumptions were established with regard to the status and operation of these reservoirs. These assumptions were applied to the analysis for each of the non-Project reservoirs where the EWA Program could purchase water.

- Non-Project reservoir operations would continue to function under the same set of demands and assumptions that have previously been employed by each system in earlier years, including reservoir drawdown to targeted storage levels.

- Analysis relating to the timing, magnitude and duration of water transport activities and their potential effects on riverine flow processes were developed using a monthly time-step, culminating at the end of the water year in late-September. Where applicable, the period of time that was used to evaluate resource-specific effects (e.g., water quality, fisheries) concurred with the timeframe associated with potential asset transfers, as identified in the available modeling output for the EWA Program.

- EWA asset availability from non-Project reservoirs and any associated potential effects were evaluated by reviewing hydrologic data and reservoir specific area-capacity curves to predict changes in surface water elevation and reservoir refill frequencies. This information provides an indication of the target storage capacities, minimum pool volume and range of surface water elevations under normal operating conditions, and the probability of annual refill for each reservoir. Estimations for flow changes were translated into relative changes in surface water elevations and used to evaluate resource specific effects.

Additional information regarding assumptions for each non-project reservoir is provided in Attachment 1. In order to identify potential effects to water quality within non-Project reservoirs, a comparison of reservoir storage elevations was conducted using median reservoir storage and median water surface elevation values over the historical period of record, using current operating parameters as a baseline. These values were then compared against potential EWA actions to determine positive or negative fluctuations in reservoir levels. It was assumed that EWA acquisition amounts would be released evenly over a given period. The resulting estimates were used to determine the likelihood that decreases in reservoir water surface elevations of sufficient magnitude and frequency would occur over the long-term and result in negative effects to water quality within the non-Project reservoirs.

Because this comparison method supplies the most average result, 50 percent of the time actual reservoir levels will be higher and 50 percent of the time the actual levels will be lower than those used in the baseline. If reservoir levels differ greatly from the Baseline Condition during a transfer year, effects to water quality also may differ from those predicted by the analysis. If actual reservoir levels are higher than the historical average, the actual effects to water quality may be less than the predicted effects. If actual reservoir levels are lower than the historical average, the actual effects may be greater than the predicted effects.

Limitations have been placed on the maximum volume of water potentially available to EWA from each non-Project reservoir, based upon reservoir size, operational constraints and the existing refill patterns within each basin. Additionally, EWA asset acquisitions must not result in a reduction of reservoir surface water elevation beyond the minimum reservoir drawdown levels as stated in corresponding Federal Energy Regulatory Commission (FERC) licenses, where applicable. This documentation and any related material also was reviewed to ensure compliance with all appropriate regulatory requirements. See Attachment 1 for additional reservoir-specific information.

Non-Project reservoirs were additionally analyzed with respect to water year type. The data developed and used for the critical, dry, and below normal years types was based on the Sacramento River 40-30-30 index used by CALSIM II. For those reservoirs modeled for the period of 1970 to 2001, there were seven critical years, five dry years, and two below normal years. Because there were so few below normal years during the period of record, the dry and below normal years were combined within the data output for a total of seven years. For those reservoirs modeled for the period of 1974 to 2001, there were seven critical years, five dry years, and one below normal year. The dry and below normal years also were combined within the data output for this period of record as well for a total of six years.

5.2.1.1.2 Rivers Within the Upstream from the Delta Region

This section provides a discussion of the application of available hydrologic modeling output used in the determination of potential effects to water quality in the riverine environments that are within the EWA Program area of analysis. As described above, Attachment 1 includes additional detailed information regarding the assumptions utilized in the hydrologic modeling, assumptions regarding EWA water purchases and assumptions regarding EWA actions for the purpose of analyzing the Upstream from the Delta Region. Potential effects to water quality associated with the implementation of EWA actions were determined through an evaluation of the degree of change between the Baseline Condition and the EWA Program alternatives, as compared to thresholds of significance relating to designated beneficial uses, exceedance of existing water quality standards, and degradation of water quality.

Two different methods were employed to assess the water quality parameters specific to rivers that could be affected by EWA actions. The same methodology was used to assess potential effects to water quality in the Sacramento, lower American, lower Feather, Merced, and San Joaquin rivers. Flow and water temperature, where available, were used as the criteria to quantitatively evaluate potential effects to water quality within riverine environments. The analysis of potential effects to water quality focused on the frequency and magnitude of changes in mean monthly flow and mean monthly water temperature over the long-term, as compared to the Baseline Condition.

The above-named rivers were additionally analyzed with respect to water year type. The data developed and used for the critical, dry, and below normal year types was based on the model output described above. The analysis for each water year type evaluated the same metrics used in the previously described analysis of the entire 72-year period of record. Critical years, dry years, and below normal years were analyzed as three separate groups with respect to monthly flow and monthly water temperature. For each water year type, the long-term average monthly flow and monthly water temperature was examined for each month of the year.

Assessments of the Middle Fork American River and the lower Yuba River utilized an alternate methodology described below.

<u>Lower Yuba River</u>
To assess potential flow-related and water temperature-related effects on water quality in the Yuba River, comparisons were made "with" and "without" EWA Program-related transfer flows. Limited modeling output was available to assess the potential effects of the EWA Program. Therefore, to assess potential effects to water quality under the EWA Program, data was summarized describing flow and water temperature during past EWA transfers. Flow data from USGS gages at Marysville and Smartville were summarized, as well as water temperature data from USGS

gages at Marysville and Daguerre Point Dam. As with other rivers in the Sacramento and San Joaquin river basins, flow and water temperature criteria were used to evaluate potential effects to water quality in the Yuba River. The analysis of potential effects to water quality under the EWA Program in the Yuba River was based on data from previous EWA water transfers and focused on the frequency and magnitude of changes in mean daily flow and water temperature over the long-term, as compared to the Baseline Condition.

Middle Fork American River

Potential effects to water quality in the Middle Fork American River associated with EWA acquisition of stored reservoir water in French Meadows and Hell Hole reservoirs was assessed using the following methodology. Potential effects to water quality in the Middle Fork American River were analyzed using historical median flows because there was no modeling output available for this river. For the Middle Fork American River, the evaluation of potential effects to water quality was performed by comparing potential changes in flow resulting from implementation of the EWA Program to historical median flows. The analysis of potential flow-related effects to water quality focused on the frequency and magnitude of changes in mean monthly flow over the long-term, as compared to the historical period of record.

5.2.1.1.3 Sacramento-San Joaquin Delta Region

This section describes the evaluation methods for assessing the potential effects of the proposed EWA Program on water quality within the Sacramento-San Joaquin Delta Region. EWA operations have the potential to affect Delta water quality in years when CVP/SWP pumping is reduced below levels that would have been pumped in the absence of EWA actions, and when the loss of CVP/SWP project water is repaid in whole or in part by pumping water acquired from water users in the Upstream from the Delta Region through the Delta during the summer months. Pumping reductions would occur in the winter and spring months during EWA actions. When EWA acquires water upstream from the Delta to repay or assist in repaying the CVP/SWP for water lost during pumping reductions that water would be provided in the Delta when there is pumping capacity available at the SWP and/or CVP pumps and would, in most years, be replaced before the end of September. The result would be increased CVP and/or SWP pumping during the July through September period. As described in Chapter 2, no EWA actions (pumping reductions) would be taken at pumping locations other than at the Banks and Tracy Pumping Plants.

Salinity, bromide and organic carbon are specific water quality constituents of concern in the Delta with respect to implementation of EWA, as described in Section 5.1.5.2.1. The EWA Program has the potential to affect water quality in the Delta and has the potential to affect the quality of water supplied to downstream CVP and SWP water users. The methods for the analysis for each potential effect are described separately in this section. The analysis of potential effects to water quality in the Delta includes an analysis of potential effects to water quality for all in-Delta water users, including Contra Costa WD. The analysis of potential effects to in-Delta water quality consists of a detailed qualitative treatment of the use of carriage water (see Chapter 2) to maintain Delta water quality standards. In addition to the description in the Chapter 2, the analysis presented in Section 5.2.5.1.4 defines carriage water and evaluates the use of carriage water to protect Delta water quality. The evaluation includes a qualitative comparison of the chloride, bromide and organic carbon concentrations occurring under the EWA Program and under the Baseline Condition.

In order to evaluate the potential affects of EWA Program implementation to the quality of water supplied to CVP and SWP water users south of the Delta, quantitative modeling analysis of chloride and bromide loading was conducted and a qualitative analysis of organic carbon was conducted. Salinity and bromide were analyzed together using DWR/Reclamation models for several reasons. Salinity and bromide behave in similar fashions with respect to annual and seasonal variation, variation in water year type and variation in Delta outflow, as detailed in Section 5.1.5.2.1. Additionally, except for salinity predictions (including predictions of chloride and bromide), which are made possible by available mathematical modeling tools, there is currently little consensus regarding the ability to predict levels of other water quality constituents (such as organic carbon) that are present in the Delta Estuary (CALFED 2000a). Because bromide has the potential to chemically react with organic matter present in the water, thereby leading to the formation of THMs, the potential for THM formation was assessed using quantitative modeling techniques. Bromate formation was also assessed using the modeling techniques described below. The methods for evaluating chloride and bromide are discussed together, and the methods of analysis for organic carbon is described separately below.

In years when EWA actions occur in the Delta, the quality of water delivered to the CVP and SWP could be affected because of the change in the monthly pumping pattern resulting from EWA Actions. When pumping is reduced by EWA actions in the winter and spring months, the CVP/SWP forego pumping water that has relatively low chloride and bromide concentrations, with the exception of the higher chloride and bromide concentrations occurring in December and January (Figure 5-2 and Figure 5-4). To pay back the CVP/SWP projects for all or a portion of the water lost due to the pumping reductions, DWR and Reclamation would increase project pumping during July through September, when the chloride and bromide concentrations in the Delta generally are higher than the chloride and bromide concentrations during winter and spring months. However, it is difficult to generalize about seasonal trends because depending on the specific month in a season, these trends are not necessarily accurate. For example, median chloride and bromide concentrations in July are lower than median concentrations in December and January, and median chloride and bromide concentrations in August are similar to those occurring in January (Figure 5-2 and Figure 5-4). As a result, changes in the monthly pumping pattern under the EWA Program have the potential to result in water of higher chloride concentrations being delivered to the CVP and SWP water users south of the Delta during months of increased pumping, resulting in more total salts being delivered to these water users over an annual period (total annual salt load). For this reason, a quantitative analysis of the total annual chloride load and total annual bromide load was conducted in order to determine whether or not changes in the monthly pumping pattern would result in an increase in the total annual salt load delivered to CVP and SWP water users in south of the Delta.

Using the assumptions discussed above and detailed in Attachment 1, monthly average chloride and bromide loading (in tons) at CVP/SWP export locations (Tracy Pumping Plant and Banks Pumping Plant) occurring under the Baseline Condition and under the Flexible Purchase Alternative were calculated. The period of record modeled for the Baseline Condition and Flexible Purchase Alternative is the 15-year period of record extending from 1979-1993.

Organic carbon was analyzed separately because its seasonal distribution pattern varies from that of salinity and bromide, as detailed in Section 5.1.5.2.1. The response of organic carbon to EWA transfers was assessed qualitatively in the absence of modeling tools that allow quantitative prediction of organic carbon behavior and distribution. The likely outcome of altering timing of pumping under the EWA Program was assessed by providing information regarding current organic carbon concentrations and conceptually evaluating the potential changes that may occur when timing of export pumping would be altered for the EWA Program.

5.2.1.2 Crop Idling

EWA acquisitions obtained through crop idling could result in alterations to water quality through temporary conversion of lands from rice or cotton crops to bare fields. Bare fields may result in increased potential for sediment transport via wind erosion and subsequent deposition onto surface waterbodies, thus potentially affecting water quality directly. It is possible that farmers may plant dry crops or cover crops, which would not result in conversion of lands to bare fields. However, this effects analysis assumed that idled fields would be bare because bare fields represent the scenario under which it is most likely that the greatest effects to water quality could occur. The assessment methodology described below was used to evaluate the potential effects to water quality associated with wind erosion and sediment deposition potentially resulting from temporary conversion of lands from rice or cotton crops to bare fields. Additionally, because idling involves cessation of irrigation, EWA acquisitions obtained through crop idling also could result in alterations to water quality through changes in the timing and quantity of water applied to the land. Changing the timing and quantity of water applied to the land could result in changes to the amount of leaching of water quality constituents, including pesticides, fertilizers, salts, and metals.

To assess the potential effects to water quality resulting from temporary conversion of lands from rice crops to bare fields, the change in sediment transport via wind erosion under the EWA Program alternatives as compared to the Baseline Condition was evaluated. The assessment methods used to determine the change in sediment transport via wind erosion resulting from idling as described under the EWA Program alternatives is detailed for the assessment methods used to evaluate sediment transport resulting from the EWA Program alternatives as compared to the Baseline Condition. In order to assess the potential effects to water quality associated with changes in the timing and quantity of water applied to the land, a qualitative description of the changes in timing and quantity of water applied to the land under the EWA Program alternatives as compared to the Baseline Condition was provided. Potential effects to water quality occurring under the EWA Program alternatives as compared to the Baseline Condition were assessed by conceptually comparing the leaching potential, with respect to timing and quantity of water applied, under the EWA Program alternative to the leaching potential under the Baseline Condition.

Making a fully quantitative, reliable analysis of potential sediment mobilization and of fate and transport of water quality constituents under differing water application regimes requires highly complex, data intensive, site-specific data collection and modeling effort that is not practical at this level. Therefore, the methodologies described above were used to assess potential effects to water quality resulting from crop idling.

5.2.1.3 Stored Groundwater Purchase

EWA acquisitions could be obtained through stored groundwater purchase in the American River basin and the Tulare Lake Subbasin. Because groundwater banking in the American River basin is in its infancy, EWA acquisitions obtained via stored groundwater purchases in the American River basin are the same, mechanistically, as EWA acquisitions obtained through groundwater substitution, and are therefore evaluated as groundwater substitution in Section 5.2.5.4.

EWA acquisitions could be obtained through stored groundwater purchases from Kern County Water Agency in the Kern subbasin. If stored groundwater is purchased from the Kern subbasin, it would either be used in the Kern subbasin or it would be pumped directly into the California Aqueduct. Because the Kern subbasin is a closed system and has no drainage outlet for surface or groundwater, purchased stored groundwater used in the Kern subbasin would return to the Kern subbasin as groundwater. Because the potential effects to groundwater quality associated with stored groundwater purchases under the EWA Program alternatives are already detailed in the Groundwater section of this EIS/EIR (Chapter 6), and because potential effects were determined to be less than significant, in part due to the local monitoring and mitigation required by the groundwater mitigation measure, an additional redundant assessment of use of purchased stored groundwater in the Kern subbasin was not deemed warranted. See Chapter 6, Groundwater, of this EIS/EIR for additional detail regarding the potential effects associated with stored groundwater purchases under the EWA Program.

EWA acquisitions obtained through stored groundwater purchases from the Kern subbasin banking projects and conveyed directly into the California Aqueduct have the potential to affect water quality in the California Aqueduct. In the California Aqueduct, monitoring data show that TDS concentrations are lower in wet years and higher in dry years. Water quality in the California Aqueduct also has been reduced over time because of increased volumes of irrigation runoff inflow, which may contain elevated salinity levels. EWA acquisitions from groundwater substitution have the potential to influence water quality in the California Aqueduct by introducing new or increased quantities of existing constituents of concern (initially present in groundwater and pumped to the surface) into the water flowing through the California Aqueduct. EWA acquisitions from stored groundwater purchases in the Export Service Area may be conveyed directly into the California Aqueduct. In order to assess the potential effects to water quality resulting from the direct conveyance of purchased stored groundwater to the California Aqueduct, a description of the water quality criteria used by DWR for acceptance of non-Project water into the California Aqueduct was provided. Potential effects to water quality occurring under the EWA Program alternatives as compared to the Baseline Condition were assessed by evaluating whether the acceptance criteria would be exceeded under the EWA Program alternatives.

5.2.1.4 Groundwater Substitution

EWA acquisitions obtained through groundwater substitution could result in alterations to water quality through mixing of groundwater and surface water following application of groundwater to agricultural fields for irrigation. Mixing of groundwater and surface water may alter water quality constituent concentrations in agricultural drainage, which potentially could affect the water quality in rivers due to irrigation return flows. EWA acquisitions obtained through groundwater substitution could also result in alterations to water quality indirectly through changes in river flows and water surface elevation during reservoir hold-back periods when farmers participating in EWA Program groundwater substitution are not utilizing their surface water allotment. Potential water quality effects associated with EWA acquisition from groundwater substitution resulting from changes in river flows and surface water elevation in project reservoirs were assessed in Section 5.2.5.1 because the assumptions used in the hydrologic modeling conducted for this analysis account for EWA acquisitions by groundwater substitution (see Attachment 1). Potential alterations in river flows and reservoir water surface elevations for waterbodies located in basins where groundwater substitution could occur are addressed in Section 5.2.5.1.

Potential effects to water quality resulting from application of groundwater to agricultural fields was assessed using qualitative descriptions of the application of groundwater to fields under the EWA Program alternatives relative to the Baseline Condition. Potential effects to water quality occurring under the EWA Program alternatives as compared to the Baseline Condition were assessed by conceptually comparing the dilution potential under the EWA Program alternatives to the dilution potential under the Baseline Condition. Fully quantitative assessments of groundwater effects and groundwater-surface water interactions are often speculative, and rely heavily on calculations, modeling and qualitative interpretations of data, without sufficient supporting direct measurement and observation. Therefore, the methodologies described above were used to assess potential effects to water quality resulting from groundwater substitution.

5.2.1.5 Source Shifting

EWA acquisitions obtained through source shifting may result in alterations to water surface elevation in reservoirs used by the EWA Program (San Luis Reservoir, Anderson Reservoir, Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake). Reducing water surface elevation may affect water quality within these reservoirs. In order to assess whether implementation of the EWA Program alternatives would result in effects to water quality from water surface elevation reductions in San Luis Reservoir, Anderson Reservoir, Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake, a qualitative description of expected water surface elevation reductions under the EWA Program alternatives and under the Baseline Condition were provided for each evaluated reservoir. Potential effects to water quality occurring under the EWA Program alternatives, as compared to the Baseline Condition, were assessed by conceptually comparing the water surface elevation in these reservoirs under EWA Program alternatives to the water surface elevations under the Baseline Condition and assessing whether alterations in water surface elevation resulting from implementation of the EWA Program alternatives would adversely affect designated beneficial uses, exceed existing regulatory standards, or substantially degrade water quality.

5.2.2 Environmental Measures Incorporated into the Project

EWA agencies have incorporated the following measures into the project to continue with standard Project operating procedures and to improve the water quality to users south of the Delta and in the Export Service Area.

1. Carriage water will be used to protect and maintain chloride concentrations in the Delta. (Further discussed in Section 5.2.2.1.)

2. EWA agencies will only purchase water if it meets all of the required provisions of DWR's acceptance criteria governing conveyance of non-Project water through the California Aqueduct. (Further discussed in Section 5.2.2.2.)

5.2.2.1 Carriage Water

Carriage water[2] is an increase in Delta outflow that protects Delta water quality and maintains chloride concentrations at levels that would be equivalent to those under the Baseline Condition. Carriage water is currently used to increase Delta outflow and to protect and maintain Delta water quality. DWR and Reclamation historically charged entities a flat 20 percent carriage water charge for water purchased upstream from the Delta and conveyed through the CVP/SWP pumps to the south of Delta SWP/CVP water users during the summer months. For example, if an entity, in this case the EWA, wanted to pump 80 acre-feet, the entity would have to buy 100 acre-

[2] Increases in Delta chloride concentrations due to increases in CVP and SWP pumping from the south Delta could occur when the total pumping is greater than the flows into the central and south Delta, less the in-Delta agricultural uses in the central and south Delta. Flows into the central and south Delta include flows from the Sacramento River into the central Delta through the CVP Delta Cross Channel facility and Georgiana Slough; flows from eastside streams such as the Mokelumne, Cosumnes, and Calaveras rivers; and flows from the San Joaquin River. When the total SWP and CVP pumping exceeds the total inflow to the central and south Delta, less agriculture uses in the central and south Delta, the difference must come from the Sacramento River via three Mile Slough or around the western end of Sherman Island. When CVP and SWP pumping exceeds the total of inflow to the central and south Delta less agriculture uses in the central and south Delta, ocean salts move upstream in the lower San Joaquin River resulting in an increase in salinity in the Central and South Delta and at the CVP and SWP pumping plants. Thus, increased pumping in summer months to pump EWA pay-back water thought the Delta has the potential to cause increased chloride concentrations in the Delta. However, carriage water, which is an increase in Delta outflow used to maintain chloride concentrations at pre-increased CVP/SWP levels, allows the maintenance of chloride concentrations during increased pumping in the summer months, as described above.

feet. The 100 acre-feet would be provided as inflow to the Delta and 20 acre-feet of the transfer would be used to increase Delta outflow to ensure that chloride concentrations would not increase due to the 80 acre-feet of increased pumping. In the last two years, Reclamation and DWR have developed a way to use DSM2 on a real time basis to estimate the amount of carriage water needed in that year to pump EWA water (or any other water supply including SWP water users, the CVP, and other entities purchasing water upstream from the Delta) without causing an increase in chloride concentration in the Delta. DWR's and Reclamation's work the past two years indicate that the carriage water required to protect Delta water quality can range from 15 to 25 percent or more. Given these newly developed techniques, the EWA can purchase water upstream from the Delta, but for every acre-foot purchased, 15 to 25 percent or more of that acre-foot would be dedicated to increase Delta outflow. The remainder would be pumped at the CVP/SWP pumping plants to ensure, at a minimum, no net increase in chloride concentrations within the Delta would occur due to the EWA Program. During past EWA water transfers involving changes in the timing of CVP/SWP exports, carriage water has provided the mechanism necessary to maintain water quality in the Delta.

5.2.2.2 California Aqueduct Pump-in Quality

DWR has developed acceptance criteria to govern the water quality of non-Project water (groundwater) conveyed through the California Aqueduct. In accordance with the Water Code and DWR's acceptance criteria, non-Project water may be conveyed, wheeled, or transferred in the SWP provided that water quality is protected (DWR 2001a). Therefore, groundwater supplied to the California Aqueduct through groundwater substitution under the Flexible Purchase Alternative would only be purchased by EWA and accepted by the SWP if the non-Project water met all of the required provisions of the acceptance criteria.

General provisions for the acceptance criteria under this agreement include:

- The proponent of any non-Project water input proposal shall demonstrate that the water is of consistent, predictable and acceptable quality;
- The DWR shall consider all non-Project water input proposals based upon the criteria established in the acceptance criteria;
- DWR will consult with the SWP contractors and the Department of Health Services on drinking water quality issues relating to non-Project water as needed to assure the protection of SWP water quality;
- Nothing stated in the acceptance criteria shall be considered as authorizing the objectives of Article 19 of the water supply contracts or drinking water maximum contaminant levels to be exceeded; and
- These criteria shall not constrain DWR's ability to operate the SWP for its intended purposes or to protect its integrity during emergencies. There shall not be any adverse impacts to SWP water deliveries, operations, or facilities.

Under the general provisions, DWR will use a two-tier approach for accepting non-Project water into the California Aqueduct. Tier 1 programs have a "no adverse impact" criteria and shall be tied to historical water quality levels in the California Aqueduct. Programs meeting Tier 1 criteria shall be approved by DWR. Tier 2 programs have water quality levels that exceed the historical water quality levels in the California Aqueduct and have potential to cause adverse effects to State water contractors. Tier 2 programs shall be referred to a State water contract facilitation group for review. The facilitation group would review the program and, if needed, make recommendations to DWR to use during consideration of the project (DWR 2001a).

DWR monitors water quality in the California Aqueduct to ensure that SWP water quality meets Department of Health Services drinking water standards and Article 19 Water Quality Objectives for long-term SWP contracts. The objective of the SWP water quality monitoring program is to maintain project water at a quality acceptable for recreation, agriculture, and public water supply for the present and future, under a policy of multiple uses of the facilities. Recreational uses of SWP facilities included fishing, boating, and water contact sports. The Department analyzes the water for physical parameters such as water temperature, specific conductance, turbidity, and more than 60 other chemical constituents including inorganic chemicals, pesticides, and organic carbon. Under Tier 1, all constituents of non-Project water shall not exceed the historical water quality levels measured at the O'Neill Forebay Outlet (formerly Check 13) on the SWP as measured by DWR's water quality monitoring program (Table 5-32 and Table 5-33) (DWR 2001a).

Table 5-32
Historical Water Quality Conditions 1988-2001 at O'Neill Forebay Outlet (mg/L)

Metals, Minerals and Others					
	Mean	***Min***	***Max***	***Stand Dev***	***Count***
Aluminum	0.029	0.004	0.527	0.050	137
Antimony	0.005*	0.005*	0.005*	0.000	10
Arsenic	0.002	0.001	0.004	0.000	215
Barium	0.050	0.037	0.068	0.002	139
Beryllium	0.001*	0.001*	0.001*	0.000	11
Bromide	0.21	0.05	.54	0.11	121
Cadmium	0.004	0.001*	0.005	0.002	139
Chromium	0.005*	0.005*	0.011	0.001	189
Copper	0.005	0.001*	0.028	0.003	214
Fluoride	0.09	0.01*	0.40	0.05	225
Iron	0.049	0.005	0.416	0.058	214
Manganese	0.007	0.003	0.06	0.004	17
Mercury	0.0008	0.0002*	0.0010	0.0004	163
Nickel	0.002	0.001*	0.004	0.001	11
Nitrate	3.5	0.6	9.6	1.8	192
Nitrate-Nitrite	0.6	0.1	1.2	0.3	22
Nitrite	0.5	0.3	1.1	0.2	21
Selenium	0.001	0.001*	0.001*	0	208
Silver	0.004	0.001*	0.005	0.002	139

Table 5-32 Historical Water Quality Conditions 1988-2001 at O'Neill Forebay Outlet (mg/L)					
Metals, Minerals and Others					
	Mean	Min	Max	Stand Dev	Count
Sulfate	43	16	99	15	228
Total Organic Carbon	4	3	10	2	131
Zinc	0.009	0.005*	0.210	0.016	206

Source: DWR 2001.
* These values represent reporting limits, actual values would be lower.
Pesticides, herbicides and synthetic organic chemicals are not detected in water samples at this location. Therefore, historical conditions are considered to be represented by less than detection levels for these compounds.

Table 5-33 Salinity Criteria 1979-2000 (Specific Conductance, us/cm)												
Year Type*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet	454	401	393	363	355	351	338	340	299	302	350	343
Near Normal*	474	430	511	302	415	520	462	371	430	474	528	623
Dry	566	510	472	469	403	424	441	486	613	498	715	495
Critical	673	728	642	578	548	597	586	609	648	668	604	756

* Year type is based on water year classification; below normal and above normal have been combined into one designation as near normal.

As stated in the acceptance criteria, "*Blending of multiple water sources prior to inflow into the SWP is acceptable. As part of the non-Project water proposal, water may be introduced into the aqueduct that by itself might cause the ambient baseline to be exceeded, provided that the sum total of all introduced water from a defined project do not exceed the historical baseline for the Aqueduct on an instantaneous flow weighted basis. Blending (mixing) within the aqueduct must be between and cannot overlap any active municipal and industrial delivery locations, without approval of DWR. The proponent shall demonstrate by model or an approach acceptable to DWR and the State water contractor facilitation group, that the water is adequately mixed before reaching the first M&I customer*" (DWR 2001a).

Non-Project water proposals meeting Tier 1 water quality standards shall be approved by DWR without further review by other agencies except as required by law. However, upon approval by DWR of any pumping under Tier 1, the State water contractor facilitation group will be notified by DWR of the action.

Non-Project water exceeding Tier 1 standards or contributing to aqueduct levels that exceed the historical water quality baseline may be considered for input into the SWP on a case-by-case basis by the SWP contractors and DWR. Proposals that would affect SWP water quality delivered to downstream State water contractors will be reviewed by State water contractors. The intent is that proposals that produce an overall net water quality benefit will be approved (DWR 2001a).

A State water contractor non-Project inflow facilitation group will be established and will review all requests for non-Project inflow that do not meet the Tier 1 water quality criteria. This group will consist of representatives from each State water contractor, that chooses to participate. DWR may also participate as an observer. The group will consider the merits, effects, mitigation, cost/benefit ratio and other issues of each Tier 2 non-Project water proposal and provide recommendations to DWR. A consensus recommendation from the facilitation group would be sought regarding a potential exceedance of the historical water quality levels. In the absence of consensus from the facilitation group, DWR will base its decision on the merits of the program and its ability to provide overall benefits to the SWP (DWR 2001a).

Following input from the group, DWR will then consider the facilitation group and any individual SWP contractor recommendations in reviewing the proposal. DWR will make the final decision to approve, modify or deny the non-Project water proposal. Any decision must be in compliance with the law and existing contracts. Once a program for delivery of non-Project water to the Aqueduct has been approved, an annual review of the program will occur by DWR and the State water contractors. As needed, DWR, DHS or State water contractors may recommend changes or additions to these water quality criteria governing non-Project water proposals. Proposed changes or additions will be reviewed by the facilitation group prior to consideration by DWR (DWR 2001a).

5.2.3 Significance Criteria

Table 5-34 lists the effects indicators and significance criteria developed for use in assessing the significance of potential effects upon water quality that may result from implementation of EWA Program alternatives.

Table 5-34
Water Quality Impact Indicators and Significance Criteria for EWA Actions

Impact Indicators	***Significance Criteria***
Stored Reservoir Water (including stored water acquired from crop idling and groundwater substitution)	
CVP/SWP Project Reservoirs Within the Upstream from the Delta Region	
Lake Shasta/Lake Oroville/Folsom Reservoir	
End-of-month reservoir water surface elevation (feet/msl) occurring for each month of the year.	Decrease in reservoir water surface elevation, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 72-year period of record.
End-of-month storage (TAF) for each month of the year.	Decrease in reservoir storage, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 72-year period of record.
Rivers Within the Upstream from the Delta Region	
Sacramento River	
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the year.	Decrease in flow, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge and Freeport for each month of the year.	Increase in water temperature, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 69-year period of record.

Table 5-34
Water Quality Impact Indicators and Significance Criteria for EWA Actions

Impact Indicators	Significance Criteria
Lower Feather River	
Monthly mean flow (cfs) below the Thermalito Afterbay Outlet and at the mouth of the Feather River for each month of the year.	Decrease in flow, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 72-year period of record.
Monthly mean water temperature (°F) below the Thermalito Afterbay Outlet and at the mouth of the Feather River for each month of the year.	Increase in water temperature, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 69-year period of record.
Lower Yuba River	
Mean daily flows (cfs) occurring at the USGS (Marysville and Smartville) gages for each month of the year.	Decrease in flow, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the period of record.
Mean daily water temperatures (°F) at the USGS (Marysville and Daguerre Point Dam) gages for each month of the year.	Increase in water temperature, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the period of record.
Middle Fork American River	
Monthly median flows below Ralston Afterbay for each month of the year.	Decrease in flow, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the period of record.
Lower American River	
Monthly mean flow (cfs) below Nimbus Dam, below Watt Avenue, and at the mouth of the American River for each month of the year.	Decrease in flow, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 72-year period of record.
Monthly mean water temperature (°F) below Nimbus Dam, below Watt Avenue, and at the mouth of the American River for each month of the year.	Increase in water temperature, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 69-year period of record.
Merced River	
Monthly mean flow (cfs) below Crocker-Huffman Dam and at the mouth of the Merced River for each month of the year.	Decrease in flow, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 72-year period of record.
San Joaquin River	
Monthly mean flow (cfs) at the confluence of the Merced River and at Vernalis for each month of the year.	Decrease in flow, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the 72-year period of record.

Table 5-34
Water Quality Impact Indicators and Significance Criteria for EWA Actions

Impact Indicators	Significance Criteria
Non-Project Reservoirs Within the Upstream from the Delta Region	
Little Grass Valley Reservoir/Sly Creek Reservoir/New Bullards Bar Reservoir/French Meadows Reservoir/Hell Hole Reservoir/ Lake McClure	
Median reservoir storage (TAF) and median water surface elevation (feet/msl) occurring each month of the year.	Decrease in median reservoir storage or median water surface elevation, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period over the historical period of record.
Sacramento-San Joaquin Delta Region	
Chloride, bromide, and organic carbon concentrations within the Delta during months of increased pumping.	Alteration in the chloride, bromide, and organic carbon concentrations within the Delta during months of increased pumping resulting in an increase in chloride, bromide or organic carbon, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for the July through September period.
Annual total chloride, bromide, and organic carbon load delivered to CVP and SWP water users.	Increase in the annual salt and organic carbon load delivered to CVP and SWP water users, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality for any month of the annual period.
Crop Idling	
Sediment transport due to wind erosion.	Increase in sediment transport, resulting in sediment deposition in surrounding waterbodies, due to wind erosion, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality.
Timing and quantity of water applied to the land.	Change in the timing and quantity of water applied to the land, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to decrease the physiochemical qualities of surface water resulting in adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality.
Stored Groundwater Purchase	
Export Service Area	
DWR/SWP non-Project water acceptance criteria.	Exceedance of Tier 1 and Tier 2 water quality standards resulting in a deterioration in the physiochemical qualities of water in the California Aqueduct resulting from an input of stored groundwater, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality.
Groundwater Substitution	
Groundwater applied to agricultural fields.	Deterioration in the physiochemical qualities of surface runoff, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term to result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality.

Table 5-34 Water Quality Impact Indicators and Significance Criteria for EWA Actions	
Impact Indicators	**Significance Criteria**
Source Shifting	
Export Service Area Reservoirs (San Luis Reservoir, Anderson Reservoir, Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake)	
Water surface elevation.	Decrease in water surface elevation, relative to the basis of comparison, of sufficient magnitude and frequency over the long-term, to adversely affect designated beneficial uses, exceed existing regulatory standards or substantially degrade water quality.

5.2.4 Environmental Consequences/Environmental Impacts of the No Action/No Project Alternative

The California Environmental Quality Act (CEQA) basis for comparison is defined as the Affected Environment/Existing Condition. It is anticipated that if the EWA were not implemented, actions to protect water quality would continue under existing regulatory requirements. DWR and Reclamation would continue to attempt to re-operate the SWP and CVP, respectively, to avoid decreased deliveries to export users. These actions are described in Chapter 2.

There would be no variation in the reservoir storage levels, river flows, or water temperatures under the No Action/No Project Alternative, as described for the Affected Environment/ Existing Condition. As such, water quality under the No Action/No Project Alternative would exhibit the same range of constituent levels and be subject to the same environmental, riverine, and oceanic influences and variations (e.g., tidal currents, wind patterns, oceanic inflow, climatic variations, water supply operations, and established inland flow regimes) that already are present under the Affected Environment/Existing Condition. Further, there would be no variation in the existing range of timing, magnitude and duration of actions occurring under the No Action/No Project Alternative, as compared to the Affected Environment/ Existing Condition. Therefore, there would be no water quality effects associated with No Action/No Project Alternative.

As described in the above paragraphs, the Affected Environment and the No Action/No Project Alternative are the same; therefore, they are collectively referred to as the Baseline Condition in the following sections.

5.2.5 Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative

The Flexible Purchase Alternative allows asset acquisition of up to 600,000 acre-feet[3] and does not specify transfer limits in the Upstream from the Delta Region or the Export Service Area. Total transfers made in the Upstream from the Delta Region would range from 50,000 to 600,000 acre-feet, limited by hydrologic year and conveyance capacity through the Delta. Although potential transfers would not all

[3] Flexible Purchase Alternative acquisition amount includes all variable assets except Export/Inflow Ratio. (Refer to Section 2.4.2.2 for description of variable assets.)

occur in one year, this section discusses maximum transfers to the EWA from all agencies (a transfer amount that would result in greater than 600,000 acre-feet) to provide an effect analysis of a maximum transfer scenario. Similarly, the evaluation includes an analysis of up to 540,000 acre-feet from the Export Service Area to cover a maximum transfer scenario for that region.

The analysis provides an evaluation of the Flexible Purchase Alternative as compared to the Baseline Condition. The impact indicators selected to evaluate the resource topics represent the potential effect issues. A discussion for each effect issue is presented for the alternative. The anticipated change that would occur under each scenario is compared to the significance criteria to ascertain whether the EWA Program alternative would result in "*beneficial*," "*less-than-significant*," or "*significant*" impacts on water quality. Appendix G, Water Quality Technical Appendix, presents a detailed discussion of the changes in the Flexible Purchase Alternative compared to the Baseline Condition.

5.2.5.1 Stored Reservoir Water (Including Stored Water Acquired from Crop Idling and Groundwater Substitution)

5.2.5.1.1 CVP/SWP Reservoirs Within the Upstream from the Delta Region

<u>Lake Shasta</u>

EWA acquisition of Sacramento River contractor water via stored reservoir water, groundwater substitution and crop idling under the Flexible Purchase Alternative would alter surface water elevation and reservoir storage in Lake Shasta, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, long-term average end-of-month water surface elevation and storage in Lake Shasta would remain essentially equivalent to the Baseline Condition during every month of the year. Table 5-35 and Table 5-36 show the long-term end-of-month surface elevation and storage differences for the flexible purchase alternative compared to the Baseline Condition. The long-term average end-of-month water surface elevation in Lake Shasta would not decrease by more than 1 foot in any of the months included in the analysis. Long-term end-of-month storage would not change by more than 0.6 percent.

Table 5-35 Long-term Average Lake Shasta End-of-Month Elevation Under the Baseline Condition and Flexible Purchase Alternative			
Month	**Average Elevation[1] (feet msl)**		
	Baseline Condition	**Flexible Purchase Alternative**	**Difference**
Jan	998	998	0
Feb	1011	1011	0
Mar	1027	1027	0
Apr	1037	1037	0
May	1036	1036	0
Jun	1024	1024	0
Jul	1001	1001	0
Aug	984	983	-1
Sep	977	977	0
Oct	973	972	0
Nov	977	977	0
Dec	985	985	0

[1] Based on 72 years modeled.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Table 5-36 Long-term Average Lake Shasta End-of-Month Storage Under the Baseline Condition and Flexible Purchase Alternative				
Month	**Average Storage[1] (TAF)**		**Difference**	
	Baseline Condition	**Flexible Purchase Alternative**	**(TAF)**	**(%)[2]**
Jan	2914	2914	0	0.0
Feb	3184	3184	0	0.0
Mar	3544	3544	0	0.0
Apr	3793	3793	0	0.0
May	3780	3780	0	0.0
Jun	3495	3495	0	0.0
Jul	3018	2999	-19	-0.6
Aug	2655	2645	-10	-0.4
Sep	2511	2510	-1	0.0
Oct	2432	2432	0	0.0
Nov	2509	2509	0	0.0
Dec	2672	2672	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

In addition to an evaluation of average end-of-month surface elevation and storage differences over the projected EWA project time, end-of-month surface elevation and storage differences were evaluated under critical year, dry year and below normal year conditions. The results are presented in Table 5-37.

Table 5-37
Lake Shasta End-of-Month Surface Elevation and Storage for Critical, Dry and Below Normal Years

	Water Surface Elevation				Reservoir Storage			
	Largest Increase	Percent Difference	Largest Decrease	Percent Difference	Largest Increase	Percent Difference	Largest Decrease	Percent Difference
Year-type	(FT)	(%)	(FT)	(%)	(TAF)	(%)	(TAF)	(%)
Critical	0.4	0.05%	-2.3	-0.26%	4.4	0.44%	-28	-2.6%
Dry	0.3	0.03%	-1	-0.11%	5	0.2%	-15	-0.9%
Below Normal	0.7	0.07%	-1.3	-0.13%	14	0.6%	-30	-1%

Overall, Lake Shasta end-of-month water surface elevation and reservoir storage under the Flexible Purchase Alternative would be essentially equivalent to or greater than end-of-month water surface elevation and reservoir storage under the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative would not adversely affect concentrations of water quality constituents or water temperatures in Lake Shasta. As a result, any differences in water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect water quality in such a way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality. Consequently, potential effects to water quality in Lake Shasta would be less than significant.

Lake Oroville

EWA acquisition of Feather River contractor water via stored reservoir water, groundwater substitution and crop idling under the Flexible Purchase Alternative would alter surface water elevations or reservoir storage in Lake Oroville, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, the long-term average end-of-month water surface elevation and storage in Lake Oroville would remain essentially equivalent to or greater than the Baseline Condition during most months of the year. Tables 5-38 and 5-39 show the long-term end-of-month elevation and storage differences for the flexible purchase alternative compared to the Baseline Condition.

Table 5-38 Lake Oroville End-of-Month Elevation Under the Baseline Condition and Flexible Purchase Alternative			
	Average Elevation[1] (feet msl)		
Month	Baseline Condition	Flexible Purchase Alternative	Difference
Jan	807	807	0
Feb	824	824	0
Mar	840	840	0
Apr	857	857	0
May	864	866	2
Jun	849	852	3
Jul	825	821	-4
Aug	794	791	-3
Sep	782	782	0
Oct	775	775	0
Nov	780	780	0
Dec	791	791	0

[1] During 72 years modeled.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1, Assessment Methods.

Table 5-39 Long-term Average Lake Oroville End of Month Storage Under the Baseline Condition and Flexible Purchase Alternative				
	Average Storage[1] (TAF)		Difference	
Month	Baseline Condition	Flexible Purchase Alternative	(TAF)	(%)[2]
Jan	2350	2350	0	0.0
Feb	2525	2525	0	0.0
Mar	2704	2704	0	0.0
Apr	2953	2953	0	0.0
May	3056	3073	17	0.6
Jun	2849	2888	39	1.4
Jul	2557	2507	-50	-2.0
Aug	2218	2192	-26	-1.2
Sep	2105	2103	-2	-0.1
Oct	2047	2047	0	0.0
Nov	2099	2099	0	0.0
Dec	2199	2199	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

In addition to an evaluation of average end-of-month surface elevation and storage differences over the projected EWA project time, end-of-month surface elevation and storage differences were evaluated under critical year, dry year and below normal year conditions. Tables 5-40 summarizes the results.

Table 5-40 Lake Oroville End-of-Month Surface Elevation and Storage for Critical, Dry and Below Normal Years								
	Water Surface Elevation				**Reservoir Storage**			
	Largest Increase	***Percent Difference***	***Largest Decrease***	***Percent Difference***	***Largest Increase***	***Percent Difference***	***Largest Decrease***	***Percent Difference***
Year-type	(FT)	(%)	(FT)	(%)	(TAF)	(%)	(TAF)	(%)
Critical	10	1.3%	-7	-1%	92	6%	-52	-4%
Dry	6	0.7%	-5	-0.6%	77	3.1%	-50	-2.3%
Below Normal	3	0.3%	-4	-0.5%	40	1.3%	-53	-2.1%

Overall, Lake Oroville end-of-month water surface elevation and reservoir storage under the Flexible Purchase Alternative would not be substantially less than end-of-month water surface elevation and reservoir storage under the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative would not adversely affect concentrations of water quality constituents or water temperatures in Lake Oroville. As a result, any differences in water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect water quality in such as way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality. Consequently, potential effects to water quality would be less than significant.

Folsom Reservoir

EWA acquisition of American River contractor water via stored reservoir water, groundwater substitution and crop idling under the Flexible Purchase Alternative would alter surface water elevation and reservoir storage in Folsom Reservoir, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, the long-term average end-of-month water surface elevation and storage in Folsom Reservoir would remain essentially equivalent to the Baseline Condition during every month of the year. Table 5-41 and Table 5-42 show the long-term end-of-month elevation and storage differences for the flexible purchase alternative compared to the Baseline Condition. Under the Flexible Purchase Alternative, the end-of-month water surface elevation and storage in Folsom Reservoir would be essentially equivalent to or greater than the Baseline Condition for 863 months of the 864 months included in the analysis.

Table 5-41 ***Long-term Average Folsom Reservoir End-of-Month Elevation Under the Baseline Condition and Flexible Purchase Alternative***			
	Average Elevation[1] (feet msl)		
Month	***Baseline Condition***	***Flexible Purchase Alternative***	***Difference***
Jan	411	411	0
Feb	414	414	0
Mar	425	425	0
Apr	438	438	0
May	449	449	0
Jun	444	444	0
Jul	428	427	-1
Aug	421	420	-1
Sep	411	411	0
Oct	409	409	0
Nov	407	407	0
Dec	408	408	0

[1] Based on 72 years modeled.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Table 5-42 ***Long-term Average Folsom Reservoir End-of-Month Storage Under the Baseline Condition and Flexible Purchase Alternative***				
	Average Storage[1] (TAF)		***Difference***	
Month	***Baseline Condition***	***Flexible Purchase Alternative***	***(TAF)***	***(%)[2]***
Jan	473	473	0	0.0
Feb	495	495	0	0.0
Mar	584	584	0	0.0
Apr	703	703	0	0.0
May	815	815	0	0.0
Jun	769	769	0	0.0
Jul	626	622	-4	-0.6
Aug	568	565	-3	-0.5
Sep	488	488	0	0.0
Oct	469	469	0	0.0
Nov	451	451	0	0.0
Dec	457	457	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

In addition to an evaluation of average end-of-month surface elevation and storage differences over the projected EWA project time, end-of-month surface elevation and storage differences were evaluated under critical year, dry year and below normal year conditions. Table 5-43 summarizes the results.

Table 5-43 Folsom Reservoir End-of-Month Surface Elevation and Storage for Critical, Dry and Below Normal Years								
	Water Surface Elevation				**Reservoir Storage**			
	Largest Increase	**Percent Difference**	**Largest Decrease**	**Percent Difference**	**Largest Increase**	**Percent Difference**	**Largest Decrease**	**Percent Difference**
Year-type	(FT)	(%)	(FT)	(%)	(TAF)	(%)	(TAF)	(%)
Critical	0	0	-1	-0.2%	0	0	-3	-0.1%
Dry	0	0	-0.4	-0.1%	0	0	-3	-0.8%
Below Normal	0	0	-0.4	-0.1%	0	0	-4	-0.6%

Overall, Folsom Reservoir end-of-month water surface elevation and reservoir storage under the Flexible Purchase Alternative would be essentially equivalent to or greater than end-of-month water surface elevation and reservoir storage under the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative would not adversely affect concentrations of water quality constituents or water temperatures in Folsom Reservoir. As a result, any differences in water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect water quality in such as way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality. Consequently, potential effects to water quality would be less than significant.

5.2.5.1.2 Non-Project Reservoirs Within the Upstream from the Delta Region

Little Grass Valley and Sly Creek Reservoirs

EWA acquisition of OWID stored reservoir water would reduce surface water elevation and reservoir storage in Little Grass Valley and Sly Creek reservoirs, relative to the Baseline Condition.

Table 5-44 provides monthly median reservoir storage and water surface elevation for Little Grass Valley Reservoir. Reductions in median reservoir storage would range from 3 percent in April to 24 percent in December under the Flexible Purchase Alternative relative to the Baseline Condition. Reductions in median water surface elevation would range from 2 feet in April to 12 feet in December under the Flexible Purchase Alternative relative to the Baseline Condition.

Table 5-44
Little Grass Valley Reservoir Monthly Median Storage, and Water Surface Elevation Under the Baseline Condition and Flexible Purchase Alternative

	Storage				Elevation		
Month	Baseline Condition (TAF)	Flexible Purchase Alternative (TAF)	Diff (TAF)	Diff (%)	Baseline Condition (ft msl)	Flexible Purchase Alternative (ft msl)	Diff (ft msl)
Oct	52	52	0	0	5018	5018	0
Nov	50	44	-6	-12	5015	5010	-6
Dec	50	38	-12	-24	5016	5004	-12
Jan	57	48	-10	-17	5022	5013	-9
Feb	63	55	-7	-11	5027	5021	-6
Mar	70	65	-5	-7	5033	5029	-4
Apr	76	73	-2	-3	5037	5035	-2
May	86	86	0	0	5044	5044	0
Jun	86	86	0	0	5044	5044	0
Jul	76	76	0	0	5037	5037	0
Aug	66	66	0	0	5029	5029	0
Sep	58	58	0	0	5023	5023	0

Based on median monthly storage and flow over the historical record from 1970 to 2001.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

In Little Grass Valley Reservoir, hydrologic conditions under the Flexible Purchase Alternative during critical years would result in reduction of median reservoir storage and median water surface elevation from the months of November through April as compared to the Baseline Condition. Hydrologic conditions under the Flexible Purchase Alternative during dry and below normal years would result in similar reductions than those of the critical year. Table 5-45 summarizes reductions in water surface elevation and reservoir storage in Little Grass Valley reservoir in critical and dry and below normal years, compared to the Baseline Condition.

Table 5-45
Little Grass Valley Reservoir End-of-Month Surface Elevation and Storage for Critical, Dry and Below Normal Years

	Water Surface Elevation Reductions				Reservoir Storage Reductions	
	Largest Reduction	Percent Difference	Smallest Reduction	Percent Difference	Largest Reduction	Smallest Reduction
Year-type	(FT)	(%)	(FT)	(%)	(TAF)	(TAF)
Critical	-12	-24%	-2	-3%	-12	-2
Dry and Below Normal	-12	-24%	-2	-3%	-12	-2

In Sly Creek Reservoir, hydrologic conditions under the Flexible Purchase Alternative would result in reduction of median reservoir storage and water surface elevation from the months of November through April as compared to the Baseline Condition (Table 5-46). Reductions in median reservoir storage would range from 2 percent in April to 27 percent in December under the Flexible Purchase Alternative relative to the Baseline Condition. Reductions in median water surface elevation would range from 2 feet in April to 18 feet in December under the Flexible Purchase Alternative relative to the Baseline Condition.

Table 5-46 Sly Creek Reservoir Monthly Median Storage and Elevation Under the Baseline Condition and Flexible Purchase Alternative							
	Storage				*Elevation*		
Month	***Baseline Condition (TAF)***	***Flexible Purchase Alternative (TAF)***	***Diff (TAF)***	***Diff (%)***	***Baseline Condition (ft msl)***	***Flexible Purchase Alternative (ft msl)***	***Diff (ft msl)***
Oct	22	22	0	0	3438	3438	0
Nov	21	18	-3	-12	3434	3425	-8
Dec	19	14	-5	-27	3427	3410	-18
Jan	27	23	-4	-15	3453	3441	-12
Feb	36	33	-3	-8	3476	3468	-8
Mar	48	46	-2	-4	3504	3500	-4
Apr	55	54	-1	-2	3521	3519	-2
May	62	62	0	0	3536	3536	0
Jun	58	58	0	0	3525	3525	0
Jul	48	48	0	0	3504	3504	0
Aug	33	33	0	0	3469	3469	0
Sep	25	25	0	0	3447	3447	0

Based on median monthly storage and flow over the historical record from 1970 to 2001. Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Hydrologic conditions under the Flexible Purchase Alternative during critical and dry and below normal years would result in reduction of median reservoir storage for the months of November through April as compared to the Baseline Condition. The largest reductions would occur during December and the smallest during April, relative to the Baseline Condition. Table 5-47 summarizes reductions in water surface elevation and reservoir storage in Sly Creek Reservoir in critical and dry and below normal years, compared to the Baseline Condition.

Table 5-47 Sly Creek Reservoir End-of-Month Surface Elevation and Storage for Critical, Dry and Below Normal Years						
	Water Surface Elevation Reductions				***Reservoir Storage Reductions***	
	Largest Reduction	***Percent Difference***	***Smallest Reduction***	***Percent Difference***	***Largest Reduction***	***Smallest Reduction***
Year-type	(FT)	(%)	(FT)	(%)	(TAF)	(TAF)
Critical	-5	-27%	-1	-2%	-18	-2
Dry and Below Normal	-5	-27%	-1	-2%	-21	-2

Overall, median water surface elevation and median reservoir storage in Little Grass Valley and Sly Creek Reservoirs under the Flexible Purchase Alternative would be decreased from November to April as compared to the Baseline Condition. Water temperatures during these months of the year would be at their lowest points during the annual cycle, and therefore the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in water temperature that would affect overall reservoir water quality. Additionally, because of the high quality of the water flowing into these reservoirs, the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in concentrations of water quality constituents that would affect overall reservoir water quality. As a result, any differences in median water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect long-term water quality in such a way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality. Consequently, potential effects to water quality in Little Grass Valley and Sly Creek Reservoirs would be less than significant.

<u>New Bullards Bar Reservoir</u>
EWA acquisition of Yuba County Water Agency via stored reservoir water and groundwater substitution would alter surface water elevation and reservoir storage in New Bullards Bar Reservoir, relative to the Baseline Condition.

Table 5-48 provides monthly median reservoir storage and water surface elevation for New Bullards Bar Reservoir. In New Bullards Bar Reservoir, hydrologic conditions under the Flexible Purchase Alternative would result in reduction of median reservoir storage and water surface elevation from the months of July through January as compared to the Baseline Condition. Median reservoir storage would increase by up to 5 percent between April and June. Additionally, median water surface elevation would increase by up to 5 feet between April and June.

Table 5-48
New Bullards Bar Reservoir Monthly Median Storage and Elevation Under the Baseline Condition and Flexible Purchase Alternative

Month	Storage				Elevation		
	Baseline Condition (TAF)	Flexible Purchase Alternative (TAF)	Diff (TAF)	Diff (%)	Baseline Condition (ft msl)	Flexible Purchase Alternative (ft msl)	Diff (ft msl)
Oct	544	446	-98	-18	1838	1812	-27
Nov	546	449	-98	-18	1839	1812	-26
Dec	532	442	-90	-17	1835	1810	-25
Jan	593	578	-15	-3	1850	1847	-3
Feb	649	649	0	0	1862	1862	0
Mar	735	735	0	0	1878	1878	0
Apr	774	788	14	2	1884	1886	2
May	879	908	28	3	1899	1902	3
Jun	917	960	43	5	1903	1908	5
Jul	825	820	-5	-1	1892	1891	-1
Aug	713	660	-52	-7	1874	1864	-10
Sep	614	514	-100	-16	1855	1831	-24

Based on median monthly storage and flow over the historical record from 1970 to 2001. Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Hydrologic conditions under the Flexible Purchase Alternative during critical years would result in reduction of median water surface elevation and median reservoir storage for the months of July through December as compared to the Baseline Condition. During dry and below normal years, reductions of median water surface elevation and median reservoir storage in would occur from July through January compared to the Baseline Condition. The largest reductions would occur during September and the smallest during July under critical and dry and below normal years, relative to the Baseline Condition. Table 5-49 summarizes reductions in water surface elevation and reservoir storage in New Bullards Bar Reservoir in critical and dry and below normal years, compared to the Baseline Condition.

Table 5-49
New Bullards Bar Reservoir End-of-Month Surface Elevation and Storage for Critical, Dry and Below Normal Years

	Water Surface Elevation Reductions				Reservoir Storage Reductions	
	Largest Reduction	Percent Difference	Smallest Reduction	Percent Difference	Largest Reduction	Smallest Reduction
Year-type	(FT)	(%)	(FT)	(%)	(TAF)	(TAF)
Critical	-100	-19%	-5	-0.8	-28	-1
Dry and Below Normal	-100	-17%	-5	-0.6%	-25	-1

Overall, median water surface elevation and median reservoir storage at New Bullards Bar Reservoir under the Flexible Purchase Alternative would be decreased from July to January, but would increase from April through June as compared to the Baseline Condition. Water temperatures during the months of greatest reductions (September through December) would be low enough that the decrease in median reservoir storage and water surface elevation would not cause an increase in water temperature that would affect overall reservoir water quality. Additionally, because of the high quality of the water flowing into this reservoir, the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in concentrations of water quality constituents that would affect overall reservoir water quality. As a result, any differences in median water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect long-term water quality in such as way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality. Consequently, potential effects to water quality would be less than significant.

<u>French Meadows and Hell Hole Reservoirs</u>

EWA acquisition of Placer County Water Agency-stored reservoir water would decrease surface water elevation and reservoir storage in French Meadows and Hell Hole reservoirs, relative to the Baseline Condition.

Table 5-50 provides monthly median reservoir storage and water surface elevation for French Meadows Reservoir. In French Meadows Reservoir, hydrologic conditions under the Flexible Purchase Alternative would result in reduction of median reservoir storage and median water surface elevation from the months of July through January as compared to the Baseline Condition.

Table 5-50 French Meadows Reservoir Monthly Median Storage, Elevation and Flow Below Ralston Afterbay Under the Baseline Condition and Flexible Purchase Alternative											
	Storage				Elevation			Median Flow Below Ralston (1974-2001)			
Month	Baseline Condition (TAF)	FPA (TAF)	Diff (TAF)	Diff (%)	Baseline Condition (ft msl)	FPA (ft msl)	Diff (ft msl)	Base Cond. (cfs)	FPA (cfs)	Diff (cfs)	Diff (%)
Oct	67	59	-8	-12	5205	5197	-8	258	258	0	0
Nov	59	57	-3	-5	5197	5194	-3	488	275	-213	-43.6
Dec	56	53	-3	-5	5193	5189	-3	265	265	0	0
Jan	61	58	-2	-4	5198	5196	-3	281	266	-15	-5.3
Feb	61	61	0	0	5199	5199	0	437	325	-112	-25.6
Mar	75	75	0	0	5213	5213	0	615	615	0	0
Apr	93	93	0	0	5229	5229	0	554	554	0	0
May	116	116	0	0	5246	5246	0	656	656	0	0
Jun	129	129	0	0	5256	5256	0	631	698	67	10.7
Jul	113	111	-3	-2	5244	5242	-2	629	736	107	17.1
Aug	100	94	-5	-5	5234	5230	-4	666	773	107	16.1
Sep	82	74	-8	-9	5219	5212	-7	456	500	44	9.6

Based on median monthly storage and flow over the historical record from 1974 to 2001 with a maximum 20 TAF EWA Action on French Meadows and Hell Hole Reservoirs combined.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Table 5-51 summarizes monthly median reservoir storage and water surface elevation for French Meadows Reservoir during critical and dry and below normal years. In French Meadows Reservoir, hydrologic conditions under the Flexible Purchase Alternative during critical and dry and below normal years would result in reduction of median reservoir storage during the months of July through October as compared to the Baseline Condition.

Table 5-51 French Meadows Reservoir End-of-Month Surface Elevation and Storage for Critical, Dry and Below Normal Years						
	Water Surface Elevation Reductions				Reservoir Storage Reductions	
	Largest Reduction	Percent Difference	Smallest Reduction	Percent Difference	Largest Reduction	Smallest Reduction
Year-type	(FT)	(%)	(FT)	(%)	(TAF)	(TAF)
Critical	-8	-19%	-2	-4%	-11	-2
Dry and Below Normal	-8	-12%	-3	-3%	-8	-2

In Hell Hole Reservoir, hydrologic conditions under the Flexible Purchase Alternative would result in reduction of median reservoir storage from the months of June through January as compared to the Baseline Condition (Table 5-52).

Table 5-52 Hell Hole Reservoir Monthly Median Storage and Elevation Under the Baseline Condition and Flexible Purchase Alternative							
	Storage				Elevation		
Month	Baseline Condition (TAF)	FPA (TAF)	Diff (TAF)	Diff (%)	Baseline Condition (ft msl)	FPA (ft msl)	Diff (ft msl)
Oct	120	108	-12	-10	4555	4540	-15
Nov	110	106	-4	-4	4542	4536	-6
Dec	104	100	-4	-4	4534	4528	-6
Jan	102	98	-4	-4	4531	4525	-5
Feb	104	104	0	0	4533	4533	0
Mar	110	110	0	0	4542	4542	0
Apr	140	140	0	0	4578	4578	0
May	173	173	0	0	4616	4616	0
Jun	191	187	-4	-2	4637	4632	-5
Jul	168	160	-8	-5	4610	4601	-9
Aug	136	124	-12	-9	4573	4559	-14
Sep	121	109	-12	-10	4555	4540	-15

Based on median monthly storage and flow over the historical record from 1974 to 2001 with a maximum 20 TAF EWA Action on French Meadows and Hell Hole Reservoirs combined. Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Table 5-53 summarizes monthly median reservoir storage and water surface elevation for Hell Hole Reservoir during critical and dry and below normal years. In Hell Hole Reservoir, hydrologic conditions under the Flexible Purchase Alternative during critical and dry and below normal years would result in reduction of median reservoir storage during the months of June through October as compared to the Baseline Condition. The largest decreases in monthly median reservoir storage and water surface elevation would occur during September in both critical and dry and below normal years compared to the Baseline Condition.

Table 5-53 Hell Hole Reservoir End-of-Month Surface Elevation and Storage for Critical, Dry and Below Normal Years						
	Water Surface Elevation Reductions				Reservoir Storage Reductions	
	Largest Reduction	Percent Difference	Smallest Reduction	Percent Difference	Largest Reduction	Smallest Reduction
Year-type	(FT)	(%)	(FT)	(%)	(TAF)	(TAF)
Critical	-12	-3%	-2	-2%	-18	-3
Dry and Below Normal	-12	-11%	-4	-2%	-16	-4

Overall, median water surface elevation and median reservoir storage under the Flexible Purchase Alternative would decrease from June to January in Hell Hole Reservoir and from July to January in French Meadows Reservoir as compared to the Baseline Condition. Water temperatures during the months of greatest reduction (September and October) would be low enough, given the percentage reduction in median reservoir storage, that the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in water temperature that would affect overall reservoir water quality. Additionally, because of the high quality of the water flowing into these reservoirs, the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in concentrations of water quality constituents that would affect overall reservoir water quality. As a result, any differences in median water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect long-term water quality in such as way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality. Consequently, potential effects to water quality in Hell Hole and French Meadows Reservoirs would be less than significant.

Lake McClure

EWA acquisition of Merced Irrigation District (Merced ID) water via groundwater substitution would increase surface water elevation or reservoir storage in Lake McClure, relative to the Baseline Condition.

Table 5-54 provides monthly median reservoir storage and water surface elevation for Lake McClure. In Lake McClure, hydrologic conditions under the Flexible Purchase Alternative would result in an increase in median reservoir storage from the months of May through October as compared to the Baseline Condition. No decreases in median reservoir storage or median water surface elevation would be expected in any month.

Table 5-54
Lake McClure Monthly Median Storage and Elevation
Under the Baseline Condition and Flexible Purchase Alternative

Month	Storage				Elevation		
	Baseline Condition (TAF)	FPA (TAF)	Diff (TAF)	Diff (%)	Baseline Condition (ft msl)	FPA (ft msl)	Diff (ft msl)
Oct	598	611	13	2	778	779	2
Nov	590	590	0	0	777	777	0
Dec	581	581	0	0	776	776	0
Jan	584	584	0	0	776	776	0
Feb	627	627	0	0	781	781	0
Mar	656	656	0	0	784	784	0
Apr	683	687	3	0	787	787	0
May	774	781	8	1	793	794	0
Jun	865	877	13	1	798	799	1
Jul	774	792	18	2	793	794	1
Aug	682	703	22	3	787	788	2
Sep	615	640	25	4	780	783	3

Based on median monthly storage and flow over the historical record from 1970 to 2001.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

In Lake McClure, hydrologic conditions under the Flexible Purchase Alternative during critical and dry and below normal years would not decrease median water surface elevation and median reservoir storage during any month as compared to the Baseline Condition. Increases would occur from April through October compared to the Baseline Condition.

Overall, median water surface elevation and median reservoir storage under the Flexible Purchase Alternative would be increased from May to October and would remain essentially equivalent from June through September as compared to the Baseline Condition. Increases in median reservoir storage and median water surface elevation would benefit the water quality by providing additional water for dilution of constituents and by providing additional water to buffer water temperature increases. As a result, increases in median water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect long-term water quality in such as way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality. Consequently, potential effects to water quality would be less than significant.

5.2.5.1.3 Rivers Within the Upstream from the Delta Region

<u>Sacramento River</u>

EWA acquisition of Sacramento River contractor water via stored reservoir water, groundwater substitution, and crop idling under the Flexible Purchase Alternative would not substantially decrease Sacramento River flow, relative to the Baseline Condition.

The long-term average flow in the Sacramento River below Keswick Dam would decrease by less than 0.8 percent under the Flexible Purchase Alternative, compared to the Baseline Condition, during all months of the year as shown in Table 5-55. In fact, long-term average Sacramento River flow below Keswick Dam under the Flexible Purchase Alternative would not decrease in comparison to flows under the Baseline Condition in any month except August and September, when the long-term average decrease in flow would be 0.5 and 0.8 percent, respectively.

Table 5-55
Long-term Average Release From Keswick Dam
Under the Baseline Condition and Flexible Purchase Alternative

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline Condition	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	5842	5842	0	0.0
Nov	4854	4854	0	0.0
Dec	6672	6672	0	0.0
Jan	7951	7951	0	0.0
Feb	10,056	10,056	0	0.0
Mar	8249	8249	0	0.0
Apr	7706	7706	0	0.0
May	8381	8381	0	0.0
Jun	10,529	10,529	0	0.0
Jul	13,284	13,398	114	0.9
Aug	10,556	10,498	-58	-0.5
Sep	7278	7222	-56	-0.8

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

An evaluation of long-term average flows under the Flexible Purchase Alternative was also done for critical, dry and below normal year hydrologic conditions. Decreases in long-term average flow under the Flexible Purchase Alternative occurred from July through September during a dry year and August through September for critical and below normal years. Table 5-56 summarizes average decreases in long-term average flow in the Sacramento River compared to the Baseline Condition.

Table 5-56
Sacramento River below Keswick Average Decreases in Long-term Average Flow for Critical, Dry and Below Normal Years

Long-term Average Flow Reductions						
	Critical		Dry		Below Normal	
	(cfs)	(%)	(cfs)	(%)	(cfs)	(%)
July	0	0	-17	0.1%	0	0
August	-170	2%	-42	0.5%	-445	4.4%
September	-187	3.5%	-87	1.7%	-319	4.9%

The long-term average flow in the Sacramento River at Freeport would not decrease under the Flexible Purchase Alternative as compared to the Baseline Condition, during any month of the year as shown in Table 5-57. In fact, long-term average flows in the Sacramento River at Freeport would increase by more than one percent from April through September under the Flexible Purchase Alternative as compared to the Baseline Condition. Additionally, under the Flexible Purchase Alternative, flow in the Sacramento River at Freeport during critical, dry, and below normal years would be essentially equivalent to or greater than the Baseline Condition for all months included in the analysis.

Table 5-57
Long-term Average Sacramento River Flow at Freeport
Under the Baseline Condition and Flexible Purchase Alternative

	Monthly Mean Flow[1] (cfs)		Difference	
Month	**Baseline Condition**	**Flexible Purchase Alternative**	**(cfs)**	**(%)[2]**
Oct	11956	12044	88	0.7
Nov	14769	14783	14	0.1
Dec	24922	24927	5	0.0
Jan	33069	33071	2	0.0
Feb	39225	39226	1	0.0
Mar	34296	34299	3	0.0
Apr	25184	25665	481	1.9
May	19724	20076	352	1.8
Jun	18183	18533	350	1.9
Jul	17777	20919	3142	17.7
Aug	13762	15929	2167	15.7
Sep	13729	14373	644	4.7

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Overall, under the Flexible Purchase Alternative, Sacramento River flow at Keswick Dam and Freeport would be essentially equivalent to or greater than the flows under the Baseline Condition. Increases in Sacramento River flow at Freeport during summer months would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. As a result, any differences in flow under the Flexible Purchase Alternative would not be of sufficient frequency and magnitude to affect water quality in a way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Therefore, potential flow-related changes to water quality under the Flexible Purchase Alternative would be less than significant.

EWA acquisition of Sacramento River contractor water via stored reservoir water, groundwater substitution, and crop idling under the Flexible Purchase Alternative would not substantially increase Sacramento River water temperature, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, long-term average water temperature in the Sacramento River at Bend Bridge would not differ during any month of the year, relative to the Baseline Condition (Table 5-58). Moreover, under the Flexible Purchase Alternative, water temperatures in the Sacramento River at Bend Bridge would be essentially equivalent to or less than water temperatures under the Baseline Condition in 826 out of 828 months included in the analysis. Water temperature increases in 2 of 828 months modeled at Bend Bridge would range from 0.1 to 0.5°F [Appendix H, p. 469-480].

Table 5-58
Long-term Average Water Temperature in the Sacramento River at Bend Bridge Under the Baseline Condition and Flexible Purchase Alternative

Month	Water Temperature[1] (ºF)		
	Baseline Condition	Flexible Purchase Alternative	Difference (ºF)
Oct	53.6	53.6	0.0
Nov	51.0	51.0	0.0
Dec	47.0	47.0	0.0
Jan	44.9	44.9	0.0
Feb	48.3	48.3	0.0
Mar	52.1	52.1	0.0
Apr	54.5	54.5	0.0
May	54.6	54.6	0.0
Jun	54.6	54.6	0.0
Jul	54.6	54.6	0.0
Aug	56.8	56.8	0.0
Sep	55.8	55.8	0.0

[1] Based on 69 years modeled.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Under the Flexible Purchase Alternative, the long-term average water temperature in the Sacramento River at Bend Bridge during critical years would be essentially equivalent to or less than the Baseline Condition for 132 months of the 132 months included in the analysis. Under the Flexible Purchase Alternative, the long-term average water temperature in the Sacramento River at Bend Bridge during dry years would be essentially equivalent to or less than the Baseline Condition for 192 months of the 192 months included in the analysis. Under the Flexible Purchase Alternative, the long-term average water temperature in the Sacramento River at Bend Bridge during below normal years would be essentially equivalent to or less than the Baseline Condition for 166 months of the 168 months included in the analysis [Appendix H, p. 1008].

Under the Flexible Purchase Alternative, long-term average water temperature in the Sacramento River at Freeport would not differ from long-term average water temperatures under the Baseline Condition by more than 0.1°F during any month. Additionally, under the Flexible Purchase Alternative, water temperature in the Sacramento River at Freeport during critical, dry, and below normal years would be essentially equivalent to or less than the Baseline Condition for all months included in the analysis.

Overall, water temperature in the Sacramento River at Bend Bridge and Freeport under the Flexible Purchase Alternative would be essentially equivalent to or less than water temperatures relative to the Baseline Condition. Any differences in water temperature would not be of sufficient frequency and magnitude to affect water quality in such as way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Consequently, potential water temperature-related changes to water quality would be less than significant.

Lower Feather River

EWA acquisition of Feather River contractor water via groundwater substitution and crop idling under the Flexible Purchase Alternative would not substantially decrease Feather River flow, relative to the Baseline Condition.

The long-term average flow in the Feather River below the Thermalito Afterbay would not decrease under the Flexible Purchase Alternative as compared to the Baseline Condition, during any month of the year as shown in Table 5-59. In fact, long-term average flows in the lower Feather River below the Thermalito Afterbay would increase by more than one percent from April through October under the Flexible Purchase Alternative as compared to the Baseline Condition.

Table 5-59
Long-term Average lower Feather River Flow Below Thermalito Afterbay Under the Baseline Condition and Flexible Purchase Alternative

	Monthly Mean Flow[1] (cfs)		Difference	
Month	**Baseline Condition**	**FPA**	**(cfs)**	**(%)[2]**
Oct	2441	2509	68	2.8
Nov	2301	2315	14	0.6
Dec	3984	3989	5	0.1
Jan	5005	5007	2	0.0
Feb	5930	5931	1	0.0
Mar	6144	6146	2	0.0
Apr	3416	3734	318	9.3
May	3826	3969	143	3.7
Jun	5084	5192	108	2.1
Jul	5896	7210	1314	22.3
Aug	4434	5737	1303	29.4
Sep	1600	1977	377	23.6

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Decreases in long-term average flow would occur more often during critical, dry, and below normal hydrologic conditions under the Flexible Purchase Alternative. The long-term average flow decrease during critical years would average 1 cfs or less for all months, representing a 0.1 percent or less decrease, compared to the Baseline Condition [Appendix H, p. 1019]. The long-term average flow decrease during dry years would average 163 cfs (2 percent decrease) in July and 3 cfs or less (0.2 percent or smaller decrease) for all other months compared to the Baseline Condition [Appendix H, p. 1019]. The long-term average flow decrease for below normal years would average 252 cfs (3 percent decrease) in July and 4 cfs or less (0.1 percent or less decrease) for all other months, compared to the Baseline Condition [Appendix H, p. 1019].

The long-term average flow at the mouth of the Feather River would not decrease under the Flexible Purchase Alternative as compared to the Baseline Condition, during any month of the year, as shown in Table 5-60. Additionally, under the Flexible Purchase Alternative, flow at the mouth of the Feather River during critical, dry, and below normal years would be essentially equivalent to or greater than the Baseline Condition for all months included in the analysis.

Table 5-60
Long-term Average Feather River Flow at the Mouth
Under the Baseline Condition and Flexible Purchase Alternative

	Monthly Mean Flow[1] (cfs)		Difference	
Month	**Baseline Condition**	**FPA**	**(cfs)**	**(%)[2]**
Oct	3284	3352	68	2.1
Nov	3482	3496	14	0.4
Dec	6227	6232	5	0.1
Jan	11355	11357	2	0.0
Feb	13096	13097	1	0.0
Mar	13182	13184	2	0.0
Apr	9518	9836	318	3.3
May	7735	7877	142	1.8
Jun	7647	7755	108	1.4
Jul	6311	8497	2186	34.6
Aug	4881	6512	1631	33.4
Sep	3404	3852	448	13.2

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Overall, under the Flexible Purchase Alternative, Feather River flow below the Thermalito Afterbay and at the mouth would be essentially equivalent to or greater than the flows under the Baseline Condition. Increases in Feather River flow below Thermalito Afterbay and at the mouth during summer months would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. As a result, any differences in flow would not be of sufficient frequency and magnitude to affect water quality in a way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Therefore, potential flow-related changes to water quality under the Flexible Purchase Alternative would be less than significant.

EWA acquisition of Feather River contractor water via stored reservoir water, groundwater substitution, and crop idling under the Flexible Purchase Alternative would not substantially increase Feather River water temperature, relative to the Baseline Condition. Under the Flexible Purchase Alternative, long-term average water temperature in the Feather River at the Fish Barrier Dam would not differ during any month of the year, relative to the Baseline Condition (Table 5-61).

Table 5-61
Long-term Average Water Temperature in the Feather River Below the Fish Barrier Dam Under the Baseline Condition and Flexible Purchase Alternative

	Water Temperature[1] (ºF)		
Month	**Baseline Condition**	**FPA**	**Difference (ºF)**
Oct	54.0	54.0	0.0
Nov	52.4	52.4	0.0
Dec	48.0	48.0	0.0
Jan	46.0	46.0	0.0
Feb	47.1	47.1	0.0
Mar	49.0	49.0	0.0
Apr	51.0	51.0	0.0
May	55.3	55.3	0.0
Jun	57.4	57.4	0.0
Jul	61.6	61.6	0.0
Aug	60.8	60.8	0.0
Sep	56.5	56.5	0.0

[1] Based on 69 years modeled.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Under the Flexible Purchase Alternative, long-term average water temperature in the Feather River below Thermalito Afterbay would not differ from long-term average temperatures under the Baseline Condition during any month of the year. Additionally, under the Flexible Purchase Alternative, water temperature below the Thermalito Afterbay in the Feather River during critical, dry, and below normal years would be essentially equivalent to or less than the Baseline Condition for all months included in the analysis.

Under the Flexible Purchase Alternative, long-term average water temperature at the mouth of the Feather River would not increase from the long-term average water temperature under the Baseline Condition by more than 0.2°F during any month, as shown in Table 5-62.

Table 5-62
Long-term Average Water Temperature at the Mouth of the Feather River Under the Baseline Condition and Flexible Purchase Alternative

Month	Water Temperature[1] (ºF)		
	Baseline Condition	FPA	Difference (ºF)
Oct	61.3	61.3	0.0
Nov	52.4	52.4	0.0
Dec	45.9	45.9	0.0
Jan	45.3	45.3	0.0
Feb	49.6	49.6	0.0
Mar	54.2	54.2	0.0
Apr	59.8	59.9	0.1
May	65.5	65.6	0.1
Jun	70.0	70.2	0.2
Jul	73.6	73.6	0.0
Aug	72.2	71.8	-0.4
Sep	69.7	69.2	-0.5

[1] Based on 69 years modeled.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Increases in long-term average temperatures at the mouth of the Feather River also would occur in critical, dry and below normal hydrologic conditions, under the Flexible Purchase Alternative. The greatest long-term average water temperature increase (0.35ºF or 0.5 percent) during critical years would occur in May compared to the Baseline Condition [Appendix H, p. 1018]. The greatest long-term average water temperature increase (0.33ºF or 0.5 percent) during dry years also would occur during May, compared to the Baseline Condition [Appendix H, p. 1018]. The greatest long-term average water temperature increase (0.24ºF or 0.3 percent) during below normal years would occur during June, compared to the Baseline Condition [Appendix H, p. 1018].

Overall, water temperature in the Feather River below the Thermalito Afterbay, and at the mouth under the Flexible Purchase Alternative would infrequently be increased by up to 0.7°F and would otherwise be essentially equivalent to or less than water temperatures relative to the Baseline Condition. Any differences in water temperature would not be of sufficient frequency and magnitude to affect water quality in a way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Consequently, potential water temperature-related changes to water quality would be less than significant.

Lower Yuba River

EWA acquisition of lower Yuba River contractor water via stored reservoir water, groundwater substitution and crop idling under the Flexible Purchase Alternative would alter lower Yuba River flow, relative to the Baseline Condition.

The Yuba River is one of many Central Valley rivers that have been utilized in water transfer projects for a number of years. In 2001, Yuba County Water Agency (YCWA) and other local water agencies initiated water transfers from New Bullards Bar Reservoir through the Yuba River in order to satisfy a variety of downstream needs. The total water transfer consisted of approximately 172,000 acre-feet of water, including 114,052 acre-feet utilized by DWR. The water transfers occurred approximately between July 1, 2001 and October 14, 2001. The water transfers increased flows by about 1,200 cfs in the lower Yuba River through late August. Yuba River water transfers also occurred during 2002. Yuba County Water Agency transferred a total of 162,050 acre-feet of water for downstream needs (157,050 acre-feet allocated to DWR, and 5,000 acre-feet to the Contra Costa WD) from approximately mid-June through September, 2002.

Recent historic flows in the Yuba River below Englebright Dam during June through October, the typical time period for water transfers, have been between approximately 600 and 2,500 cfs. Preliminary hydrologic modeling output for flows under the Baseline Condition (without EWA transfer) below Englebright Reservoir would range between approximately 1,000 and 1,800 cfs during June, July, and most of August, ramp down in late August and early September to 500 cfs to 900 cfs, and remain relatively constant at 600 to 900 cfs for October and November until the wet season, at which time unregulated winter storm and snowmelt flows affect the lower Yuba River hydrology. Below Daguerre Point Dam, baseline flows could range from approximately 245 to 800 cfs in June, and from 100 to 250 cfs during July, August, and September. Flows below Daguerre Point Dam in the first two weeks in October could be about 320 to 400 cfs and increase to 400 to 500 cfs for the last two weeks of October through the time period in the winter when runoff from winter storms significantly affect river flows.

Under the Flexible Purchase Alternative, the proposed transfer of 185,000 acre-feet to the EWA is expected to take place mainly in July and August, with some water potentially released between June 1 and July 31, and between September 1 and October 31. During late June, July, and August, flow rates would be relatively constant, at up to 1,200 to 1,500 cfs above Yuba River instream flow and diversion delivery requirements.

Overall, under the Flexible Purchase Alternative, lower Yuba River flow would be greater than the flows under the Baseline Condition, based on data from previous water transfers. Increases in lower Yuba River flow would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. As a result, increases in flow would not be of sufficient frequency and magnitude to affect water quality in such as way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Therefore, potential flow-related changes to water quality under the Flexible Purchase Alternative would be less than significant.

EWA acquisition of lower Yuba River contractor water via stored reservoir water, groundwater substitution and crop idling under the Flexible Purchase Alternative would alter lower Yuba River water temperature, relative to the Baseline Condition.

Monitoring of lower Yuba River water temperatures during past water transfers showed that water temperatures at the mouth of the Yuba River (Highway 70 Bridge) were approximately 73°F prior to the 2001 water transfers. At the same time, similar water temperatures were observed on the Feather River, one kilometer above its confluence with the Yuba River. After the initiation of the 2001 water transfers, water temperatures at the mouth of the Yuba River dropped to an average of 61°F for the remainder of the month (CDFG, unpublished data). Water temperatures at this site remained around 61°F until flows were reduced in late August, at which time the water temperatures increased coincident with flow reduction. Although an evaluation of the numerous variables (e.g., ambient air temperature, cloud cover, diversion rates) which may influence instream water temperatures has not yet been conducted, changes in Yuba River water temperatures were observed coincident with the water transfers.

Overall, under the Flexible Purchase Alternative, lower Yuba River water temperatures would be less than the water temperatures under the Baseline Condition, based on data from previous water transfers. Decreases in Yuba River water temperature with implementation of the Flexible Purchase Alternative would not be of sufficient frequency and magnitude to affect water quality in such as way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Consequently, potential water temperature-related changes to water quality would be less than significant.

<u>Middle Fork American River</u>
EWA acquisition of American River contractor water via stored reservoir water and crop idling under the Flexible Purchase Alternative would alter Middle Fork American River flow, relative to the Baseline Condition.

The median flow in the Middle Fork American River below Ralston Afterbay would not decrease under the Flexible Purchase Alternative, compared to the Baseline Condition, during nine months of the year as shown in Table 5-50. However, median flow in the Middle Fork American River would decrease under the Flexible Purchase Alternative, compared to the Baseline Condition, during November, January and February. Median flow in the Middle Fork American River would decrease by 43.6 percent in November, 5.3 percent in January, and 25.6 percent in February.

Table 5-63 summarizes the largest increases and reductions in median flow in the Middle Fork American River below Ralston Afterbay during critical, dry, and below normal years under the Flexible Purchase Alternative, compared to the Baseline Condition. Decreases in flow generally occur during October or November in critical and dry and below normal years relative to the Baseline Condition.

Table 5-63
Median Flows in Middle Fork American River below Ralston Afterbay for Critical, Dry and Below Normal Years

	Changes in Median Flows			
	Largest Increase	*Percent Difference*	*Largest Decrease*	*Percent Difference*
Year-type	(cfs)	(%)	(cfs)	(%)
Critical	107	27.5%	-265	-81.9%
Dry and Below Normal	107	21.3%	333	-60.4%

Overall, under the Flexible Purchase Alternative, Middle Fork American River median flow below Ralston Afterbay would be essentially equivalent to greater than flows under the Baseline Condition in nine months out of the year. Median flow in the Middle Fork American River would decrease in November, January, and February under the Flexible Purchase Alternative as compared to the Baseline Condition. Increases in Middle Fork American River flow below Ralston Afterbay in June, July, August, and September would allow dilution of water quality constituents. Decreased flows during the months of greatest flow reduction (November and February) would not be expected to cause an increase in water quality constituents that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality because the water quality in the Middle Fork American River is of high quality and concentrations of constituents are generally low. Consequently, potential flow-related effects to water quality would be less than significant.

<u>Lower American River</u>

EWA acquisition of stored groundwater from Sacramento Groundwater Authority members, stored reservoir water, and water obtained through Placer Country Water Agency crop idling and retained in Folsom Reservoir under the Flexible Purchase Alternative would increase lower American River flow, relative to the Baseline Condition.

The long-term average flow in the lower American River below Nimbus Dam, at Watt Avenue, and at the mouth of the American River would not decrease under the Flexible Purchase Alternative, compared to the Baseline Condition, during all months of the year as shown in Table 5-64, Table 5-65, and Table 5-66 respectively. Additionally, under the Flexible Purchase Alternative, flow in the lower American River below Nimbus Dam, at Watt Avenue, and at the mouth of the American River during critical, dry, and below normal years would be essentially equivalent to or greater than the Baseline Condition for all months included in the analysis [Appendix H, p. 1015].

Table 5-64
Long-term Average Release to the Lower American River From Nimbus Dam Under the Baseline Condition and Flexible Purchase Alternative

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline Condition	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	1678	1678	0	0.0
Nov	2502	2502	0	0.0
Dec	3498	3498	0	0.0
Jan	4124	4124	0	0.0
Feb	4989	4989	0	0.0
Mar	3941	3941	0	0.0
Apr	3616	3616	0	0.0
May	3793	3793	0	0.0
Jun	4166	4166	0	0.0
Jul	4100	4208	108	2.6
Aug	2482	2528	46	1.9
Sep	2876	2885	9	2.6

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Table 5-65 Long-term Average Flow at Watt Avenue Under the Baseline Condition and Flexible Purchase Alternative				
	Monthly Mean Flow[1] (cfs)		Difference	
Month	Baseline Condition	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	1507	1507	0	0.0
Nov	2385	2385	0	0.0
Dec	3402	3402	0	0.0
Jan	4038	4038	0	0.0
Feb	4906	4906	0	0.0
Mar	3861	3861	0	0.0
Apr	3428	3428	0	0.0
May	3531	3531	0	0.0
Jun	3814	3814	0	0.0
Jul	3729	3837	108	2.9
Aug	2148	2194	46	2.1
Sep	2633	2642	9	0.3

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Table 5-66 Long-term Average Flow at the Mouth of the lower American River Under the Baseline Condition and Flexible Purchase Alternative				
	Monthly Mean Flow[1] (cfs)		Difference	
Month	Baseline Condition	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	1557	1557	0	0.0
Nov	2426	2426	0	0.0
Dec	3441	3441	0	0.0
Jan	4077	4077	0	0.0
Feb	4949	4949	0	0.0
Mar	3902	3902	0	0.0
Apr	3518	3518	0	0.0
May	3632	3632	0	0.0
Jun	3936	3936	0	0.0
Jul	3851	3958	107	2.8
Aug	2253	2299	46	2.0
Sep	2707	2716	9	0.3

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1, Assessment Methods.

Overall, under the Flexible Purchase Alternative, lower American River flow below Nimbus Dam, at Watt Avenue, and at the mouth would be essentially equivalent to or greater than the flows under the Baseline Condition. Increases in lower American River flow at all three locations during July and August and during September at Nimbus Dam would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. As a result, any differences in flow would not be of sufficient frequency and magnitude to affect water quality in a way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Therefore, potential flow-related changes to water quality under the Flexible Purchase Alternative would be less than significant.

EWA acquisition of stored groundwater from Sacramento Groundwater Authority members, stored reservoir water, and water obtained through Placer Country Water Agency crop idling and retained in Folsom Reservoir under the Flexible Purchase Alternative would not substantially increase American River water temperature, relative to the Baseline Condition. Under the Flexible Purchase Alternative, long-term average water temperature in the American River below Nimbus Dam would slightly increase during several months, relative to the Baseline Condition (Table 5-67).

Table 5-67
Long-term Average Water Temperature in the American River Below Nimbus Dam Under the Baseline Condition and Flexible Purchase Alternative

Month	Water Temperature[1] (ºF)		
	Baseline Condition	Flexible Purchase Alternative	Difference (ºF)
Oct	56.3	56.3	0.0
Nov	56.5	56.5	0.0
Dec	51.2	51.2	0.0
Jan	47.2	47.1	-0.1
Feb	47.8	47.8	0.0
Mar	50.3	50.4	0.1
Apr	53.7	53.8	0.1
May	56.5	56.6	0.1
Jun	59.6	59.6	0.0
Jul	64.3	64.3	0.0
Aug	64.5	64.6	0.1
Sep	65.9	66.1	0.2

[1] Based on 69 years modeled.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1, Assessment Methods.

Evaluation of long-term average water temperature in the American River below Nimbus Dam under the Flexible Purchase Alternative was also done for critical, dry, and below normal hydrologic conditions. Table 5-68 summarizes the largest increases in long-term average water temperature during each hydrologic condition.

Table 5-68
Long-term Average Temperature Increases in the Lower American River below Nimbus Dam for Critical, Dry and Below Normal Years

Year-type	Changes in Average Temperature		
	Largest Increase	Percent Difference	Month Largest Increase Occurs
Critical	0.36ºF	0.5%	September
Dry	0.27ºF	0.5%	September
Below Normal	0.25ºF	0.4%	October

Under the Flexible Purchase Alternative, long-term average water temperature in the American River at Watt Avenue would not differ from long-term average water temperatures under the Baseline Condition by more than 0.1°F during any month, as shown in Table 5-69.

Table 5-69
Long-term Average Water Temperature in the American River at Watt Avenue Under the Baseline Condition and Flexible Purchase Alternative

Month	Water Temperature[1] (ºF)		
	Baseline Condition	Flexible Purchase Alternative	Difference (ºF)
Oct	57.7	57.7	0.0
Nov	55.8	55.8	0.0
Dec	50.2	50.2	0.0
Jan	46.7	46.7	0.0
Feb	48.2	48.2	0.0
Mar	51.2	51.3	0.1
Apr	55.1	55.2	0.1
May	58.7	58.7	0.0
Jun	62.0	62.0	0.0
Jul	66.2	66.2	0.0
Aug	66.9	66.9	0.0
Sep	66.8	66.8	0.0

[1] Based on 69 years modeled.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Evaluation of long-term average water temperature in the American River at Watt Avenue under the Flexible Purchase Alternative was also done for critical, dry, and below normal hydrologic conditions. Table 5-70 summarizes the largest increases in long-term average water temperature during each hydrologic condition.

Table 5-70
Long-term Average Temperature Increases in the Lower American River at Watt Avenue for Critical, Dry and Below Normal Years

Year-type	Changes in Average Temperature		
	Largest Increase	Percent Difference	Month(s) Largest Increase Occurs
Critical	0.33ºF	0.5%	September
Dry	0.20ºF	0.3%	July, August, September
Below Normal	0.23ºF	0.4%	November

Under the Flexible Purchase Alternative, long-term average water temperature at the mouth of the American River would slightly differ from long-term average temperatures under the Baseline Condition during any month, as shown in Table 5-71.

Table 5-71 ***Long-term Average Water Temperature at the Mouth of the American River Under the Baseline Condition and Flexible Purchase Alternative***			
	Water Temperature¹ (ºF)		
Month	***Baseline Condition***	***Flexible Purchase Alternative***	***Difference (ºF)***
Oct	58.4	58.4	0.0
Nov	55.5	55.5	0.0
Dec	49.7	49.6	-0.1
Jan	46.5	46.5	0.0
Feb	48.5	48.5	0.0
Mar	51.7	51.8	0.1
Apr	55.8	55.9	0.1
May	59.7	59.8	0.1
Jun	63.2	63.3	0.1
Jul	67.2	67.2	0.0
Aug	68.1	68.1	0.0
Sep	67.3	67.3	0.0

[1] Based on 69 years modeled.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Evaluation of long-term average water temperature at the mouth of the American River under the Flexible Purchase Alternative was also done for critical, dry, and below normal hydrologic conditions. Table 5-72 summarizes the largest increases in long-term average water temperature during each hydrologic condition.

Table 5-72 ***Long-term Average Temperature Increases Lower American River Mouth for Critical, Dry and Below Normal Years***			
	Changes in Average Temperature		
Year-type	***Largest Increase***	***Percent Difference***	***Month(s) Largest Increase Occurs***
Critical	0.45ºF	0.7%	September
Dry	0.20ºF	0.3%	July
Below Normal	0.25ºF	0.5%	November

Overall, water temperature in the American River below Nimbus Dam, at Watt Avenue and at the mouth under the Flexible Purchase Alternative would slightly increase or would otherwise be essentially equivalent to or less than water temperatures relative to the Baseline Condition. Any differences in water temperature would not be of sufficient frequency and magnitude to affect water quality in such as way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Consequently, potential water temperature-related changes to water quality would be less than significant.

<u>Merced River</u>

EWA acquisition of Merced River contractor water via groundwater substitution under the Flexible Purchase Alternative would increase Merced River flow, relative to the Baseline Condition.

The long-term average flow in the Merced River below Crocker-Huffman Dam and at the mouth of the Merced River would not decrease under the Flexible Purchase Alternative, compared to the Baseline Condition, during any month of the year as shown in Table 5-73 and Table 5-74, respectively.

Table 5-73
Long-term Average Flow Below Crocker-Huffman Dam
Under the Baseline Condition and Flexible Purchase Alternative

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline Condition	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	812	1015	203	25.0
Nov	231	441	210	90.9
Dec	353	353	0	0.0
Jan	493	493	0	0.0
Feb	784	784	0	0.0
Mar	500	500	0	0.0
Apr	501	501	0	0.0
May	894	894	0	0.0
Jun	881	881	0	0.0
Jul	329	329	0	0.0
Aug	159	159	0	0.0
Sep	178	178	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Table 5-74
Long-term Average Flow at the Mouth of the Merced River
Under the Baseline Condition and Flexible Purchase Alternative

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline Condition	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	881	1085	204	23.2
Nov	288	499	211	73.3
Dec	438	438	0	0.0
Jan	596	596	0	0.0
Feb	936	936	0	0.0
Mar	654	654	0	0.0
Apr	517	517	0	0.0
May	865	865	0	0.0
Jun	827	827	0	0.0
Jul	333	333	0	0.0
Aug	189	189	0	0.0
Sep	193	193	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Overall, under the Flexible Purchase Alternative, Merced River flow below Crocker-Huffman Dam and at the mouth would be essentially equivalent to or greater than the flows under the Baseline Condition. Increases in Merced River flow at Crocker-Huffman Dam and at the mouth during October and November would allow dilution of water quality constituents. As a result, any differences in flow would not be of sufficient frequency and magnitude to affect water quality in such a way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Therefore, potential flow-related changes to water quality under the Flexible Purchase Alternative would be less than significant.

San Joaquin River

EWA acquisition of Merced River contractor water via groundwater substitution under the Flexible Purchase Alternative would increase San Joaquin River flow, relative to the Baseline Condition.

The long-term average flow in the San Joaquin River below the confluence with the Merced River would not decrease under the Flexible Purchase Alternative, compared to the Baseline Condition, during any month of the year as shown in Table 5-75.

Table 5-75
Long-term Average San Joaquin River Flow Below the Merced River Under the Baseline Condition and Flexible Purchase Alternative

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline Condition	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	1391	1594	203	14.6
Nov	729	939	210	28.8
Dec	1138	1138	0	0.0
Jan	1648	1648	0	0.0
Feb	2381	2381	0	0.0
Mar	2066	2066	0	0.0
Apr	1739	1739	0	0.0
May	2236	2236	0	0.0
Jun	1997	1997	0	0.0
Jul	830	830	0	0.0
Aug	575	575	0	0.0
Sep	774	774	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

The long-term average flow at Vernalis in the San Joaquin River (for this analysis, also referred to as the long-term average Delta inflow from the San Joaquin River) would not decrease under the Flexible Purchase Alternative as compared to the Baseline Condition, during any month of the year as shown in Table 5-76.

Table 5-76
Long-term Average Delta Inflow from the San Joaquin River Under the Baseline Condition and Flexible Purchase Alternative

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline Condition	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	3016	3219	203	6.7
Nov	1980	2190	210	10.6
Dec	3038	3038	0	0.0
Jan	4505	4505	0	0.0
Feb	6392	6392	0	0.0
Mar	6361	6361	0	0.0
Apr	6127	6127	0	0.0
May	5482	5482	0	0.0
Jun	4219	4219	0	0.0
Jul	2314	2314	0	0.0
Aug	1696	1696	0	0.0
Sep	1909	1909	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.
Note: For a further description of the methodology used for the data assessment, please refer to Section 5.2.1 Assessment Methods.

Overall, under the Flexible Purchase Alternative, San Joaquin River flow below the confluence with the Merced River and at Vernalis would be essentially equivalent to or greater than the flows under the Baseline Condition. Increases in San Joaquin River flow at both locations during October and November would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. As a result, any differences in flow would not be of sufficient frequency and magnitude to affect water quality in such as way that would result in long-term adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Therefore, potential flow-related changes to water quality under the Flexible Purchase Alternative would be less than significant.

5.2.5.1.4 Sacramento-San Joaquin Delta Region

EWA acquisition of water under the Flexible Purchase Alternative would alter the timing of CVP/SWP exports from the Delta, relative to the Baseline Condition.

As discussed in Section 5.2.1.1.3, EWA agencies would implement actions to protect fish in the winter and spring months. The water supply lost due to pumping reductions during these months would be repaid in whole or in part during the summer by water acquired upstream from the Delta and pumped through the Delta to the CVP/SWP water users. Acquired water would reach the Delta during July through September and the CVP and/or SWP pumping plants would pump this water during that period.

The EWA actions implemented in the winter and spring months are reductions in export pumping at the CVP and SWP pumping plants. The reductions in export pumping almost always result in an increase in Delta outflow which in turn results in improvement of in-Delta water quality. The increase in CVP and SWP export pumping during the July through September months to assist in paying back the CVP and SWP for water lost due to the export pumping reductions has the potential to degrade in-Delta water quality. Any increase in chloride concentrations in the Delta would have some potentially adverse effects on in-Delta water users and water users south of the Delta. One of the primary objectives of CALFED is to improve the water quality received by urban water users from the Delta. Any degradation of in-Delta water quality, especially the water received by urban users of Delta water, would be contrary to EWA and CALFED objectives and would be an adverse effect.

As described in Section 5.2.2, EWA agencies would use carriage water to protect and maintain chloride concentrations in the Delta. Therefore, water quality within the Delta would remain essentially unchanged during increased pumping periods under the Flexible Purchase Alternative as compared to the Baseline Condition. As a result the quality of water supplied to in-Delta water users, including Contra Costa WD and others, would be expected to remain essentially equivalent to the Baseline Condition.

The use of carriage water as a mechanism to increase Delta outflows would not only result in no increase in chloride concentrations within the Delta during increased pumping, but would also result in no increase in bromide concentrations within the Delta during increased pumping. The increase in Delta outflow will hold the ocean salts at the same point they were before pumping was increased for the EWA Program. Because bromide is primarily present as a result of seawater intrusion, the use of carriage water to increase Delta outflow and hold ocean salts at the same point they were before pumping was increased would result in no increase in bromide concentrations. As a result, water quality, including salinity, bromide, and the potential for THM and bromate formation, would not be altered in a way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality.

With respect to organic carbon, the Sacramento River consistently exhibits lower organic carbon concentrations than the San Joaquin River and other locations in the Delta. Because increases in Delta outflow during months of increased pumping will come from additional inflow from the Sacramento River, which is water of relatively high quality with respect to organic carbon, increased pumping during the summer months would not result in concentrations of carbon in the Delta under the Flexible Purchase Alternative as compared to the Baseline Condition. Therefore, water quality, including total organic carbon and the potential for THM formation associated with organic carbon, would not be altered in a way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality.

Consequently, overall potential effects to water quality, including salinity, bromide, organic carbon, THM formation potential, and potential for bromate formation, would be less than significant.

EWA acquisition of water under the Flexible Purchase Alternative would alter the timing of CVP/SWP exports to downstream municipal users, relative to the Baseline Condition.

In years when EWA actions occur in the Delta, the quality of water (specifically, the average annual salt load) delivered to the CVP and SWP could be affected because of the change in the monthly pumping pattern resulting from EWA actions. When pumping is reduced by EWA actions in the winter and spring months to repay in whole or in part the water lost from pumping reductions, the CVP/SWP forego pumping water that has relatively low chloride concentrations. To pay back the CVP/SWP projects for all or a portion of the water lost due to the pumping reductions, DWR and Reclamation would increase project pumping during July through September, when the chloride in the Delta may be higher than the chloride concentrations during winter and spring months. However, it is difficult to generalize about seasonal trends because depending on the specific month in a season, these trends are not consistent. For example, median chloride concentrations in July are lower than median concentrations in December and January, and median chloride concentrations in August are similar to those occurring in January (Figure 5-4). As a result, changes in the monthly pumping pattern under the EWA Program have the potential to result in water of higher chloride concentrations being delivered to the CVP and SWP water users south of the Delta during months of increased pumping, resulting in more total salts being delivered to these water users over an annual period (total annual salt load). Similar patterns and trends exist for bromide. Therefore, changes in the monthly pumping pattern under the EWA Program have the potential to change the bromide concentrations of water being delivered to the CVP/SWP water users south of the Delta during months of increased pumping. This would result in a change of the total salts being delivered to these water users over an annual period (total annual salt load). For this reason, a quantitative analysis of the total annual chloride load and total annual bromide load was conducted to determine whether or not changes in the monthly pumping pattern would result in an increase in the total annual salt load delivered to CVP and SWP water users in south of the Delta.

To assess the effect of changing the pumping patterns associated with EWA actions on the total annual salt load delivered to the CVP and SWP water users, two analyses were conducted that assumed there would be no change in the chloride or bromide concentrations within the Delta under the Flexible Purchase Alternative as compared to the Baseline Condition. This assumption was made because carriage water would be used to ensure no change to chloride or bromide concentrations under the Flexible Purchase Alternative as compared to the Baseline Condition, as described above. The EWA actions (export reductions) assumed to occur in the Delta are described in detail in Attachment 1. Assumed EWA actions are described for the period of 1979 to 1993 as described in Attachment 1, and therefore the chloride and bromide loading was calculated for this 15 year period. The modeling results describing chloride and bromide loading under the Flexible Purchase Alternative are presented below.

Under the Flexible Purchase Alternative, the median monthly chloride loading (in tons) over the 15 year period of record at CVP/SWP export locations (Tracy Pumping

Plant and Banks Pumping Plant) would be less than the median monthly chloride loading under the Baseline Condition from December through June, as illustrated in Figure 5-12. Median monthly chloride loading would decrease by 6.2 percent in December, 5.2 percent in January, 4.3 percent in February, 22.0 percent in March, 44.7 percent in April, 41.2 percent in May, and 15.8 percent in June. Additionally, the median monthly chloride loading (in tons) over the 15 year period of record at CVP/SWP export locations (Tracy Pumping Plant and Banks Pumping Plant) would be the same as the median monthly chloride loading under the Baseline Condition in October and November, as illustrated in Figure 5-12. In July, August and September, the median monthly chloride loading would be greater under Flexible Purchase Alternative than under the Baseline Condition. Median monthly chloride loading would increase by 10.8 percent in July, 20.9 percent in August, and 18.0 percent in September. Overall, the total chloride loading at CVP/SWP export locations over the 15 year period of record would be 7,238,736 tons of chloride under the Baseline Condition, and 7,118,109 tons of chloride under the Flexible Purchase Alternative. Thus, compared to the Baseline Condition, the total chloride loading to CVP/SWP export locations under the Flexible Purchase Alternative over the 15 year period of record represents a 1.7 percent decrease in total chloride loading.

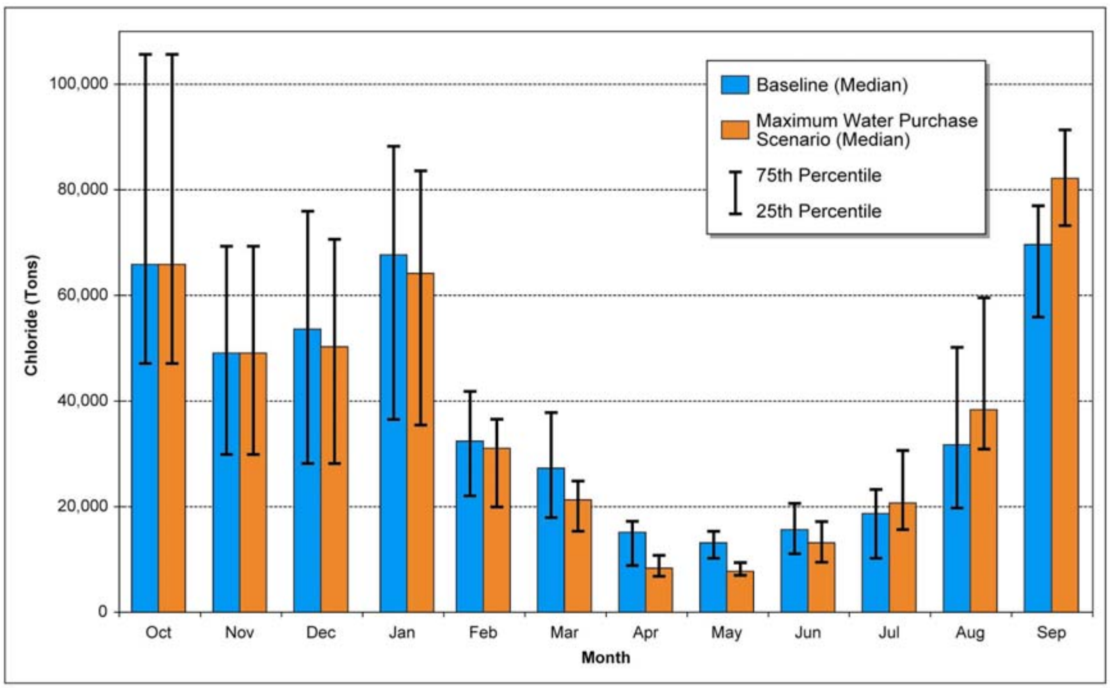

Figure 5-12
Median monthly chloride loading at CVP/SWP except locations (combined Tracy Pumping Plant and Banks Pumping Plant) occurring under the Flexible Purchase Alternative over the 15 year period of record

Note: Bars represent median monthly chloride loading, while error bars represent the 25th-perentile and 75th-percentile monthly chloride loading.

As described in Section 5.1.5.2.1, bromide patterns in the Delta are generally similar to salinity patterns in the Delta. As a result, it is not unexpected that under the Flexible Purchase Alternative, median monthly bromide loading to CVP/SWP export locations exhibit similar trends as median monthly chloride loading. For example, under the Flexible Purchase Alternative, the median monthly bromide loading (in tons) over the 15 year period of record at CVP/SWP export locations (Tracy Pumping Plant and Banks Pumping Plant) would be less than the median monthly bromide loading under the Baseline Condition from December through June, as illustrated in Figure 5-13. Additionally, the median monthly bromide loading (in tons) over the 15 year period of record at CVP/SWP export locations (Tracy Pumping Plant and Banks Pumping Plant) would be the same as the median monthly bromide loading under the Baseline Condition in October and November, as illustrated in Figure 5-13. In July, August and September, the median monthly bromide loading would be greater under the Flexible Purchase Alternative than under the Baseline Condition, as illustrated in Figure 5-13. Overall, the total bromide loading at CVP/SWP export locations over the 15 year period of record would be 24,684 tons of bromide under the Baseline Condition, and 24,273 tons of bromide under the Flexible Purchase Alternative, or a 1.7 percent decrease in total bromide loading.

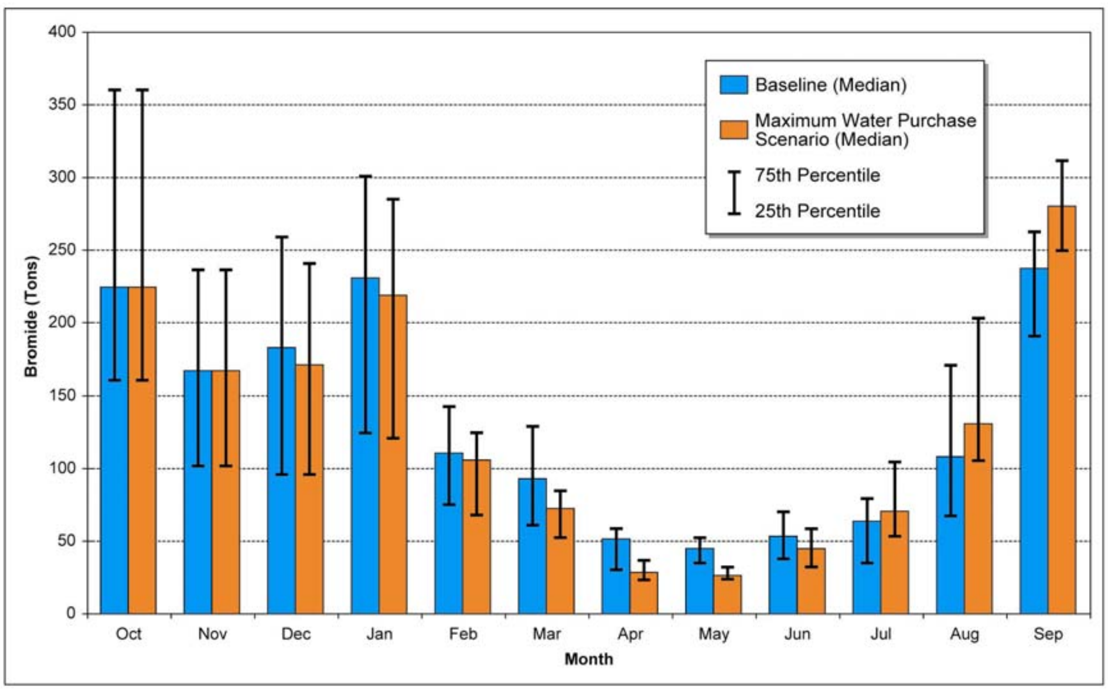

Figure 5-13
Median monthly bromide loading at CVP/SWP export locations (combined Tracy Pumping Plant and Banks Pumping Plant) occurring under the Flexible Purchase Alternative over the 15 year period of record

Note: Bars represent median monthly bromide loading, while error bars represent the 25th-perentile and 75th-percentile monthly bromide loading.

The results of the chloride and bromide modeling illustrate that under Flexible Purchase Alternative, in 9 months of the year, the median monthly chloride and bromide loading at CVP/SWP export locations over the period of record would be less than the median monthly chloride and bromide loading occurring under the Baseline Condition. Additionally, the total chloride and bromide loading at

CVP/SWP export locations over the period of record would be less than the total chloride and bromide loading occurring under the Baseline Condition. The model results illustrate that water quality, including salinity, bromide, and the potential for THM and bromate formation, of the water delivered to the CVP and SWP water users south of the Delta would not being altered in a way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality.

With respect to organic carbon, the EWA Program would decrease pumping during winter and spring months, and would increase pumping in summer months, primarily during July, August, and September. By decreasing pumping when carbon concentrations are highest (winter months) and increasing pumping and when carbon concentrations are lowest (summer months), organic carbon concentrations in water supplied to in-Delta water users and CVP and SWP users would, at a minimum, remain equivalent to the carbon concentrations that would have occurred in the absence of the EWA Program. In fact, under the Flexible Purchase Alternative, the increased pumping that would occur during the summer months when organic carbon concentrations are lower may potentially result in a net benefit to water quality with respect to organic carbon concentrations in water supplied to in-Delta water users and CVP and SWP users. Therefore, water quality, including total organic carbon and the potential for THM formation associated with organic carbon, would not be altered in a way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality.

In summary, increasing SWP and CVP pumping for the purpose of transporting EWA water acquired in the Upstream from the Delta Region during the summer months would not increase chloride or bromide concentrations in the Delta, because of the utilization of carriage water. Therefore, water quality supplied to downstream users and in-Delta users would be equivalent during periods EWA water is being pumped at the CVP and SWP pumping plants under the Flexible Purchase Alternative and under the Baseline Condition.

Even though carriage water would ensure no Delta water quality degradation during periods of increased pumping of EWA water during the summer, and even though Delta water quality will be improved when the EWA Management Agencies decrease SWP and CVP pumping to protect and restore listed and candidate fish species during the winter and spring months, the total annual salt load pumped at SWP and CVP pumping plants could be increased due to changes in pumping patterns caused by EWA Actions. Modeling results illustrate that EWA Actions do not increase the total salts (total chloride and bromide loading) pumped at the SWP and CVP pumping plants to CVP and SWP water users.

Overall, water quality, including salinity, bromide and organic carbon and the potential for THM and bromate formation, would not be altered in a way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Consequently, overall potential effects to water quality within the Delta would be less than significant.

5.2.5.2 Crop Idling

5.2.5.2.1 Upstream from the Delta Region

The potential effects to water quality associated with crop idling in Butte, Colusa, Glenn, Placer, Sutter, and Yolo Counties would not differ by county, river, or basin. Therefore, the potential effects to water quality under the Flexible Purchase Alternative as compared to the Baseline Condition are evaluated for all areas upstream from the Delta as a whole.

EWA acquisition of water via crop idling of rice in the Sacramento Valley would result in temporary conversion of lands from rice crops to bare fields.

Crop management practices and soil textures are key factors in determination of erosion potential. Idling would result in an increased number of bare fields, which may result in increased potential for sediment transport via wind erosion. Increased sediment transport via wind erosion could result in increased deposition of transported sediment onto surface waterbodies, thus potentially affecting water quality directly. However, the rice crop cycle and the soil textures in the Sacramento Valley reduce the potential for wind erosion in this region. The process of rice cultivation includes incorporating the leftover rice straw into the soils after harvest through discing, a commonly used practice among farmers. After harvest and discing in late September and October, the fields are flooded to aid in decomposition of the straw. Under the crop idling component of the Flexible Purchase Alternative, no irrigation water would be applied to the fields after farmers flood their fields in the winter, and the soil would be expected to remain moist until approximately mid-May. Once dried, the combination of decomposed straw and clay soils produces a hard, crust-like surface. If left undisturbed, this surface texture would remain intact throughout the summer, when wind erosion would be expected to occur, until winter rains begin. In contrast to sandy topsoil, this surface type would not be conductive to soil loss from wind erosion. During the winter rains, the hard, crust-like surface would remain intact and the amount of sediment transported through winter runoff would not be expected to increase. Therefore, there would be little to no increase in sediment transport resulting from wind erosion or winter runoff from idled fields under the Flexible Purchase Alternative as compared to the Baseline Condition. Because there would be little to no increase in sediment transport under the Flexible Purchase Alternative as compared to the Baseline Condition, there would be little to no increase in the amount of fugitive dust or sediment that could be deposited onto and in surface waterbodies. As a result, there would be little to no decrease in the physiochemical qualities of surface water and adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality would not be expected. The effect to water quality would therefore be less than significant.

EWA acquisition of water via crop idling of rice in the Sacramento Valley would alter the timing and quantity of water applied to the land.

Under the Baseline Condition, farmers would harvest their crop in late September and October. Residue disposal and discing would occur in late October and November. During the winter, farmers would flood the rice fields to aid in decomposition of the rice straw. Fields would be disced the following March and April, planted, and irrigated throughout the summer. Harvest of the rice crop would occur in late September and October, thus completing the rice crop cycle. Under the Flexible Purchase Alternative, farmers would harvest in late September and October, and disc in late October and November for residue disposal purposes. Farmers would flood the rice fields during the winter to aid in decomposition of the rice straw. However, with idling, crop lands would not be planted and irrigated the following summer. The soil would be expected to remain moist until approximately mid-May as a result of the flooding of the fields in the winter. The decomposed straw and clay soil would dry throughout the summer, resulting in a hard, crust-like surface. The soil would not become moist again until the winter rains begin in approximately November.

With respect to the timing and quantity of water applied to the land, the Baseline Condition and conditions under the Flexible Purchase Alternative differ in some regards. Under the Baseline Condition, crops would be harvested in late September and October and the leftover rice straw would be incorporated into the soil through discing following harvest. During the winter rains, beginning in November, fields would be wetted by rainfall. Additionally, under the Baseline Condition, water would be applied to fields in the winter to aid in rice straw decomposition and in the summer for irrigation. Fertilizers and pesticides would be applied in the spring, and the land would be irrigated throughout the summer. Under the Flexible Purchase Alternative, crops would be harvested in late September and October and the leftover rice straw would be incorporated into the soil through discing following harvest. Water would be applied to fields in the winter as in the Baseline Condition. However, water would not be applied during the following summer for irrigation because of crop idling. As in the Baseline Condition, rainfall beginning in November would serve to wet the fields in the fall. Water would not be applied to fields during the following winter because there would be little rice straw to decompose due to crop idling.

The difference in timing and quantity of water applied to the land may have the potential to alter the timing or concentration of associated leaching and runoff. Because more total water would be applied to fields under the Baseline Condition as compared to the Flexible Purchase Alternative, there would be more potential for leaching of salts and trace elements under the Baseline Condition. Additionally, application of fertilizers and pesticides associated with growing crops under the Baseline Condition would result in increased concentrations of nitrogen and phosphorus in surface water runoff as compared to the Flexible Purchase Alternative. Because there would be less total leaching potential under the Flexible Purchase Alternative as compared to the Baseline Condition, there would be no decrease in water quality due to timing and application of water to the land as a result of idling. In fact, there would potentially be an improvement in the quality of surface water runoff returning to rivers and lakes. Overall, the effect to water quality with respect to leaching and surface water runoff would therefore be less than significant.

5.2.5.2.2 Export Service Area

Tulare Lake Subbasin

EWA acquisition of water via crop idling of cotton in the Tulare Lake Subbasin would result in temporary conversion of lands from cotton crops to bare fields.

Under the Flexible Purchase Alternative, farmers would not plant cotton and no irrigation water would be supplied to the field. These barren fields would be dry and contain no cover, making them potentially susceptible to erosion from strong winds. In Fresno, Kern, Kings, and Tulare counties, the predominant soil texture classes of the surface layer include loamy sand, sandy loam, clay loam, silty clay, clay, and loam, which are classes that could be susceptible to wind erodibility. However, following harvest, farmers disc and plow under residual plant matter, such as cotton stalks, leaving the soil surface slightly furrowed. This practice would provide additional texture to the soil, reduce the surface area that is exposed, and increase the surface roughness. Depending on the soil texture type, idled cotton fields lose an estimated 48 to 134 tons soil/acre/year due to wind erosion under the worst cases. Because many variables affect a soil's erodibility index, and because the exact locations of the idled fields are not known, it is not possible to estimate a soil loss due to crop idling with more precision.

While crop idling would contribute to a substantial loss of topsoil under the Flexible Purchase Alternative as compared to the Baseline Condition, implementation of mitigation measures would reduce the potentially significant loss of topsoil to less than significant (see Chapter 8, Air Quality, Section 8.2.7, Mitigation Measures). With mitigation measures reducing the potentially significant loss of topsoil to less than significant, there would be a less than significant amount of fugitive dust that could be deposited onto surface waterbodies. As a result, there would be little to no decrease in the physiochemical qualities of surface water and adverse effects to designated beneficial uses, exceedance of existing regulatory standards or substantial degradation of water quality would not be expected. The effect to water quality would therefore be less than significant.

EWA acquisition of water via crop idling of cotton in the Tulare Lake Subbasin would alter the timing and quantity of water applied to the land.

Under the Baseline Condition, farmers would harvest their crop in late fall. Following harvest, cotton stalks would be plowed under, providing addition texture to the soil, reducing the surface area that is exposed, and increasing the surface roughness. Fields would be planted the following spring and irrigated throughout the summer. Harvest of the cotton crop would occur in late fall, thus completing the cotton crop cycle. Under the Flexible Purchase Alternative, after harvest in late fall, farmers would plow cotton stalks under, providing addition texture to the soil, reducing the surface area that is exposed, and increasing the surface roughness. With idling, crop lands would not be planted in the spring or irrigated in the summer. The soil would be expected to dry throughout the summer and would not become moist again until the winter rains begin in approximately November.

With respect to the timing and quantity of water applied to the land, the Baseline Condition and conditions under the Flexible Purchase Alternative differ in some regards. Under the Baseline Condition, fertilizers and pesticides are applied in the spring, and the land is irrigated throughout the summer. During the winter rains, beginning in November, fields would be wetted by rainfall. Aside from rainfall, no irrigation would be expected until planting in the following spring. Under the Flexible Purchase Alternative, cotton would not be planted in the spring, and fertilizers and pesticides would not be applied. Additionally, water would not be applied during the summer for irrigation. As in the Baseline Condition, rainfall beginning in November would serve to wet the fields throughout the rainy season.

The difference in timing and quantity of water applied to the land may have the potential to alter the timing or concentration of associated leaching and runoff. Because more total water would be applied to fields under the Baseline Condition as compared to the Flexible Purchase Alternative, there would be more potential for leaching of salts and trace elements under the Baseline Condition. Additionally, application of fertilizers and pesticides associated with growing crops under the Baseline Condition would result in increased concentrations of nitrogen and phosphorus in surface water runoff as compared to the Flexible Purchase Alternative. Because there would be less total leaching potential under the Flexible Purchase Alternative as compared to the Baseline Condition, there would be no decrease in water quality due to timing and application of water to the land as a result of idling. There would potentially be an improvement in the quality of surface water runoff returning to rivers and lakes. As a result, any differences in timing and application of water to the land would not be expected to affect water quality in such as way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. The effect to water quality with respect to leaching and surface water runoff would therefore be less than significant.

5.2.5.3 Stored Groundwater Purchase

EWA acquisition of water via stored groundwater purchase in the Export Service Area could result in direct conveyance of purchased stored groundwater to the California Aqueduct.

Because EWA acquisitions from stored groundwater purchase under the Flexible Purchase Alternative would not occur unless the water transfer conformed to the provisions set forth in the acceptance criteria for non-Project water (See Section 5.2.2), water quality in the California Aqueduct would not be adversely affected. In fact, water quality in the California Aqueduct may be improved with respect to bromide and organic carbon as a result of pumped-in groundwater, which typically has lower levels of these constituents than surface water in the California Aqueduct. As a result, EWA purchase of stored groundwater would not be expected to affect water quality in such as way that would result in adverse effects to designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. Therefore, it is expected that direct conveyance of purchased stored groundwater would result in a less than significant impact to water quality.

5.2.5.4 Groundwater Substitution

The potential effects to water quality associated with groundwater substitution in the Sacramento River, Feather River, Yuba River, American River, and Merced/San Joaquin River areas of analysis would not be expected to differ by basin. Therefore, the potential effects to water quality under the Flexible Purchase Alternative as compared to the Baseline Condition are evaluated for all areas of the Upstream from the Delta Region as a whole.

EWA acquisition of water via groundwater substitution in the Upstream from the Delta Region would result in substitution of groundwater for surface water typically applied to agricultural fields.

EWA acquisition of water via groundwater substitution under the Flexible Purchase Alternative would involve substitution of groundwater for surface water. Under the Flexible Purchase Alternative, groundwater would be pumped from wells and used to irrigate fields, allowing farmers to forego their surface water entitlements, which would be sold to the EWA. Groundwater would be applied to fields in lieu of surface water and would mix with surface water in agricultural drainages prior to irrigation return flow reaching the mainstem rivers. Under the Baseline Condition, some groundwater is currently used to supplement surface water entitlements in the Upstream from the Delta Region. However, the additional groundwater substitution that would be needed for implementation of the Flexible Purchase Alternative would not be required under the Baseline Condition, and surface water would be used to irrigate fields instead of substituted groundwater under the Baseline Condition.

The increase in the amount of groundwater substituted for surface water under the Flexible Purchase Alternative, as compared to the Baseline Condition, would be so small in comparison to the amount of surface water currently used to irrigate agricultural fields that the quality of the surface water, even after mixing with groundwater, would not be substantially decreased. Constituents of concern that may be present in the groundwater and subsequently input into surface water as a result of mixing with irrigation return flows, would be heavily diluted once in contact with the existing supply of surface water, given the high volume of surface water that is currently used for irrigation purposes.

Additionally, any acquisitions purchased by groundwater substitution under the EWA Program must adhere to the collaborative and systematic process set forth by DWR and Reclamation regarding obligatory transfer requirements between willing sellers and the purchasing agencies. This process has been established to ensure that potential effects to other legal users of water and third party effects are detected and that a local mitigation strategy has been developed prior to the groundwater transfer (see Chapter 6, Groundwater Mitigation Measures). As part of this process, the seller must recognize, assess and mitigate any adverse effects resulting from the transfer. Purchasing agencies also have a responsibility for assuring that the seller has an adequate mitigation program in place. To assist both parties of the transaction, a groundwater mitigation measure has been established to provide a framework with which to consider potential effects resulting from groundwater substitution (see Chapter 6). The groundwater mitigation measure includes: 1) a well review; 2) pre-purchase groundwater evaluation; 3) a monitoring program; and 4) a mitigation program. In addition to this environmental review, the groundwater mitigation measure set forth by the EWA Program provide further assurances that all potential adverse effects resulting from groundwater substitution are identified through a local monitoring program and locally mitigated (Chapter 6). Any associated mitigation measures and related funding shall be provided through local mitigation programs, which are tailored to the local conditions specific to each region.

In summary, the proportion of potential EWA-purchased groundwater that would be available for irrigation purposes using groundwater substitution under the Flexible Purchase Alternative, as compared to the total volume of surface water that is already in used on agricultural fields, would result in dilution of constituents of concern that may be input into surface water. Mixing of agricultural groundwater runoff with agricultural surface water runoff would result in sufficient dilution within the irrigation return flows, prior to draining into mainstem river reaches. Therefore, it is expected that groundwater substitution would result in a less than significant impact to water quality. Additionally, acquisitions via groundwater substitution under the Flexible Purchase Alternative would not occur unless the water transfer conformed to the provisions set forth in the groundwater mitigation measure.

5.2.5.5 Source Shifting

Borrowing water from San Luis Reservoir, Anderson Reservoir, Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake via source shifting would change the water surface elevations of these reservoirs.

Source shifting is a tool that was developed in the CALFED Record of Decision to help make the EWA Program more flexible. With source shifting, the EWA agencies borrow scheduled water from a project contractor for a fee, returning the water at a later date. The result of this option is to delay delivery of SWP or CVP contract water.

To participate in source shifting, contractors must have storage from which to draw while their deliveries are delayed. The EWA agencies could engage in source shifting agreements with Metropolitan WD or DWR, using several southern California reservoirs that deliver water to SWP contractors. Metropolitan WD is considering participation using surface water reservoirs (Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake) and groundwater storage programs. DWR may participate using its storage in Castaic Lake and Lake Perris. If source shifting were implemented in surface water storage facilities, it would cause the participating reservoir levels to fall earlier in the year than they would without the EWA, but the reservoir levels would level out and return to levels that would occur without the EWA as the water is paid back.

Under the Flexible Purchase Alternative, the EWA Program would take actions in the winter and spring, resulting in export reductions during that time period. Therefore, the amount of water that could have been pumped into San Luis Reservoir is less compared to the Baseline Condition. This results in lower storage in San Luis Reservoir under the Flexible Purchase Alternative as compared to the Baseline Condition. In order to prevent the storage in San Luis Reservoir from reaching the point at which deliveries can no longer be made or the point at which water quality creates a problem (300,000 AF) before it would have without the EWA Program due to EWA actions taken earlier in that year, the EWA agencies would activate a source shifting agreement. Source shifting is a shift in the timing of water deliveries from San Luis Reservoir. Source shifting participants reduce water deliveries from the SWP in comparison to the deliveries that would have occurred under the Baseline Condition in the early part of the summer resulting in less water being withdrawn from San Luis Reservoir, allowing San Luis Reservoir storage to remain above the point at which deliveries can no longer be made and to remain above 300,000 acre-feet for the same amount of time storage would have remained above 300,000 acre-feet under the Baseline Condition. During this time, source shifting participants rely on their own local resources in place of the water that would have been delivered from the SWP. After the San Luis Reservoir low point has occurred, the source shifting participants would be able to obtain the remaining water that was not delivered as a result of participating in source shifting. The discussion that follows addresses the water surface elevation reductions and potential effects that may be expected to occur in San Luis Reservoir, Castaic Lake, Lake Perris, and Diamond Valley Lake as a result of implementation of source shifting under the Flexible Purchase Alternative.

5.2.5.5.1 San Luis Reservoir

As described in Chapter 2, the objectives of source shifting are to prevent San Luis Reservoir from reaching the point where it cannot continue to make project deliveries (approximately 80,000 acre-feet) or where water quality creates problems for contractors (approximately 300,000 acre-feet) before it would have without the EWA Program. Under the Baseline Condition, water surface elevations in San Luis Reservoir would begin to decrease in mid-April and would continue to decrease until reservoir storage reached the low point for the year in late summer.

As detailed in Chapter 2, EWA acquisitions would not cause the reservoir to reach this target level more quickly, and would not reduce the reservoir level below 80,000 acre-feet, or below 300,000 acre-feet in years when reservoir levels would not have gone below this level under the Baseline Condition. If projections show that the EWA could cause San Luis Reservoir to reach 80,000 acre-feet or 300,000 acre-feet of storage sooner than it would have without the EWA, then the EWA agencies would implement source shifting agreements. In some years, San Luis Reservoir storage would fall below 300,000 acre-feet without the EWA Program. In this situation, the EWA agencies would not be responsible for source shifting to bring storage back up to 300,000 acre-feet, but would only need to shift sources to bring the storage back up to the without-EWA levels. Because source shifting would not result in a decrease in water surface elevation causing San Luis Reservoir to reach levels where it cannot continue to make project deliveries (80,000 acre-feet) or where water quality creates a problem for contractors (at approximately 300,000 acre-feet) sooner than it would have without implementation of the Flexible Purchase Alternative, alterations in water surface elevation resulting from implementation of the Flexible Purchase Alternative would not be expected to adversely affect designated beneficial uses, exceed existing regulatory standards, or substantially degrade water quality. As a result, the effect to water quality with respect to decreases in water surface elevation in San Luis Reservoir resulting from implementation of the Flexible Purchase Alternative would be less than significant.

5.2.5.5.2 Anderson Reservoir

Santa Clara Valley WD is considering two actions, pre-delivery and source shifting, involving the EWA Program. Pre-delivery actions would occur in the fall when EWA assets would be in risk of spill from San Luis Reservoir. EWA water assets would be transferred to Anderson Reservoir, only if Anderson Reservoir had available capacity under Anderson Reservoir's flood control operation rules (Anderson Reservoir needs to maintain flood control runoff capacity December through March of each year). The District may also use the EWA Program's ability to source shift assets based on conditions of San Luis Reservoir. If San Luis Reservoir were in risk of reaching low-point earlier than without EWA, the District would delay delivery of its project water supply later into the year to protect water quality of San Luis Reservoir. The District would only engage in source shifting if it could maintain its 20,000 acre-feet minimum storage amount and address in-stream flow requirements for Coyote Creek. Therefore, the effect to water quality with respect to decreases in water surface elevation in Anderson Reservoir resulting from implementation of the Flexible Purchase Alternative would be less than significant.

5.2.5.5.3 Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake

Source shifting under the EWA Flexible Purchase Alternative would result in a decrease in water surface elevations in Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake, as compared to the Baseline Condition. As the water is paid back, water levels would return to water surface elevations similar to those under the Baseline Condition. Source shifting would lower water surface elevations temporarily in these reservoirs, but only within existing operational parameters. In 2001, 50,000 acre-feet of source shifting occurred and Metropolitan WD used its flexible storage and drew replacement water from Castaic Lake during the source shift to meet demands (Hirsch 2003). During reductions in water surface elevations in Castaic Lake in 2001, there was no effect to water quality in the reservoir itself (Hirsch 2003). However, because of the heavy reliance on water from Castaic Lake, water treatment methods at the Jensen Treatment Plant needed to be altered (Hirsch 2003). The alterations to the Jensen Treatment Plant process included increasing the alum and chlorine feed rates in order to combat taste and odor problems (Hirsch 2003). This alteration resulted in Metropolitan WD incurring some additional costs at the water treatment plant, but this cost is factored into Metropolitan WD's participation in source shifting (Hirsch 2003), as described in Chapter 2. Water surface elevation reductions and heavy reliance on Castaic Lake water resulted in additional treatment costs, but because these costs are covered by factoring these costs into participation in source shifting, the use of Castaic Lake water for municipal water supply is protected. Therefore, the effect to water quality with respect to decreases in water surface elevation in Castaic Lake resulting from implementation of the Flexible Purchase Alternative would be less than significant.

Lake Perris and Diamond Valley Lake have not been used to participate in source shifting in the past (Hirsch 2003). Water surface elevation reductions in these two reservoirs are not likely to precipitate additional treatment requirements, such as those described above for Castaic Lake, because Metropolitan WD is able to avoid water quality concerns by blending SWP and Colorado River water at most water treatment plants (Hirsch 2003). Because Metropolitan WD can adjust the source water, the water surface elevation reductions in these reservoirs are not expected to necessitate increased water treatment costs (Hirsch 2003). However, if additional treatment was necessary, the fee for participation in source shifting would factor in additional treatment costs. Lake Perris specifically has water quality concerns regarding algae which are described in Section 5.1.5.3.4. As a result, it is unlikely that Lake Perris would be utilized in source shifting agreements (Hirsch 2003). Because blending of SWP and Colorado River water can be used to avoid water quality concerns regarding taste and odor associated with increased water surface elevation reductions and algal growth, the use of Lake Perris, Diamond Valley Lake, and Lake Mathews water for municipal water supply is protected. Therefore, the effect to water quality with respect to decreases in water surface elevation in Lake Perris, Diamond Valley Lake, and Lake Mathews resulting from implementation of the Flexible Purchase Alternative would be less than significant.

5.2.6 Environmental Consequences/Environmental Impacts of the Fixed Purchase Alternative

Extensive hydrologic modeling was performed for the Flexible Purchase Alternative to provide a quantitative basis from which to assess potential impacts of the Flexible Purchase Alternative within the EWA area of analysis. As discussed in Section 3.3, Framework for Environmental Consequences/Environmental Impact Analysis, the effects analysis for water quality does not depend on the location of a particular seller, but on the total amount of EWA water to be transferred via a particular tributary and receiving water body. Therefore, water quality effects were evaluated based on the largest amount of water that EWA agencies could manage for Delta actions (approximately 600,000 acre-feet), regardless of whether the specific water sellers could be identified at this time. The effect analysis with implementation of the Flexible Purchase Alternative represents a "worst case scenario" based on the maximum amount of water purchased by the EWA agencies. The impacts described in Section 5.2.5, Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative, represent the effects on water quality for this maximum transfer amount.

The Fixed Purchase Alternative would involve the same actions as the Flexible Purchase Alternative, but to a lesser degree. The Fixed Purchase Alternative specifies purchases of 35,000 acre-feet from the Upstream from the Delta Region, and 150,000 acre-feet from the Export Service Area. While the amounts in each region are fixed, the acquisition types and sources could vary. Potential impacts associated with implementation of the Fixed Purchase Alternative were analyzed on a qualitative basis, in relation to the hydrologic modeling results for the maximum amount of water that could be purchased under the Flexible Purchase Alternative.

5.2.6.1 Stored Reservoir Water (Including Stored Water Acquired from Crop Idling and Groundwater Substitution)

5.2.6.1.1 CVP/SWP Reservoirs Within the Upstream from the Delta Region

Lake Shasta, Lake Oroville, and Folsom Reservoir

EWA acquisition of Sacramento River contractor water via stored reservoir water, groundwater substitution, and crop idling would alter surface water elevation and reservoir storage in Lake Shasta, relative to the Baseline Condition. EWA acquisition of Feather River contractor water via stored reservoir water, groundwater substitution, and crop idling would alter surface water elevations or reservoir storage in Lake Oroville, relative to the Baseline Condition. EWA acquisition of American River contractor water via stored reservoir water, groundwater substitution, and crop idling would alter surface water elevation and reservoir storage in Folsom Reservoir, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, Lake Shasta, Lake Oroville, and Folsom Reservoir end-of-month water surface elevations and reservoir storages would not be substantially less than end-of-month water surface elevations and reservoir storages under the Baseline Condition. Implementation of the Flexible Purchase Alternative would not be expected to adversely affect concentrations of water quality constituents in Lake Shasta, Lake Oroville, or Folsom Reservoir. As a result, changes in water surface elevation and reservoir storages would not be of sufficient magnitude and frequency to affect water quality in such a way that would result in long-term adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality within Lake Shasta, Lake Oroville, and Folsom Reservoir with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

5.2.6.1.2 Non-Project Reservoirs Within the Upstream from the Delta Region

Little Grass Valley and Sly Creek Reservoirs

EWA acquisition of OWID stored reservoir water would reduce surface water elevation and reservoir storage in Little Grass Valley and Sly Creek reservoirs, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, median water surface elevation and median reservoir storage would decrease from November to April, relative to the Baseline Condition. Water temperatures during these months of the year would be at their lowest points during the annual cycle, and therefore the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in water temperature that would affect overall reservoir water quality. Additionally, because of the high quality of the water flowing into these reservoirs, the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in concentrations of water quality constituents that would affect overall reservoir water quality. As a result, changes in median water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect long-term water quality in such a way that would result in adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality within Little Grass Valley and Sly Creek reservoirs with implementation of the Fixed Purchase Alternative would be less than significant.

New Bullards Bar Reservoir

EWA acquisition of Yuba County Water Agency via stored reservoir water and groundwater substitution would alter surface water elevation and reservoir storage in New Bullards Bar Reservoir, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, median water surface elevation and median reservoir storage would decrease from July to January, but would increase from April through June, relative to the Baseline Condition. Water temperatures during the months of greatest reductions (September through December) would be low enough that the decrease in median reservoir storage and water surface elevation would not cause an increase in water temperature that would affect overall reservoir water quality. Additionally, because of the high quality of the water flowing into this reservoir, the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in concentrations of water quality constituents that would affect overall reservoir water quality. As a result, changes in median water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect long-term water quality in such as way that would result in adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality within New Bullards Bar Reservoir with implementation of the Fixed Purchase Alternative would be less than significant.

French Meadows and Hell Hole Reservoirs

EWA acquisition of Placer County Water Agency-stored reservoir water would decrease surface water elevation and reservoir storage in French Meadows and Hell Hole reservoirs, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, median water surface elevation and median reservoir storage would decrease from June to January in Hell Hole Reservoir and from July to January in French Meadows Reservoir, relative to the Baseline Condition. Water temperatures during the months of greatest reduction (September and October) would be low enough, given the percentage reduction in median reservoir storage, that the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in water temperature that would affect overall reservoir water quality. Additionally, because of the high quality of the water flowing into these reservoirs, the decrease in median reservoir storage and water surface elevation would not be expected to cause an increase in concentrations of water quality constituents that would affect overall reservoir water quality. As a result, changes in median water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to affect long-term water quality in such as way that would result in adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality within French Meadows and Hell Hole reservoirs with implementation of the Fixed Purchase Alternative would be less than significant.

Lake McClure
EWA acquisition of Merced ID water via groundwater substitution would increase surface water elevation or reservoir storage in Lake McClure, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, median water surface elevation and median reservoir storage would increase from May to October and would remain essentially equivalent from June through September, relative to the Baseline Condition. Increases in median reservoir storage and median water surface elevation would benefit water quality by providing additional water for dilution of constituents and to buffer water temperature increases. As a result, increases in median water surface elevation and reservoir storage would not be of sufficient magnitude and frequency to result in long-term adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality within Lake McClure with implementation of the Fixed Purchase Alternative would be less than significant.

5.2.6.1.3 Rivers Within the Upstream from the Delta Region

Sacramento River
EWA acquisition of Sacramento River contractor water via stored reservoir water, groundwater substitution, and crop idling would not substantially decrease Sacramento River flow, and would not substantially increase Sacramento River water temperature, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, Sacramento River flows at Keswick Dam and Freeport would be essentially equivalent to or greater than flows under the Baseline Condition. Increases in Sacramento River flows at Freeport during the summer months would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. Under the Flexible Purchase Alternative, water temperatures in the Sacramento River at Bend Bridge and Freeport would be essentially equivalent to or less than water temperatures under the Baseline Condition. As a result, changes in Sacramento River flows and water temperatures under the Flexible Purchase Alternative would not be of sufficient magnitude and frequency to result in long-term adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be considered less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, flow- and water temperature-related impacts on water quality within the Sacramento River with implementation of the Fixed Purchase Alternative would be less than significant.

Lower Feather River

EWA acquisition of Feather River contractor water via stored reservoir water, groundwater substitution, and crop idling would not substantially decrease Feather River flow, and would not substantially increase Feather River water temperature, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, Feather River flow below the Thermalito Afterbay and at the mouth of the Feather River would be essentially equivalent to or greater than flows under the Baseline Condition. Increases in Feather River flow below Thermalito Afterbay and at the mouth during summer months would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. Under the Flexible Purchase Alternative, water temperatures in the Feather River below the Thermalito Afterbay and at the mouth of the Feather River would infrequently be increased by up to 0.7°F and would otherwise be essentially equivalent to or less than water temperatures under the Baseline Condition. As a result, changes in lower Feather River flows and water temperatures would not be of sufficient frequency and magnitude to result in long-term adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be considered less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, flow- and water temperature-related impacts on water quality within the lower Feather River with implementation of the Fixed Purchase Alternative would be less than significant.

Lower Yuba River

EWA acquisition of lower Yuba River contractor water via stored reservoir water, groundwater substitution, and crop idling would alter lower Yuba River flow and water temperature, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, lower Yuba River flows would be greater than the flows under the Baseline Condition, based on data from previous water transfers. Increases in lower Yuba River flows would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. In addition, lower Yuba River water temperatures would be less than the water temperatures under the Baseline Condition, based on data from previous water transfers. As a result, changes in lower Yuba River flows and water temperatures would not be of sufficient frequency and magnitude to result in long-term adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, flow- and water temperature-related impacts on water quality within the lower Yuba River with implementation of the Fixed Purchase Alternative would be less than significant.

<u>Middle Fork American River</u>
EWA acquisition of American River contractor water via stored reservoir water and crop idling would alter Middle Fork American River flow, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, Middle Fork American River median flows below Ralston Afterbay would be essentially equivalent to or great than flows under the Baseline Condition, in nine months of the year. Median flow in the Middle Fork American River would decrease in November, January, and February under the Flexible Purchase Alternative as compared to the Baseline Condition. Increases in Middle Fork American River flows below Ralston Afterbay in June, July, August, and September would allow dilution of water quality constituents. Decreased flows during the months of greatest flow reduction (November and February) would not be expected to cause an increase in concentration of water quality constituents that would result in adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality because the water quality in the Middle Fork American River is of high quality and concentrations of constituents are generally low. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, flow-related impacts on water quality within the Middle Fork American River with implementation of the Fixed Purchase Alternative would be less than significant.

<u>Lower American River</u>
EWA acquisition of stored groundwater from Sacramento Groundwater Authority members, stored reservoir water, and water obtained through Placer Country Water Agency crop idling and retained in Folsom Reservoir under the Flexible Purchase Alternative would increase lower American River flow, and would not substantially increase American River water temperature, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, long-term average lower American River flows below Nimbus Dam, at Watt Avenue, and at the mouth of the American River would be essentially equivalent to or greater than flows under the Baseline Condition. Increases in lower American River flows at all three locations during July and August and during September would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. Water temperature in the American River below Nimbus Dam, at Watt Avenue, and at the mouth of the American River under the Flexible Purchase Alternative would infrequently increase by up to 1.0°F and would otherwise be essentially equivalent to or less than water temperatures under the Baseline Condition. As a result, changes in lower American River flows and water temperatures would not be of sufficient frequency and magnitude to result in long-term adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, flow- and water temperature-related impacts on water quality within the lower American River with implementation of the Fixed Purchase Alternative would be less than significant.

<u>Merced River</u>
EWA acquisition of Merced River contractor water via groundwater substitution would increase Merced River flow, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, Merced River flows below Crocker-Huffman Dam and at the mouth of the Merced River would be essentially equivalent to or greater than flows under the Baseline Condition. Increases in Merced River flows at Crocker-Huffman Dam and at the mouth of the Merced River during October and November would allow dilution of water quality constituents. As a result, changes in Merced River flows would not be of sufficient frequency and magnitude to result in long-term adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, flow-related impacts on water quality within the Merced River with implementation of the Fixed Purchase Alternative would be less than significant.

<u>San Joaquin River</u>
EWA acquisition of Merced River contractor water via groundwater substitution would increase San Joaquin River flow, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, San Joaquin River flows below the confluence with the Merced River and at Vernalis would be essentially equivalent to or greater than flows under the Baseline Condition. Increases in San Joaquin River flows at both locations during October and November would allow dilution of water quality constituents, including pesticides and fertilizers present in agricultural run-off. As a result, changes in San Joaquin River flows would not be of sufficient frequency and magnitude to result in long-term adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, flow-related impacts on water quality within the San Joaquin River with implementation of the Fixed Purchase Alternative would be less than significant.

5.2.6.1.4 Sacramento-San Joaquin Delta Region

EWA acquisition of water would alter the timing of CVP/SWP exports from the Delta, relative to the Baseline Condition.

Under both Flexible Purchase Alternative and the Fixed Purchase Alternative, carriage water would be used to protect water quality and maintain chloride standards in the Delta during the period when water is purchased and moved from the Upstream from the Delta Region. Carriage water is an increase in Delta outflow that maintains chloride and bromide concentrations at levels that would be equivalent to those under the Baseline Condition. Under the Flexible Purchase Alternative, potential increases in chloride and bromide concentrations in the Delta due to increased SWP and CVP pumping of EWA water during the summer months would not occur because of the utilization of carriage water to ensure no significant changes in Delta water quality during the periods of increased pumping. Sufficient carriage water would be purchased by EWA for use in maintaining the quality of water supplied to CVP and SWP water users, therefore the quality of water supplied to downstream and in-Delta users would be equivalent during periods EWA water is being pumped at the CVP and SWP pumping plants under the Flexible Purchase Alternative and under the Baseline Condition. Additionally, because organic carbon concentration in the Sacramento River are typically lower in the summer months when increased pumping would occur, increased pumping would not result in increased organic carbon in the Delta. In addition, in all but the driest years, EWA actions taken during the winter/spring months (decreased pumping) would result in increased Delta outflow. Increased Delta outflow would result in beneficial impacts on water quality within the Delta. As a result, water quality, including salinity, bromide, total organic carbon, and the potential for THM and bromate formation, would not be altered in a way that would result in adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, overall potential effects on water quality within the Delta related to salinity, bromide, organic carbon, THM formation potential, and the potential for bromate formation with implementation of the Fixed Purchase Alternative would be less than significant.

EWA acquisition of water would alter the timing of CVP/SWP exports to downstream municipal users, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, modeling results illustrate that EWA actions would not increase the total salts (total chloride and bromide loading) pumped at the SWP and CVP pumping plants to CVP and SWP water users. Additionally, under the Flexible Purchase Alternative, by decreasing pumping when carbon concentrations are highest and increasing pumping when carbon concentration are lowest, organic carbon concentrations in water supplied to in-Delta water users and CVP and SWP users would be expected to, at a minimum, remain equivalent to the carbon concentrations that would have occurred in the absence of the EWA Program. As a result, water quality constituents, including salinity, bromide, and organic carbon, and the potential for THM and bromate formation, would not be altered in such a way that would result in adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, overall potential effects on water quality within the Delta related to salinity, bromide, organic carbon, THM formation potential, and the potential for bromate formation with implementation of the Fixed Purchase Alternative would be less than significant

5.2.6.2 Crop Idling

5.2.6.2.1 Upstream from the Delta Region

EWA acquisition of water via crop idling of rice in the Sacramento Valley would result in temporary conversion of lands from rice crops to bare fields.

Under the Flexible Purchase Alternative, there would be little to no increase in sediment transport resulting from wind erosion or winter runoff from idled fields. As a result, there would be little to no decrease in the physiochemical qualities of surface water and adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality would not be expected. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality due to crop idling with implementation of the Fixed Purchase Alternative would be less than significant.

EWA acquisition of water via crop idling of rice in the Sacramento Valley would alter the timing and quantity of water applied to the land.

Under the Flexible Purchase Alternative, less total water would be applied to fields than under the Baseline Condition, therefore there would be less potential for leaching of salts and trace elements than under the Baseline Condition. Additionally, application of fertilizers and pesticides associated with growing crops under the

Flexible Purchase Alternative would result in decreased concentrations of nitrogen and phosphorus in surface water runoff, relative to the Baseline Condition. Because there would be less total leaching potential under the Flexible Purchase Alternative relative to the Baseline Condition, there would be no decrease in water quality due to timing and application of water to the land as a result of idling. In fact, there would potentially be an improvement in the quality of surface water runoff returning to rivers and lakes. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality due to crop idling with respect to leaching and surface water runoff with implementation of the Fixed Purchase Alternative would be less than significant.

5.2.6.2.2 Export Service Area

<u>Tulare Lake Subbasin</u>
EWA acquisition of water via crop idling of cotton in the Tulare Lake Subbasin would result in temporary conversion of lands from cotton crops to bare fields.

While crop idling would contribute to a substantial loss of topsoil under the Flexible Purchase Alternative relative to the Baseline Condition, implementation of air quality mitigation measures would reduce the potentially significant loss of topsoil to less than significant (see Chapter 8, Air Quality, Section 8.2.8, Mitigation Measures). With air quality mitigation measures reducing the potentially significant loss of topsoil to less than significant, there would be a less than significant amount of fugitive dust that could be deposited onto surface waterbodies. As a result, there would be little to no decrease in the physiochemical qualities of surface water and adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality would not be expected. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality due to crop idling within the Tulare Lake Subbasin with implementation of the Fixed Purchase Alternative would be less than significant.

EWA acquisition of water via crop idling of cotton in the Tulare Lake Subbasin would alter the timing and quantity of water applied to the land.

Under the Flexible Purchase Alternative, less total water would be applied to fields, relative to the Baseline Condition, therefore there would be less potential for leaching of salts and trace elements. Additionally, decreased application of fertilizers and pesticides associated with growing crops under the Flexible Purchase Alternative would result in decreased concentrations of nitrogen and phosphorus in surface water runoff, relative to the Baseline Condition. There would be less total leaching potential under the Flexible Purchase Alternative, relative to the Baseline Condition, therefore adverse impacts on water quality due to changes in the timing and application of water to the land as a result of idling are not anticipated. There would potentially be an improvement in the quality of surface water runoff returning to rivers and lakes. As a result, changes in the timing and quantity of water applied to the land would not be expected to result in adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality due to crop idling with respect to leaching and surface water runoff within the Tulare Lake Subbasin with implementation of the Fixed Purchase Alternative would be less than significant.

5.2.6.3 Stored Groundwater Purchase

EWA acquisition of water via stored groundwater purchase in the Export Service Area could result in direct conveyance of purchased stored groundwater to the California Aqueduct.

Under the Flexible Purchase Alternative, EWA acquisitions from stored groundwater purchase would not occur unless the water transfer conformed to the provisions set forth in the acceptance criteria for non-Project water, therefore water quality in the California Aqueduct would not be adversely affected. In fact, water quality in the California Aqueduct may be improved with respect to bromide and organic carbon as a result of pumped-in groundwater, which typically has lower levels of these constituents than surface water in the California Aqueduct. As a result, EWA purchase of stored groundwater would not be expected to affect water quality in such as way that would result in adverse effects on designated beneficial uses, exceedance of existing regulatory standards, or substantial degradation of water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality due to direct conveyance of purchased stored groundwater with implementation of the Fixed Purchase Alternative would be less than significant.

5.2.6.4 Groundwater Substitution

EWA acquisition of water via groundwater substitution in the Upstream from the Delta Region would result in substitution of groundwater for surface water typically applied to agricultural fields.

Under the Flexible Purchase Alternative, the proportion of potential EWA-purchased groundwater that would be available for irrigation purposes using groundwater substitution, compared to the total volume of surface water that is already in used on agricultural fields, would result in dilution of constituents of concern that may be input into surface water. Mixing of agricultural groundwater runoff with agricultural surface water runoff would result in sufficient dilution within the irrigation return flows, prior to draining into mainstem river reaches. Additionally, acquisitions from groundwater substitution would not occur unless the water transfer conformed to the provisions set forth in the groundwater mitigation measure, and, therefore any potential effects to water quality would be less than significant. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality due to groundwater substitution with implementation of the Fixed Purchase Alternative would be less than significant.

5.2.6.5 Source Shifting

Borrowing water from San Luis Reservoir, Anderson Reservoir, Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake via source shifting would change the water surface elevations of these reservoirs.

5.2.6.5.1 San Luis Reservoir

Under the Flexible Purchase Alternative, source shifting would not result in a decrease in water surface elevation causing San Luis Reservoir to reach levels where it cannot continue to make project deliveries (80,000 acre-feet) or where water quality creates a problem for contractors (at approximately 300,000 acre-feet) sooner than it would have without implementation of the Flexible Purchase Alternative. Therefore, alterations in water surface elevations resulting from implementation of the Flexible Purchase Alternative would not be expected to adversely affect designated beneficial uses, exceed existing regulatory standards, or substantially degrade water quality. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality with respect to decreases in San Luis Reservoir water surface elevations with implementation of the Fixed Purchase Alternative would be less than significant.

5.2.6.5.2 Anderson Reservoir

Under the Flexible Purchase Alternative, the Santa Clara Valley WD would only engage in source shifting if it could maintain its 20,000 acre-feet minimum storage amount and address in-stream flow requirements for Coyote Creek. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality with respect to decreased Anderson Reservoir water surface elevations with implementation of the Fixed Purchase Alternative would be less than significant.

5.2.6.5.3 Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake

Under the Flexible Purchase Alternative, the effect on water quality with respect to decreases Castaic Lake water surface elevations resulting from implementation of the Flexible Purchase Alternative would be less than significant. Blending of SWP and Colorado River water can be used to avoid water quality concerns regarding taste and odor associated with decreased water surface elevations and algal growth, therefore the use of Lake Perris, Diamond Valley Lake, and Lake Mathews water for municipal water supply is protected. No significant impacts on water quality under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be less than significant for an equal or lesser transfer amount (the Fixed Purchase Alternative). Therefore, impacts on water quality with respect to decreased Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake water surface elevations and algal growth with implementation of the Fixed Purchase Alternative would be less than significant.

5.2.7 Comparative Analysis of Alternatives

This chapter has thus far analyzed the effects of many potential transfers, looking at the "worst-case scenario" that would occur if all acquisitions happened in the same year. This approach ensures that all effects of transfers are included and provides the EWA Project Agencies the flexibility to choose transfers that may be preferable in a given year. The EWA, however, would not actually purchase all of this water in the same year. This section provides information about how EWA would more likely operate in different year types.

Under the No Project/No Action Alternative, increased precipitation during wet years would dilute water quality constituents in reservoirs and rivers. Additional water would also increase Delta inflows, reducing constituent levels. Dry years would produce limited inflow to the Delta, worsening water quality. Dry years would also result in reservoir constituent levels to increase.

In the Upstream from the Delta Region, the Fixed Purchase Alternative would be limited to a maximum acquisition of 35,000 acre-feet from all sources of water. In most years, this amount could be obtained from stored reservoir water purchases. This amount of water would not cause significant water quality impacts within the Delta due to changes in timing of flows.

The Flexible Purchase Alternative could involve the purchase of up to 600,000 acre-feet of water from all sources upstream from the Delta. EWA agencies would prefer to purchase water from upstream sources because the water is generally less expensive. The amount that could be purchased would be limited by the excess capacity of the Delta export pumps to move the water to the Export Service Area. During wet years, excess pump capacity may be limited to as little as 50,000 to 60,000 acre-feet of EWA asset water because the pumps primarily would be used to export Project water to Export Service Area users. Effects during wet years would therefore be close to those described under the Fixed Purchase Alternative. During dry years, when there would be less Project water available for pumping (and therefore the pumps would have greater availability capacity), the EWA Project Agencies could acquire up to 600,000 acre-feet of water from sources upstream from the Delta. The Flexible Purchase Alternative effects on the Delta would vary depending on the water-year type, with more effects during wet years when more water is moved through the Delta.

EWA asset acquisitions in the Export Service Area under the Fixed Purchase Alternative would be limited to 150,000 acre-feet from stored groundwater and crop idling sources. Kern County Water Agency would provide the stored groundwater, and the water quality would need to be coordinated with SWP operators.

EWA asset acquisitions in the Export Service Area under the Flexible Purchase Alternative would be dependent on the water year type north of the Delta. Export pump capacity during wet years would limit the ability of the EWA Project Agencies to move assets through the Delta, requiring reliance on greater purchase amounts from export area sources. During wet years, acquisitions within the Export Service Area could involve up to 600,000 acre-feet of assets. The EWA agencies would acquire assets from stored groundwater and idled cropland sources. The EWA agencies would acquire less water from the Export Service Area during dry years, when most of the assets needed could be moved through the Delta. Moving stored groundwater into the California Aqueduct, therefore, would be less of a concern during dry years. Table 5-77 summarizes and compares the potential effects and level of significance relative to water quality with implementation of the EWA Program under both the Flexible Purchase and Fixed Price Alternatives.

Table 5-77
Water Quality
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Effects

Area of Analysis	Asset Acquisition or Management Type	Result	Potential Effects	Flexible Alternative Effects Compared to Baseline Condition	Fixed Alternative Effects Compared to Baseline Condition	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region							
Sacramento River	Groundwater Substitution/Crop Idling	Seasonal changes in timing of releases from Lake Shasta.	Alteration of surface water elevation and storage in Lake Shasta to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Maximum decrease of 19,000 acre-feet reservoir storage and one foot water surface elevation in July compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
			Alteration of Sacramento River flows and water temperatures to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Maximum flow decrease of 58 cfs in August and no change in temperature in the Sacramento River compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
	Crop Idling	Conversion of rice crop to bare fields.	Changes in sediment transport via wind erosion and runoff to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Increases in sediment transport due to wind erosion, resulting in sediment deposition in surrounding waterbodies compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
		Water not applied to fields in summer for irrigation.	Alteration in timing and quantity of water applied to the land to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Decreases in the physiochemical qualities of surface water compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.

Table 5-77
Water Quality
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Effects

Area of Analysis	Asset Acquisition or Management Type	Result	Potential Effects	Flexible Alternative Effects Compared to Baseline Condition	Fixed Alternative Effects Compared to Baseline Condition	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
	Groundwater substitution	Groundwater applied to agricultural fields.	Alteration in quality of surface water following mixing of groundwater and surface water to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Deteriorations of the physiochemical qualities of surface runoff compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
Feather River	Stored Reservoir Water	Seasonal changes in timing of releases from Sly Creek and Little Grass Valley Reservoirs.	Alteration of Sly Creek and Little Grass Valley Reservoirs water surface elevation and storage to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	In Sly Creek Reservoir, maximum decrease of 5,000 acre-feet in reservoir storage and 18 feet elevation in December. In Little Grass Valley, maximum decrease of 12,000 acre-feet in reservoir storage and 12 feet elevation in December compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
	Stored Reservoir Water/Groundwater Substitution/ Crop Idling	Seasonal changes in timing of releases from Lake Oroville.	Alteration of surface water elevation and storage in Lake Oroville to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Maximum decrease of 50,000 acre-feet reservoir storage and 4 feet water surface elevation in July compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
			Alteration of Feather River flows and water temperatures to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	No change in flow and a maximum increase of 0.2˚F in temperature in the Feather River compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.

Table 5-77
Water Quality
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Effects

Area of Analysis	Asset Acquisition or Management Type	Result	Potential Effects	Flexible Alternative Effects Compared to Baseline Condition	Fixed Alternative Effects Compared to Baseline Condition	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
	Crop Idling	Conversion of rice crops to bare fields.	Changes in sediment transport via wind erosion and runoff to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Increases in sediment transport due to wind erosion, resulting in sediment deposition in surrounding waterbodies compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
		Water not applied to fields in summer for irrigation.	Alteration in timing and quantity of water applied to the land to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Decreases in the physiochemical qualities of surface water compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
	Groundwater substitution	Groundwater applied to agricultural fields.	Alteration in quality of surface water following mixing of groundwater and surface water to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Deteriorations of the physiochemical qualities of surface runoff compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
Yuba River	Stored Reservoir Water/ Groundwater Substitution	Seasonal changes in timing of releases from New Bullards Bar Reservoir.	Alteration of Yuba River flows and water temperatures to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Lower Yuba River flows would increase and temperatures would decrease compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
			Alteration of surface water elevation and storage in New Bullards Bar Reservoir to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Maximum decrease of 18,000 acre-feet reservoir storage and 27 feet water surface elevation in October compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.

Table 5-77
Water Quality
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Effects

Area of Analysis	*Asset Acquisition or Management Type*	*Result*	*Potential Effects*	*Flexible Alternative Effects Compared to Baseline Condition*	*Fixed Alternative Effects Compared to Baseline Condition*	*Significance of Flexible Purchase Alternative*	*Significance of Fixed Purchase Alternative*
	Groundwater substitution	Groundwater applied to agricultural fields.	Alteration in quality of surface water following mixing of groundwater and surface water to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Deteriorations of the physiochemical qualities of surface runoff compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
American River	Stored Reservoir Water/ Crop Idling/ Groundwater Substitution	Seasonal changes in timing of releases from French Meadows and Hell Hole reservoirs.	Alteration of surface water elevation and storage in French Meadows and Hell Hole reservoirs to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	In French Meadows Reservoir, maximum decrease of 8,000 acre-feet in reservoir storage and 8 feet elevation in October. In Hell Hole Reservoir, maximum decrease of 12,000 acre-feet in reservoir storage and 15 feet elevation in September and October compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
			Alteration of Middle Fork American River flows to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Maximum flow decrease of 213 cfs in November in the Middle Fork American River compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
		Seasonal changes in timing of releases from Folsom Reservoir.	Alteration of surface water elevation and storage in Folsom Reservoir to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Maximum decrease of 4,000 acre-feet reservoir storage and one foot water surface elevation in July compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
			Alteration of lower American River flows and water temperatures to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	No flow decreases and a maximum temperature increase in September in the Lower American River compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.

Table 5-77
Water Quality
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Effects

Area of Analysis	Asset Acquisition or Management Type	Result	Potential Effects	Flexible Alternative Effects Compared to Baseline Condition	Fixed Alternative Effects Compared to Baseline Condition	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
	Crop Idling	Conversion of rice crops to bare fields.	Changes in sediment transport via wind erosion and runoff to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Increases in sediment transport due to wind erosion, resulting in sediment deposition in surrounding waterbodies compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
		Water not applied to fields in summer for irrigation.	Alteration in timing and quantity of water applied to the land to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Decreases in the physiochemical qualities of surface water compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
	Groundwater substitution	Groundwater applied to agricultural fields.	Alteration in quality of surface water following mixing of groundwater and surface water to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Deteriorations of the physiochemical qualities of surface runoff compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
Merced and San Joaquin Rivers	Groundwater Substitution	Seasonal changes in timing of releases from Lake McClure.	Alteration of surface water elevation and storage in Lake McClure to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Decreases in reservoir storage and water surface elevation would not occur compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
			Alteration of Merced River or San Joaquin River flows to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	No flow decreases in the Merced and San Joaquin Rivers compared to the Baseline Condiiton.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.

Table 5-77
Water Quality
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Effects

Area of Analysis	Asset Acquisition or Management Type	Result	Potential Effects	Flexible Alternative Effects Compared to Baseline Condition	Fixed Alternative Effects Compared to Baseline Condition	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
		Groundwater applied to agricultural fields.	Alteration in quality of surface water following mixing of groundwater and surface water to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Deteriorations of the physiochemical qualities of surface runoff compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
Sacramento-San Joaquin Delta Region							
Sacramento-San Joaquin Delta	Crop Idling, Groundwater Substitution, Stored Groundwater Purchase, Stored Reservoir Water Purchase	Increased pumping from July through September.	Alterations in chloride, bromide, or organic carbon concentrations in the Delta during months of increased pumping to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Use of carriage water would maintain or reduce the chloride, bromide, or organic carbon concentrations in the Delta.	Use of carriage water would maintain or reduce the chloride, bromide, or organic carbon concentrations in the Delta.	Less-than-significant impact.	Less-than-significant impact.
		Shifting in timing of export pumping.	Alterations in the annual total salt and organic carbon load delivered to CVP and SWP water users to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Total chloride loading would decrease 1.7 percent and total bromide loading would decrease 1.7 percent compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
Export Service Area							
Export Service Area	Crop idling	Conversion of cotton crop to bare fields.	Change in the amount of runoff of salinity and trace elements into nearby waterbodies to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Increases in sediment transport due to wind erosion, resulting in sediment deposition in surrounding waterbodies compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.

Table 5-77
Water Quality
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Effects

Area of Analysis	Asset Acquisition or Management Type	Result	Potential Effects	Flexible Alternative Effects Compared to Baseline Condition	Fixed Alternative Effects Compared to Baseline Condition	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
		Water not applied to fields in summer for irrigation.	Alteration in timing and quantity of water applied to the land to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Decreases in the physiochemical qualities of surface water compared to the Baseline Condition.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.
	Stored Groundwater Purchase	Conveyance of stored groundwater directly into the California Aqueduct.	Exceedance of non-Project water acceptance criteria to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Purchased groundwater would adhere to the standards set forth in the acceptance criteria for non-Project water.	Purchased groundwater would adhere to the standards set forth in the acceptance criteria for non-Project water.	Less-than-significant impact.	Less-than-significant impact.
	Source Shifting	Seasonal changes in timing of releases from San Luis Reservoir, Anderson Reservoir, Castaic Lake, Lake Perris, Lake Mathews, or Diamond Valley Lake.	Alteration of water surface elevations in San Luis Reservoir, Anderson Reservoir, Castaic Lake, Lake Perris, Lake Mathews, or Diamond Valley Lake to result in long-term adverse effects on designated beneficial uses, exceedances of existing regulatory standards, or substantial degradation of water quality.	Changes in water surface elevation would be within existing operational parameters.	Effects would be equal to or less than effects under the Flexible Purchase Alternative.	Less-than-significant impact.	Less-than-significant impact.

5.2.8 Mitigation Measures

Under each of the acquisition types identified for the EWA Program, no adverse effects would occur to water quality resources. For EWA acquisitions obtained through groundwater substitution, the groundwater mitigation measure described in Chapter 6 (Groundwater Resources), provides assurances that local monitoring and mitigation programs are developed prior to an EWA acquisition via groundwater substitution. For EWA acquisitions obtained through crop idling, the air quality mitigation measure described in Chapter 8 provides assurances that the loss of topsoil resulting from idling lands is less than significant. Consequently, the EWA Program does not require mitigation measures to avoid, reduce, or eliminate adverse impacts on water quality.

5.2.9 Potentially Significant Unavoidable Impacts

There are no potentially significant unavoidable impacts to water quality associated with the implementation of the EWA Program.

5.2.10 Cumulative Effects

The analysis of potential EWA effects to water quality resources within the area of analysis compared the Flexible Purchase Alternative to the Baseline Condition. Historical data for reservoir storage volumes and water surface elevations, and river flows were used as a baseline for the comparative analysis. The analysis evaluated the effects to rivers and reservoirs as a percent change in flow and reservoir storage and water surface elevation. If additional transfer programs draw reservoirs down or reduce river flows below the acceptable criteria for water quality management, the effects could be cumulatively significant.

Upstream from the Delta, all five programs (Sacramento Valley Water Management Agreement, Dry Year Purchase Program, Critical Water Shortage Contingency Plan, Central Valley Project Improvement Act [CVPIA] Water Acquisition Program, and Environmental Water Program) have the potential to acquire water via stored reservoir water during dry years. If these programs use the same reservoirs as the EWA, water surface elevations and end-of-month storage levels could drop further, resulting in potentially significant effects to water quality, such as an increase in concentrations of constituents. In order to prevent cumulatively significant impacts, water agencies would have to cooperatively set release limits on reservoirs such that the reservoirs would not be drawn down below the levels required to maintain suitable water quality levels within the reservoirs, especially during the summer season, when water levels are already low within the reservoirs.

Actions such as groundwater substitution and crop idling upstream from the Delta would potentially occur in all cumulative programs. Transfers negotiated between CVP and SWP contractors and other water users, such as the Forbearance Agreement with Westlands Water District and the recent crop idling acquisition by Metropolitan WD from water agencies upstream from the Delta, are considered part of the Dry Year Program. These actions, in addition to EWA, would further reduce river flow during the summer and further increase flow in the fall. The decrease could be cumulatively significant if it were to further reduce flow, such that water quality (e.g., concentration of constituents of concern, water temperature) would be affected adversely. However, potential increases in flow late in the season could be cumulatively beneficial to the water quality (e.g., dilution of constituents). Overall, flow rates would most likely be governed by established regulatory requirements for anadromous and riverine fish, through such agencies as USFWS and National Oceanic and Atmospheric Administration Fisheries, which would prevent flow rates from increasing or decreasing in a manner that would be harmful to the fisheries. The fluctuations in flow caused by the cumulative actions would most likely not increase or decrease flows with sufficient magnitude or frequency to cause a cumulatively significant impact to water quality.

With regard to cumulative effects to water quality in the Sacramento-San Joaquin Delta Region, the analysis of the maximum amount of water that can be exported from the Delta provides an evaluation of the potential cumulative environmental effects of EWA water purchases and all other water transfers through the Delta. As described in detail in Attachment 1, for the EWA Program, the cumulative impact assessment comparison is the same as the impact assessment termed "Flexible Purchase Alternative Compared to the Baseline Condition" because, with regard to modeling results, the Environmental Setting is not differentiated from the Baseline Condition, and the cumulative simulation is not differentiated from the Flexible Purchase Alternative simulation. As described in Section 5.2.1.1.3, as a result of assuming utilization of all of the unused CVP and SWP pumping capacity for EWA, all potential SWP and CVP uses were analyzed. As a result, the analysis presented in Section 5.2.5.1.4 is not only an evaluation of the Flexible Purchase Alternative as compared to the Baseline Condition, but is also an evaluation of the Cumulative condition as compared to the Environmental Setting/No Action/No Project condition.

Only the Critical Water Shortage Contingency Plan and the CVPIA Water Acquisition Program operate in the Export Service Area. EWA acquisitions via crop idling and groundwater substitution would not affect the water quality adversely. Water acquired through crop idling and groundwater substitution would be held in the reservoirs and the additional water may provide opportunities for additional dilution of constituents. Water acquisition through these means, in conjunction with EWA, is not expected to have a cumulatively significant impact to water quality.

Asset management through source shifting in the Export Service Area would not likely cause a significant impact under the cumulative condition. Water storage in Anderson Reservoir would not go below 20,000 acre-feet regardless of the amount of potential water transfers under each acquisition program. Additionally, Metropolitan WD would manage its reservoirs within normal operating parameters for water transfers under all programs. Water levels in Castaic Lake and Lake Perris would not lower below the Baseline Condition. Diamond Valley Lake recently filled; therefore, there is no historical basis of comparison for effects. Consequently, cumulative effects to water quality would be less than significant.

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Chapter 6
Groundwater Resources

The use and sustainable management of groundwater resources is a crucial component in meeting the increasing water demands throughout the State of California, and groundwater resources north and south of the Delta provide a variety of acquisition options for the EWA Project Agencies. These options substantially enhance the operational flexibility of the EWA asset acquisition strategies. This chapter describes the groundwater resources in the Program area, presents the EWA Project Agencies' groundwater purchasing process, and discusses potential groundwater effects.

6.1 Affected Environment/Existing Conditions

This section introduces the boundaries of the area of analysis (Section 6.1.1), provides the regulatory setting pertaining to groundwater resources in the analysis area (Section 6.1.2), and describes the groundwater basins within the area of analysis (Sections 6.1.3 – Section 6.1.5). Information specific to the area of analysis includes regional information on the hydrology; groundwater production, levels, and storage; land subsidence; and groundwater quality. Section 6.2.4, Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative, provides more specific information relating to the potential effects within the agencies that may provide EWA Project Agencies with assets through groundwater transfers.

6.1.1 Area of Analysis

The groundwater resources area of analysis extends from the City of Redding in the northern portion of the Sacramento Valley to Kern County in the southern portion of the San Joaquin Valley. The area of analysis consists of the following groundwater basins:

- Redding Groundwater Basin
- Sacramento Groundwater Basin
- North San Joaquin Groundwater Basin
- South San Joaquin Groundwater Basin

Figure 6-1 shows the boundaries of the area of analysis and the groundwater basins. Groundwater transfers to the EWA Program could be made by selling agencies that are within these groundwater basins. The locations of the selling agencies (listed in Tables 2-5 and 2-9) are given in subsequent figures in the following sections. The groundwater area of analysis does not include all areas within the EWA Area, including the northern and southern areas outside of the Central Valley groundwater basins.

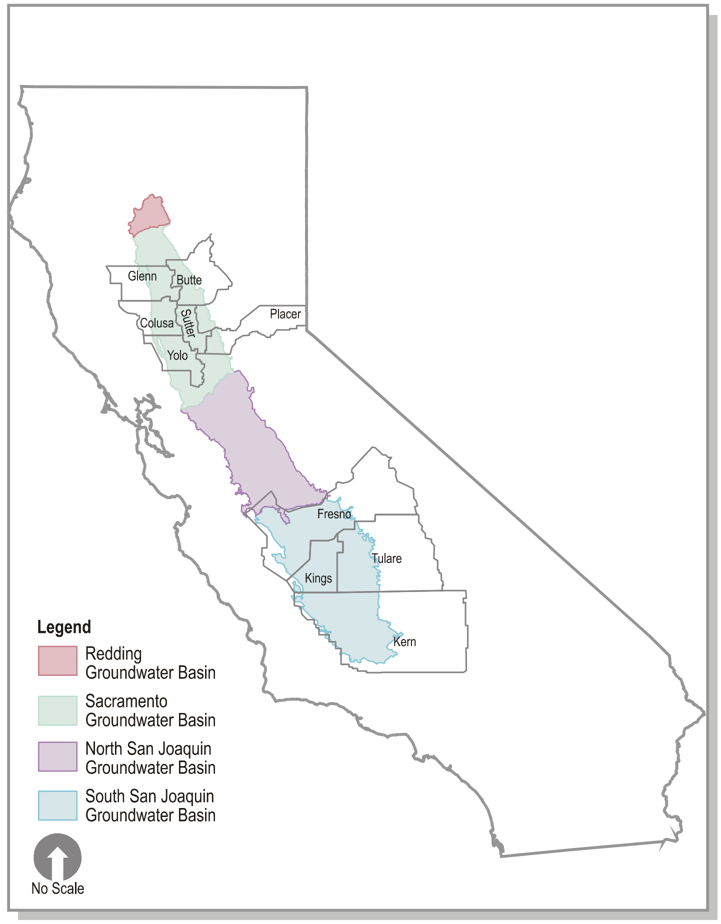

Figure 6-1
Groundwater Resources Area of Analysis

6.1.2 Regulations Affecting Water Purchases

EWA Project Agency acquisitions of groundwater would come from willing sellers, who are to comply with applicable regulations: State regulations; Central Valley Project (CVP) and State Water Project (SWP) contractual requirements; and local regulations, as described below.

6.1.2.1 State Regulation

Groundwater use is subject to limited statewide regulation; however, all water use in California is subject to constitutional provisions that prohibit waste and unreasonable use of water (SWRCB 1999). In general, groundwater and groundwater-related transfers are subject to a number of provisions in the Water Code. These provisions require compliance with: 1) local groundwater management plans, 2) the "no injury" rule[1], and 3) Section 1220 that regulates the direct export of groundwater from the combined Sacramento and Delta-Central Sierra Basins.

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1 The "no injury" rule refers collectively to Sections 1702, 1706, 1727, 1736, and 1810 of the Water Code.

The State Water Code (Section 1745.10) requires that for water transfers pursuant to Sections 1725[2] and 1735[3], the transferred water may not be replaced with groundwater unless the following criteria are met (SWRCB 1999):

- The transfer is consistent with applicable groundwater management plans; or
- The transferring water supplier approves the transfer and, in the absence of a groundwater management plan, determines that the transfer will not create, or contribute to, conditions of long-term overdraft in the groundwater basin.

In addition to these requirements, State well standards and local ordinances govern well placement, and the Water Code requires submission of well completion reports. Any groundwater transfers involving construction of new wells would be subject to these regulations, as well as other applicable local regulations and ordinances.

The "no injury" provisions of the Water Code provide that transfers cannot cause "injury to any legal user of the water involved." Groundwater users are protected by the provisions as long as they are legal users of water. The "no-injury" rules typically apply to legal third parties. Although not defined in the Water Code, third parties are typically not the entities conducting the transfer or receiving the transferred water, but are the parties (including Indian tribes) that could be affected by the transfers.

Other groundwater regulation is related primarily to water quality issues, which are addressed through a number of different legislative acts and are the responsibility of several different State agencies including:

- **The State Water Resource Control Board (SWRCB) and nine regional water quality control boards** - responsible for protecting water quality for present and future beneficial use;
- **The Department of Toxic Substances Control** - responsible for protecting public health from improper handling, storage, transport, and disposal of hazardous materials;
- **The Department of Pesticide Regulation** - responsible for preventing pesticide pollution of groundwater;
- **The Department of Health Services** - responsible for drinking water supplies and standards;

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[2] Section 1725 of the Water Code pertains to short-term/temporary transfers of water under post 1914 water rights that involve the amount of water that would have been consumptively used or stored by the transferee in the absence of the change or transfer. Such changes or transfers are exempt from CEQA, but require findings of "no injury to other legal users" and "no unreasonable effects on fish and wildlife".

[3] Section 1735 of the Water Code pertains to long-term transfers of water or water rights involving a change of point of diversion, place of use, or purpose of use. A transfer is considered long-term if it exceeds a period of one year.

- **The California Integrated Waste Management Board** - oversees non-hazardous solid waste disposal, and

- **The Department of Conservation** - responsible for preventing groundwater contamination due to oil, gas, and geothermal drilling and related activities.

Assembly Bill 3030 (AB3030), Water Code Section 10750 (commonly referred to as the Groundwater Management Act) permitted local agencies to develop groundwater management plans that covered certain aspects of management. Subsequent legislation has amended this chapter to make the adoption of a management program mandatory if an agency is to receive public funding for groundwater projects, creating an incentive and implementation of plans. The following section provides more detail on AB3030.

Senate Bill 1938 (SB 1938), Water Code Section 10753.7, requires local agencies seeking State funds for groundwater construction or groundwater quality projects are required to have the following: 1) a developed and implemented groundwater management plan that includes basin management objectives[4] (BMOs) and addresses the monitoring and management of groundwater levels, groundwater quality degradation, inelastic land subsidence, and surface water/groundwater interaction; 2) a plan addressing cooperation and working relationships with other public entities; 3) a map showing the groundwater subbasin the project is in, neighboring local agencies, and the area subject to the groundwater management plan; 4) protocols for the monitoring of groundwater levels, groundwater quality, inelastic land subsidence, and groundwater/surface water interaction; and 5) groundwater management plans with the components listed above for local agencies outside the delineated Bulletin 118 groundwater subbasins.

The Monterey Amendments to SWP contacts enhance management of SWP supplies and operations. This amendment established a number of water management tools including:

- **Turnback pool –** SWP contractors may sell unneeded SWP Table A allocated water through a "turnback pool" to other contractors.

- **Water Transfers –** Subject to DWR approval, SWP contractors may permanently transfer Table A amounts to other SWP contactors.

- **Storage outside the service area –** SWP contractors may store water outside of their service areas for use in their SWP service area at a later date. As discussed in Section 6.1.5.3, Semitropic Irrigation District (ID), Arvin-Edison Water Storage District (WSD), and other groundwater banks in Kern County provide

[4] BMOs are a management strategy designed to define the acceptable range of groundwater levels, groundwater quality, and inelastic land subsidence that can occur in a local area without causing significant adverse impacts.

groundwater storage services, allowing other districts to bank water in their service areas.

6.1.2.2 Local Regulation

Local groundwater management plans and county ordinances vary by authority/agency and region, but typically involve provisions to limit or prevent groundwater overdraft, regulate transfers, and protect groundwater quality. AB3030, the Groundwater Management Act, encourages local water agencies to establish local Groundwater Management Plans and the act lists 12 elements that should be included within the plans to ensure efficient use, good groundwater quality, and safe production of water. These 12 elements may include (State Water Code, Section 10753):

- Control of saline water intrusion;
- Identification and management of well head protection areas and recharge areas;
- Regulation of the migration of contaminated groundwater;
- Administration of a well abandonment and destruction program;
- Mitigation of conditions of overdraft;
- Replenishment of groundwater extracted by water producers;
- Monitoring of groundwater levels and storage;
- Facilitation of conjunctive use operations;
- Identification of well construction policies;
- Construction and operation (by the local agency) of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects;
- Development of relationships with State and Federal regulatory agencies; and
- Review of land use plans and coordination with land use planning agencies to assess activities that create a reasonable risk of groundwater contamination.

Table 6-1 lists the current groundwater management plans, agreements, and county ordinances that apply to agencies that may sell water to the EWA Program. These plans are discussed in further detail in Section 6.2.4**.** Table 6-2 lists the AB3030 plan components (outlined in the Water Code Section 10750) that are included in the groundwater management plan for potential EWA willing sellers.

Local Tribal groundwater ordinances and policies may also play a role in groundwater transfers to the EWA. These local ordinances would be addressed during a consultation process prior to the EWA transfers, if adverse groundwater effects were anticipated. (See Section 21.3.1 for further details.)

Table 6-1
Local Groundwater Management Plans and Ordinances

Groundwater Basin	Potential EWA Willing Sellers	Groundwater Management Plans, Agreements and County Ordinances
Redding	Anderson-Cottonwood ID	• Shasta County Ordinance No. SCC 98-1 • Tehama County Urgency Ordinance No. 1617 • Tehama County Coordinated AB3030 Plan • Redding Basin AB3030 Plan
Sacramento	Glenn Colusa ID Reclamation District 108	• Glenn County Ordinance No. 1115 • Colusa County Ordinance No. 615 • Yolo County Export Ordinance No. 1617 • Glenn-Colusa ID AB3030 Plan • Reclamation District 108 AB3030 Plan
	Biggs-West Gridley WD Butte WD Richvale ID Western Canal WD	• Chapter 33 of the Butte County Code • Butte County Well Spacing Ordinance • Glenn County Ordinance No. 1115 and BMOs • Colusa County Ordinance No. 615 • Biggs-West Gridley WD AB3030 Plan • Richvale ID AB3030 Plan • Butte WD AB3030 Plan • Western Canal Water District AB3030 Plan
	Sutter Extension WD Garden Highway MWC	• Sutter Extension AB3030 Plan
	Yuba County Water Agency Members including: Brophy WD Browns Valley ID South Yuba WD Cordua WD Ramirez WD Dry Creek MWC Hallwood ID	• Yuba County transfer policies • Cordua ID AB3030 Plan • South Yuba AB3030 Plan • Browns Valley ID transfer policies
	Natomas Central MWC Sacramento Groundwater Authority	• Water Forum Agreement • Natomas Central MWC AB3030Plan • Sacramento County Water Agency Act, Sections 32-33 • SGA Regional Water Management Plan - currently being developed
North San Joaquin	Merced ID	• Merced ID AB3030 Plan • Merced Groundwater Basin AB3030 Plan • Merced County Wellhead Protection Program • Water Supply Plan and Update
South San Joaquin	See Table 6-17	See Table 6-17

Abbreviations: ID - Irrigation District, WD – Water District, AB3030 Plan– AB3030 Plan Groundwater Management Plan, RD – Reclamation District, BMOs – Basin Management Objectives, MWC – Mutual Water Company, YCWA – Yuba County Water Agency

Table 6-2
Components of Local Groundwater Management Plans

Water Agency/District AB3030 Plan	Year Adopted	Saltwater Intrusion	Well head and recharge protection	Migration of contamination	Well abandonment and destruction	Overdraft mitigation	Groundwater replenishment	Monitoring	Conjunctive Use	Well construction policies	Construction and operation of facilities	Coordination with Other Agencies	Land use and groundwater contamination
Anderson-Cottonwood ID	1998		X		X	X		X	X	X	X	X	X
Glenn-Colusa ID	1995				X		X	X	X	X	X	X	
Reclamation District 108	1997	X				X	X	X				X	
Biggs West Gridley WD	1995	X	X	X	X	X	X	X	X	X		X	
Butte WD	1996	X	X	X	X	X	X	X	X	X		X	X
Richvale ID	1995	X	X	X	X	X	X		X			X	
Sutter Extension WD	1995	X	X	X	X	X	X	X	X	X		X	
Western Canal WD	1995	X		X		X	X	X	X			X	
Yuba County WA[1]	2002	X	X	X	X	X	X	X	X		X	X	X
Cordua ID	1995	X	X	X	X	X	X	X	X	X		X	
South Yuba WD	1996	X	X	X	X	X	X	X	X	X		X	
Sacramento Ground Water Authority[2]	-			X		X	X	X	X		X	X	
Natomas Central MWC[3]	2002		2	1	2	1		1	1	2		1	
Merced Groundwater Basin	1997	X	X	X	X	X	X	X	X	X	X	X	X
Merced ID[1]	1996	X	X			X[4]	X		X			X	

[1] This is not a formal AB3030 Plan
[2] The Sacramento Groundwater Authority Regional Water Management Plan is being developed and may contain additional components not indicated in this table. This is not a formal AB3030 plan, yet many of the AB3030 Plan components are goals of the SGA and will be incorporated in the plan.
[3] The Natomas Central MWC Plan is not a formal AB3030 Plan. However, it contains many of the same elements stipulated in the Assembly Bill AB3030 Plan. These elements are prioritized as first and second priority as shown on the chart.
[4] Informally addressed in the Plan.

6.1.3 Upstream from the Delta Region

Potential groundwater acquisition areas Upstream from the Delta Region are in the Redding, Sacramento, and North San Joaquin Groundwater Basins. The following section provides information on the geology, hydrogeology, and hydrology; groundwater production, levels, and storage; land subsidence, and groundwater quality in these areas.

6.1.3.1 Redding Groundwater Basin

The Redding Groundwater Basin is in the northernmost part of the Sacramento Valley. Underlying Tehama and Shasta Counties, it is bordered by the Klamath Mountains to the north, the Coast Range to the west, and the Cascade Mountains to the east. Red Bluff Arch,[5] separates the Redding Groundwater Basin from the Sacramento Valley Groundwater Basin to the south. DWR Bulletin 118 subdivides the Redding Groundwater Basin into six subbasins: Anderson, Enterprise, Millville, Rosewood, Bowman, and South Battle Creek. Anderson-Cottonwood ID is the agency currently expected to transfer water to the EWA via groundwater substitution. Figure 6-2 shows the Redding Groundwater Basin and the Anderson-Cottonwood ID.

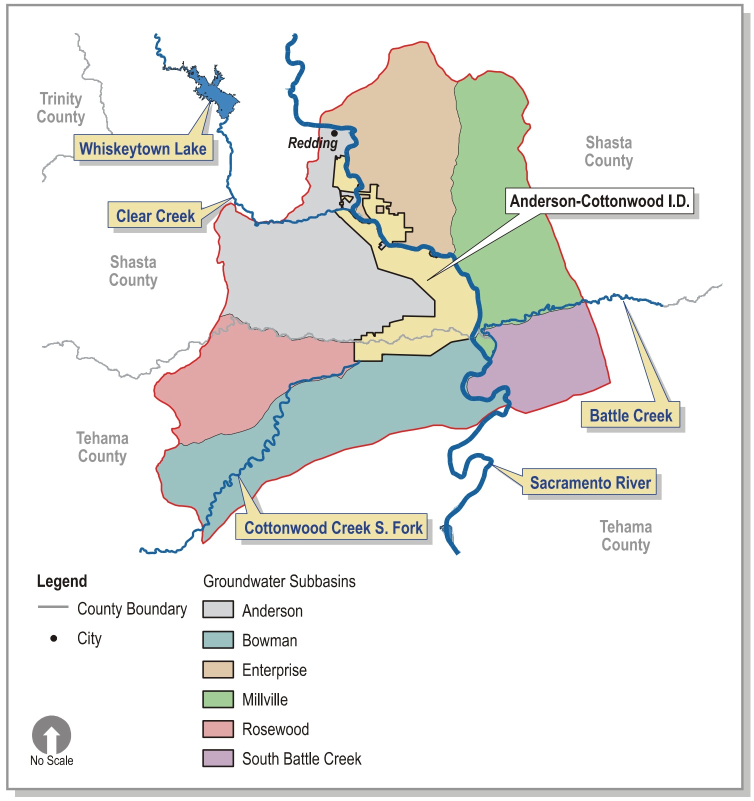

Figure 6-2
Redding Groundwater Basin

6.1.3.1.1 Geology, Hydrogeology and Hydrology

The Redding Groundwater Basin consists of a sediment-filled, southward plunging symmetrical trough (DWR 2001). Simultaneous deposition of material from the Coast Range and the Cascade Range resulted in two different formations, which are the principal freshwater-bearing formations in the basin. The Tuscan Formation in the east is derived from the Cascade Range volcanic sediments, and the Tehama Formation in the western and northwest portion of the basin is derived from Coast Range sediments. These formations are up to 2,000 feet thick near the confluence of

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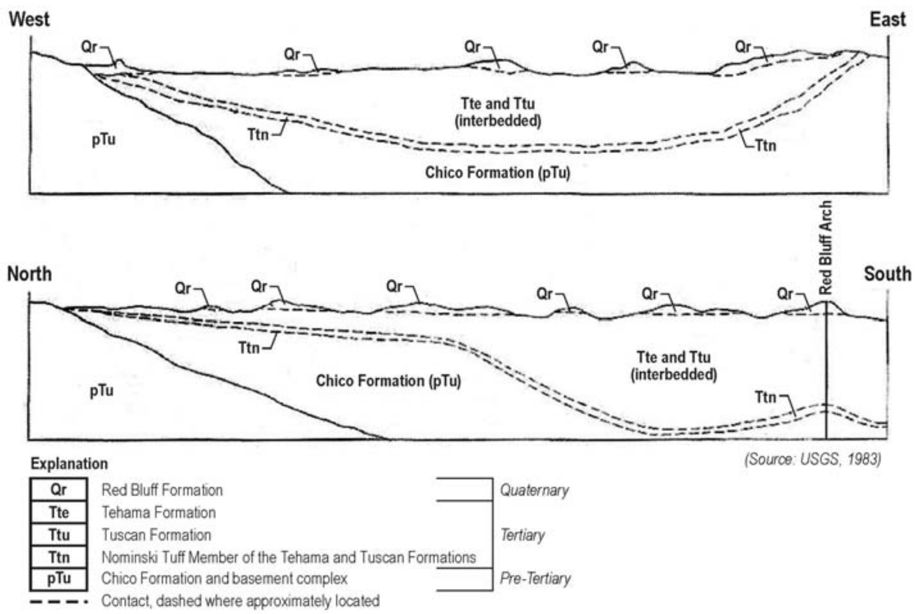
5 The Red Bluff Arch is a series of east-west trending folds of valley sediments, between the cities of Red Bluff and Redding. These folds divide the Sacramento Valley hydrogeologically into the Redding and Sacramento groundwater basins.

the Sacramento River and Cottonwood Creek, and the Tuscan Formation is generally more permeable and productive than the Tehama Formation (DWR 2001). Figure 6-3 shows generalized geologic cross sections across the Redding Basin (USGS 1983).



Source: USGS 1983

Figure 6-3
Geologic Cross Sections of the Redding Groundwater Basin

A large portion of recharge to the Redding Groundwater Basin is from precipitation and snowmelt from higher elevations. Average annual precipitation in the Redding Groundwater Basin ranges from 22 to as much as 40 inches in the higher elevations (California Spatial Library/DWR Statewide isohyet map). As is typical throughout the Central Valley, 80 to 90 percent of the area's precipitation occurs in November to April. In the surrounding mountain ranges, precipitation ranges from 40 to 75 inches, much of it in the form of snow.

The principal surface water features in the Redding Groundwater Basin are the Sacramento River and its tributaries: Battle Creek, Cow Creek, Little Cow Creek, Clear Creek, Dry Creek, and Cottonwood Creek. Surface water and groundwater interact in many areas in the Redding Basin. In general, groundwater flows southeasterly on the west side of the basin and southwesterly on the east side, toward the Sacramento River. The Sacramento River is the main drain for the basin (DWR Northern District 2002). In the northern portion of Anderson-Cottonwood ID, groundwater generally flows south-southeast toward the Sacramento River. In the southern portion of Anderson-Cottonwood ID, groundwater moves eastward along Cottonwood Creek and towards its confluence with the Sacramento River (DWR Northern District 2002). The Shasta County Water Resources Master Plan Phase 1 Report estimated the total annual groundwater discharge to rivers and streams at about 266,000 acre-foot, and seepage from streams and canals into groundwater at 59,000 and 44,000 acre-feet, respectively (Shasta County Water Agency, et al. 1997). Groundwater is typically unconfined to semi-confined in the shallow aquifer system and confined where deeper aquifers are present.

6.1.3.1.2 Groundwater Production, Levels, and Storage

Total annual groundwater pumping for the basin is approximately 37,000 acre-feet (DWR 1997), a minor amount compared to the basin's groundwater discharge to surface water of 266,000 acre-feet.

Groundwater levels typically vary annually from greater than 460 feet above mean sea level (msl) around the fringes of the basin, to less than 390 feet msl near the confluence of Cottonwood Creek and the Sacramento River. Historically, groundwater levels have remained relatively stable, with no long-term trend of declining or increasing levels. Some relatively short-term declines were noticeable during the droughts of 1976-1977 and in 1986-1994. These declines were followed by recovery to pre-drought levels.

DWR has estimated the total quantity of groundwater in storage in the Redding Groundwater Basin at approximately 6.9 MAF. This assumes a specific yield of 8.5 percent, an aquifer area of 33,300 acres, and a maximum saturated thickness of 2,470 feet (DWR 2002).

6.1.3.1.3 Land Subsidence

Land subsidence is the lowering of the land surface due to changes that take place underground. There are a number of potential causes of land subsidence including groundwater, oil, and gas extraction; dissolution of limestone aquifers; collapse of underground mines; drainage of organic soils; and initial wetting of dry soils (also called hydro-compaction). This EIS/EIR assesses land subsidence caused by groundwater pumping. Excessive groundwater extraction from confined and unconfined aquifers could result in a lowering of groundwater levels and, in confined aquifers, a decline in water pressure. Reduction in water pressure results in increased loading of the clay and silt beds, which may subsequently consolidate, resulting in lowering of the ground surface. The compaction of the fine-grained deposits is permanent.

Subsidence could cause damage to structures and increase flooding potential of low-lying land. Reduction in the permeability resulting from compaction of clay beds would slightly reduce the vertical movement of water in the aquifer system. Subsidence is most likely under the following conditions: 1) highly confined aquifer system, 2) coarse-grained aquifers that have thin clay layers interspersed throughout the strata, 3) clay interbeds that are subjected to a low degree of natural pre-consolidation pressures, and 4) large reduction in groundwater levels (DWR Northern District 2002).

Land subsidence has never been monitored in the Redding Groundwater Basin. However, there would be potential for subsidence in some areas of the basin if groundwater levels were substantially lowered. The groundwater basin west of the Sacramento River is composed of the Tehama Formation, which has exhibited subsidence in Yolo County (Dudley 2002).

6.1.3.1.4 Groundwater Quality

Groundwater in the Redding area of analysis is typically of good quality, as evidenced by its low total dissolved solids (TDS) concentrations, which range from 70 to 360 mg/L.[6] Areas of high salinity, or poor water quality, are generally on the basin margins, where the groundwater is derived from marine sedimentary rock. Elevated levels of iron, manganese, nitrate, and high TDS have been detected in some areas. High levels of boron have been detected in the southern portion of the basin (DWR 2002 and DWR Northern District 2002).

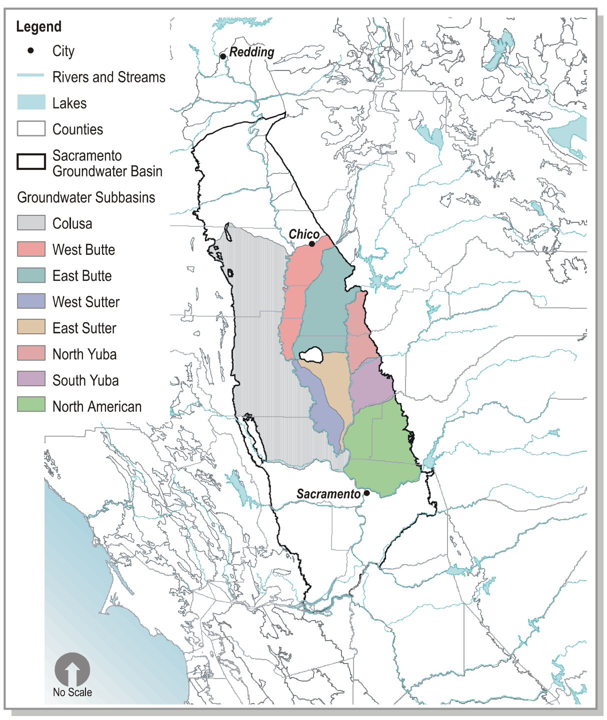


Figure 6-4
Sacramento Groundwater Basin

6.1.3.2 Sacramento Groundwater Basin

The Sacramento Groundwater Basin extends from the Redding Groundwater Basin to the San Joaquin Valley including Tehama, Glenn, Butte, Yuba, Colusa, Placer and Yolo Counties. It is bordered by Red Bluff Arch to the north, the Coast Range to the west, the Sierra Nevada to the east, and the San Joaquin Valley to the south. Bulletin 118 further divides the Sacramento Groundwater Basin into subbasins. Figure 6-4 shows the Sacramento Groundwater Basin and subbasins within the area of analysis. The agencies expected to transfer assets to the EWA Project Agencies via groundwater substitution or groundwater purchase are described in Section 6.2.4, Environmental Consequences and Impacts of the Flexible Purchase Alternative.

6.1.3.2.1 Geology, Hydrogeology, and Hydrology

The Sacramento Groundwater Basin is a north-northwestern trending asymmetrical trough filled with as much as 10 miles of both marine and continental rocks and sediment (Page 1986). On the eastern side, the basin overlies basement bedrock that rises relatively gently to form the Sierra Nevada, while on the western side the underlying basement bedrock rises more steeply to form the Coast Ranges. Overlying the basement bedrock are marine sandstone, shale, and conglomerate rocks, which generally contain

[6] TDS concentrations above 500 mg/L may cause adverse effects to some crops.

brackish or saline water (DWR 2001). The more recent continental deposits, overlying the marine sediments, contain freshwater. These continental deposits are generally 2,000 to 3,000 feet thick (Page 1986). The depth (below ground surface) to the base of freshwater typically ranges from 1,000 to 3,000 feet (Bertoldi 1991). Along the eastern and northeastern portion of the basin are the Tuscan and Mehrten formations, derived from the Cascade and Sierra Nevada. The Tehama Formation in the western portion of the basin is derived from Coast Range sediment. In most of the Sacramento Groundwater Basin, the Tuscan, Mehrten, and Tehama formations are overlain with relatively thin alluvial deposits.

In the Sacramento Groundwater Basin, freshwater is present primarily in the Tuscan, Mehrten, and Tehama formations and in alluvial deposits. Figures 6-5 and 6-6 are generalized cross sections for the northern and southern portions of the Sacramento Groundwater Basin, respectively. Groundwater users in the basin pump primarily from deeper continental deposits.

Groundwater is recharged by deep percolation of applied water and rainfall infiltration from streambeds and lateral inflow along the basin boundaries. Average annual precipitation in the Sacramento Groundwater Basin ranges from 13 to 26 inches, with the higher precipitation occurring along the eastern and northern edges of the basin. Typically, 80 to 90 percent of the basin's precipitation occurs from November to April. Further east in the Sierra Nevada, precipitation ranges from 40 to 90 inches, much in the form of snow (Bertoldi 1991). The quantity and timing of snowpack melt are the predominant factors affecting the surface and groundwater hydrology, and peak runoff in the basin typically lags peak precipitation by one to two months (Bertoldi 1991). The main surface water feature in the Sacramento Groundwater Basin is the Sacramento River, which has several major tributaries draining the Sierra Nevada, including the Feather River, Yuba River, and American River. Stony Creek, Cache Creek, and Putah Creek, draining the Coast Range are the main west side tributaries of the Sacramento River. Surface water and groundwater interact on a regional basis, and, as such, gains and losses to groundwater vary significantly geographically and temporally. In areas where groundwater levels have declined, such as in Sacramento County, streams that formerly gained water from groundwater now lose water to the groundwater system through seepage.

6.1.3.2.2 Groundwater Production, Levels and Storage

Irrigated agriculture in the Sacramento Groundwater Basin increased steadily from less than 500,000 acres in the 1940s to more than 1.5 million acres by 1980 (Reclamation 1997). Correspondingly, groundwater production to support the agriculture rose from less than 500,000 acre-feet annually to more than 2 million acre-feet annually by the mid-1990s (DWR 1998).

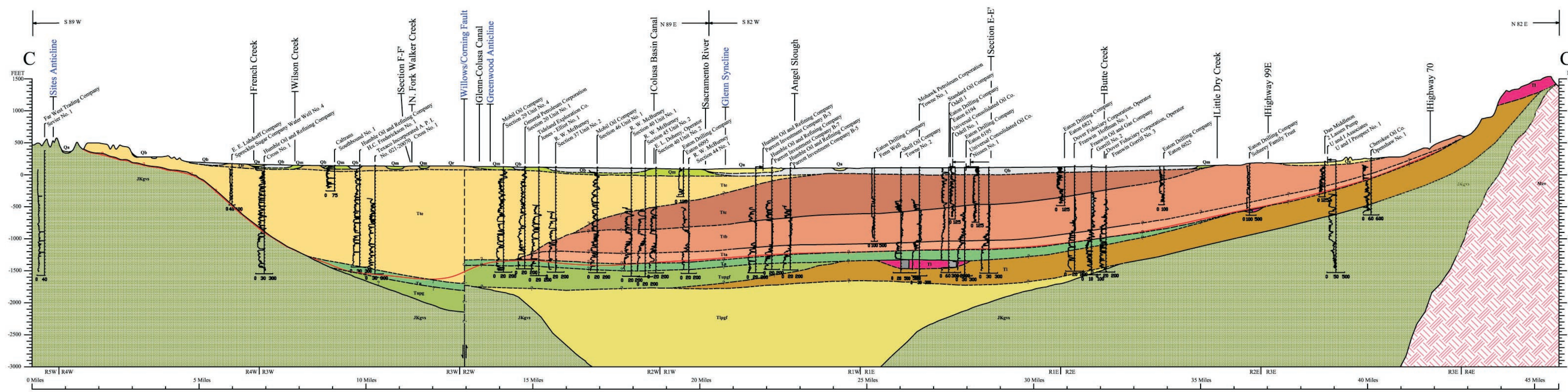
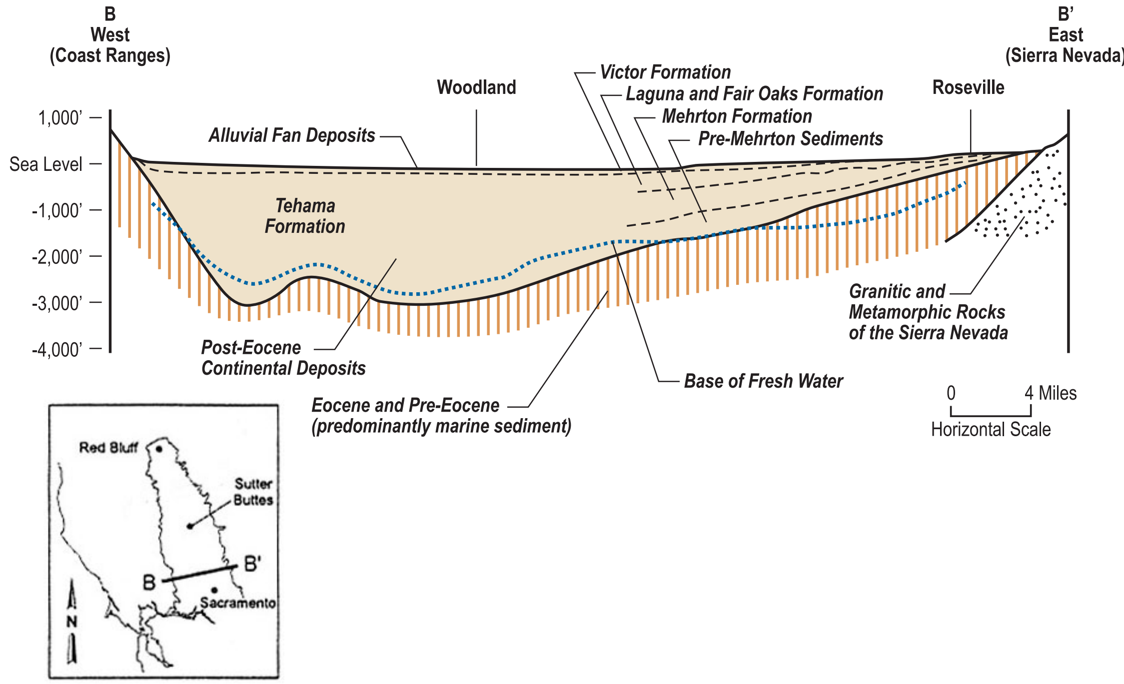


Figure 6-5
North Geologic Cross Section of the Sacramento Groundwater Basin (Chico to Black Butte)
Provided by: DWR North District



Source: DWR North District 2002

Figure 6-6
South Geologic Cross Section of the Sacramento Groundwater Basin

Figure 6-7 shows the spring 1997-groundwater elevation contours and Figure 6-8 shows the 1997 depth to groundwater contours. In general, groundwater flows inward from the edges of the basin and south parallel to the Sacramento River. In some areas there are groundwater depressions associated with extraction that influence local groundwater gradients. Prior to the completion of CVP facilities in the area (1964-1971), pumping along the west side of the basin caused groundwater levels to decline. Following construction of the CVP, the delivery of surface water and reduction in groundwater extraction resulted in a recovery to historic groundwater levels by the mid to late-1970s. Throughout the basin, individuals, counties, cities, and special legislative agencies manage and/or develop groundwater resources. Many agencies use groundwater to supplement surface water; therefore, groundwater production is closely linked to surface water availability.

6.1.3.2.3 Land Subsidence

Historically, land subsidence occurred in the eastern portion of Yolo County and the southern portion of Colusa County, owing to groundwater extraction and geology. Figure 6-9 shows the extent of documented historical subsidence and areas of possible subsidence based on anecdotal evidence and past studies. The earliest studies on land subsidence in the Sacramento Valley occurred in the early 1970s when the USGS, in cooperation with DWR, measured elevation changes along survey lines containing first and second order benchmarks. Results indicated subsidence between 1934 and

1942, in 1964, and in 1967 between Zamora and Davis and between Zamora and Arbuckle. A 1994 USGS study using a global positioning system survey indicated a subsidence rate of 4 cm/yr for areas centered on Davis and extending toward Dixon and an area centered on Woodland extending toward Zamora (DWR Northern District 2002). Figure 6-10 presents profiles of land subsidence between Madison and Davis**.** These profiles were determined from leveling-control lines and indicated a substantial amount of subsidence between 1935 and 1987 in the Davis-Woodland area (Lofgren 1987)**.**

DWR is monitoring land subsidence in several areas throughout the Sacramento Valley. Figure 6-9 shows the location of the extensometers[7] and the data from the Zamora and Conaway Ranch extensometers. These figures indicate that the ground surface displacement generally occurs during periods of high groundwater extraction. The Conaway Ranch extensometer shows a net reduction (inelastic subsidence) of less than half an inch between 1991 and 2001 while the Zamora Extensometer shows a net reduction of about 2 inches over the same time period. Additional data from the Zamora extensometer, not shown here, indicates a net subsidence of over 6 inches from 1988 to 1992. Yolo County, in cooperation with DWR, has developed a countywide global positioning system (GPS) designed to survey and monitor future land subsidence (DWR Northern District 2002).

6.1.3.2.4 Groundwater Quality

Groundwater quality in the Sacramento Groundwater Basin is generally good and sufficient for municipal, agricultural, domestic, and industrial uses. However, there are some localized groundwater quality issues in the basin. In general, natural groundwater quality is influenced by stream flow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada is generally of higher quality than runoff from the Coast Ranges, because of the presence of marine sediments in the Coast Range. Specific groundwater quality issues are discussed below.

[7] Instruments used to measure movements of soil and rock.

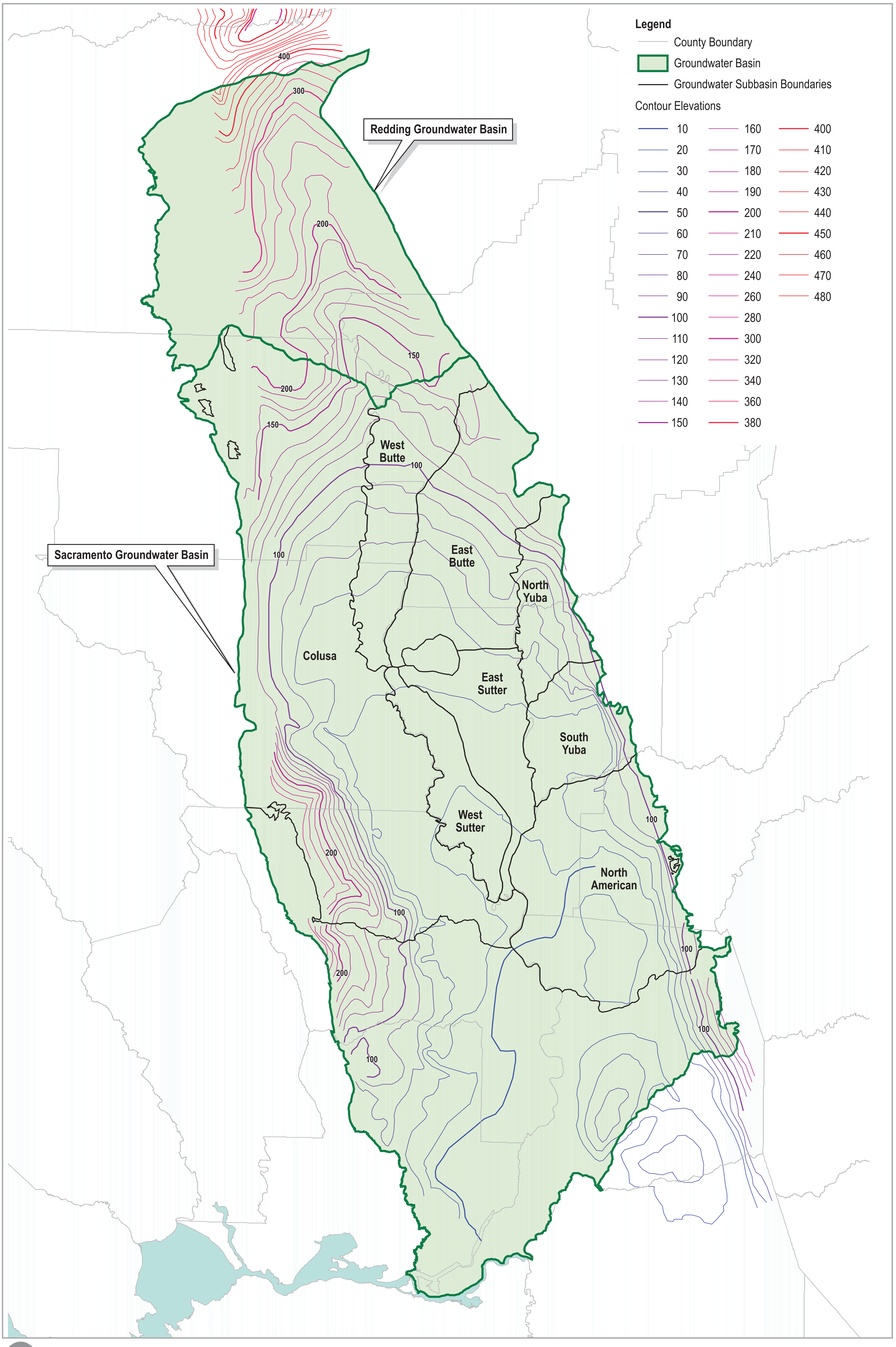


Figure 6-7
Sacramento Valley Spring 1997 Groundwater Level Elevations
Contours Provided by: DWR North District

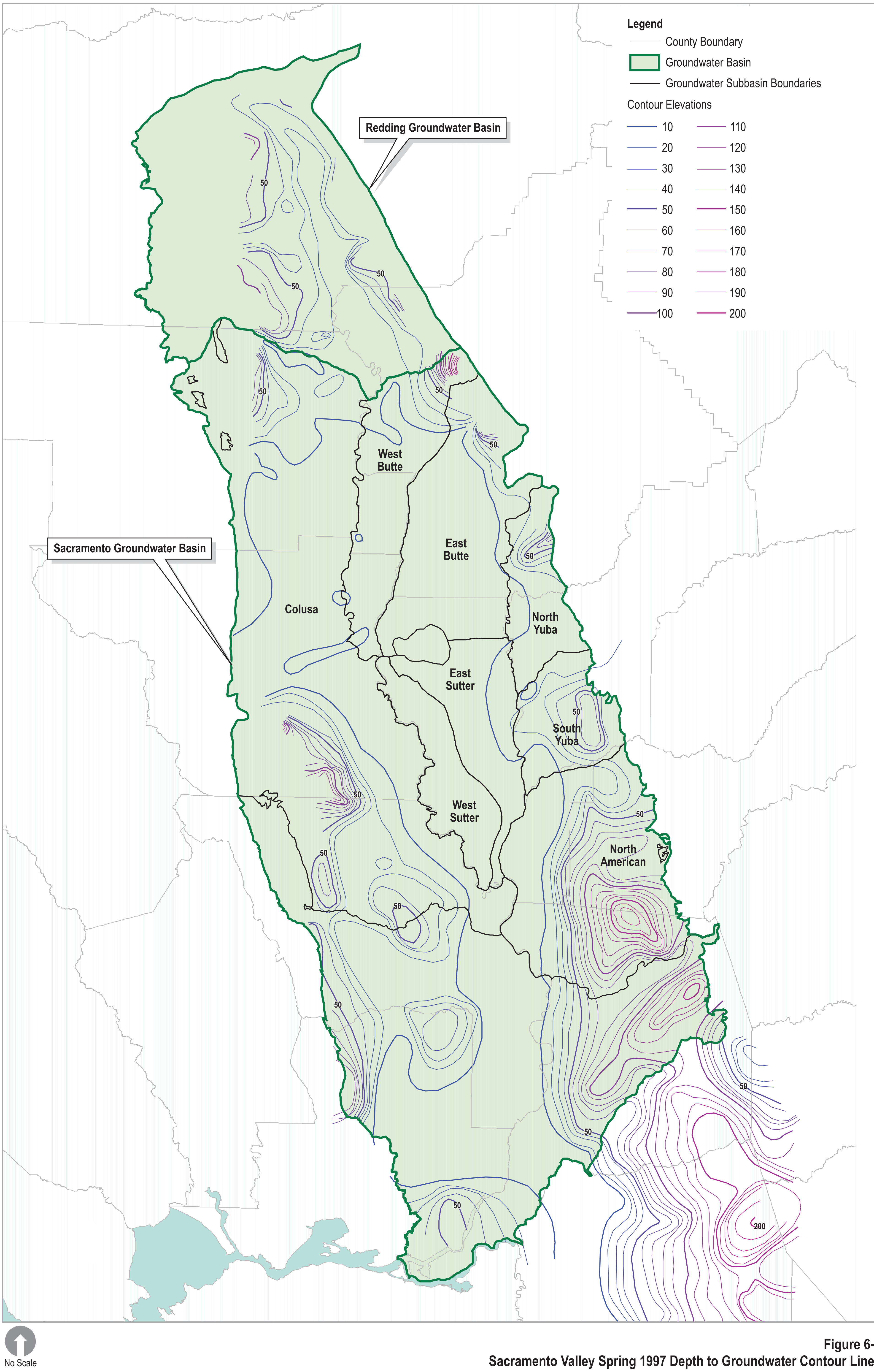


Figure 6-8
Sacramento Valley Spring 1997 Depth to Groundwater Contour Lines
Contours Provided by: DWR North and Central Districts

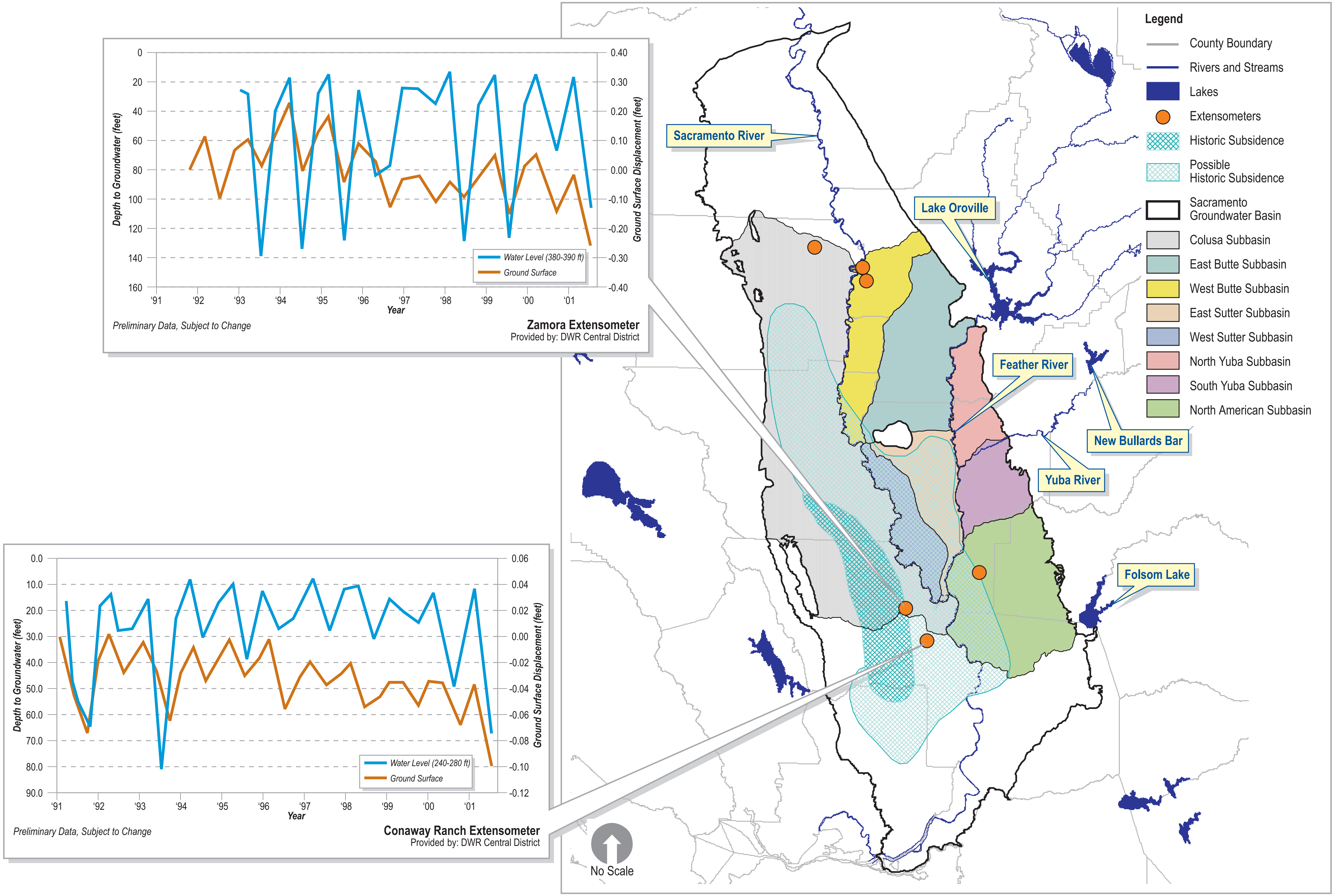
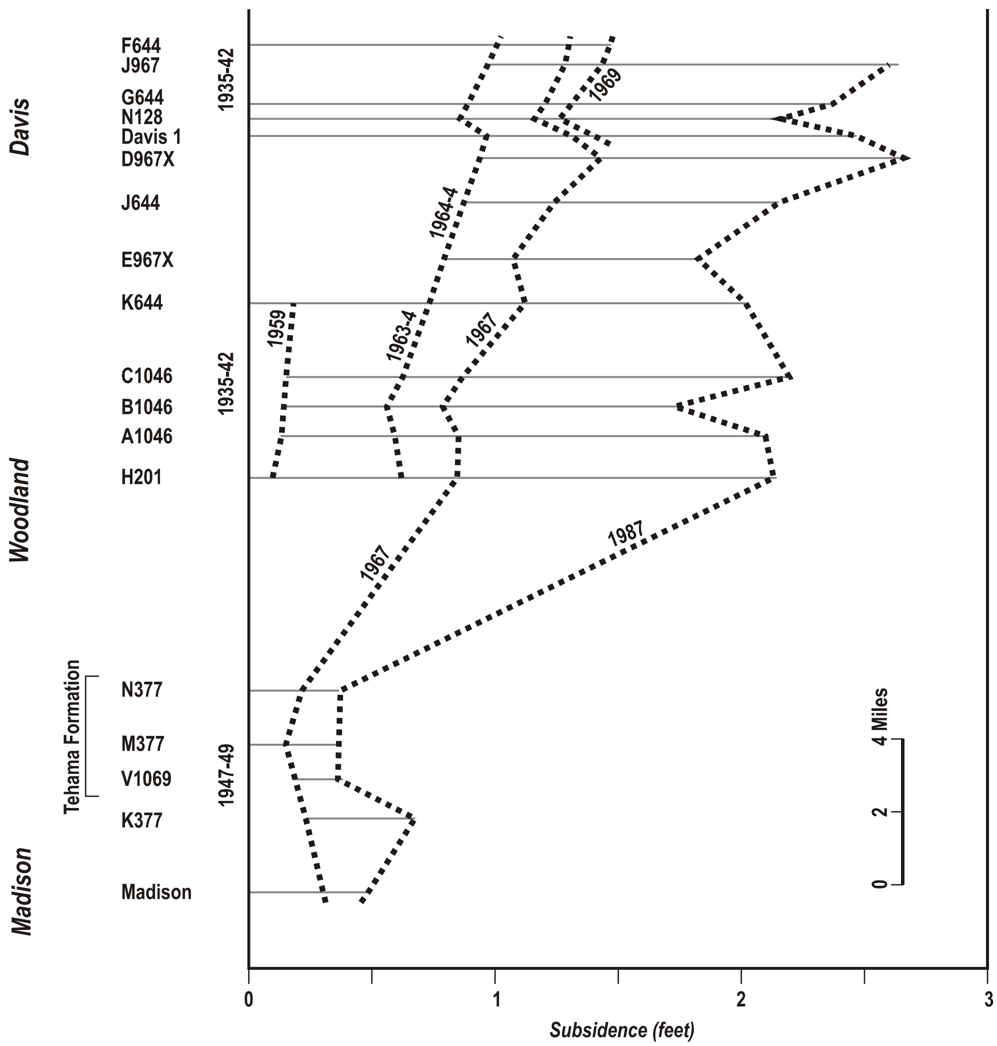


Figure 6-9
Land Subsidence in the Sacramento Groundwater Basin
Provided by: DWR Water Transfers Office



Source: Lutgren 1987

Figure 6-10
Profile of Land Subsidence in Eastern Yolo County

TDS generally consist of inorganic salts and small amounts of organic matter. The California and EPA secondary drinking water standard for TDS is 500 milligrams per liter (mg/L), and the agricultural water quality goal for TDS is 450 mg/L. Generally, in the Sacramento Basin, TDS levels are between 200 and 500 mg/L, while in the southern part of the basin the TDS levels are higher than that due to the local geology. Along the eastern boundary of the basin, TDS concentrations tend to be less than 200 mg/L, indicative of the low level of TDS concentrations in Sierra Nevada runoff. Several areas in the basin have naturally occurring high concentrations of TDS, with concentrations that exceed 500 mg/L. TDS concentrations as high as 1,500 mg/L have been recorded (Bertoldi 1991). One of these high TDS areas is west of the Sacramento

River, between Putah Creek and the confluence of the Sacramento and San Joaquin Rivers; another is in the south-central part of the Sacramento Basin, south of Sutter Buttes, in the area between the confluence of the Sacramento and Yuba Rivers.

Nitrate (measured as nitrogen) is regulated in drinking water and has an MCL of 10 mg/L. Nitrates found in groundwater could be due to fertilizer use, leachate from septic tanks, wastewater disposal, and natural deposits. In irrigation water, nitrate could be an asset because of its value as a fertilizer; however, algae growth and environmental problems could arise from concentrations exceeding 30 mg/L. Concentrations of nitrate as nitrogen exceeding 10 mg/L are found throughout the Central Valley; however, concentrations exceeding 30 mg/L are rare and localized (Bertoldi 1991). In the Sacramento Groundwater Basin, two areas of potential nitrate problems have been identified: one in northern Yuba and southern Butte Counties, east of Sutter Buttes, and another in northern Butte and southern Tehama Counties (Reclamation 1997).

In low concentrations, boron is important for plant growth, but it could adversely affect certain crops at concentrations as low as 0.5 mg/L. In the Central Valley, boron is usually from natural sources, such as marine deposits; in general, only localized portions of the Sacramento Basin have concentrations exceeding 0.75 mg/L, the largest area being in the southwestern part of the basin from Arbuckle to Rio Vista (Bertoldi 1991).

Arsenic and selenium are naturally occurring trace elements. The California drinking water standard for selenium is 0.05 mg/L. On January 22, 2001, EPA lowered the arsenic standard from 0.05 mg/L to 0.01 mg/L. All systems must comply by January 23, 2002 (Groundwater Resources Association of California 2003). For agricultural use, arsenic concentrations should not exceed 1 mg/L. Selenium is toxic to humans and animals at low concentrations and can accumulate in the environment and in wildlife (DWR Northern District 2002). According to the SWRCB, there are no elevated concentrations of arsenic or selenium in the Sacramento Groundwater Basin.

6.1.3.3 North San Joaquin Groundwater Basin

The San Joaquin Valley Basin extends over the southern two-thirds of the Central Valley regional aquifer system and has an area of approximately 13,500 square miles. The North San Joaquin Groundwater Basin, shown on Figure 6-11, is the northern half of the San Joaquin Valley Basin, extending from just south of Stockton in San Joaquin County to north of Fresno in Fresno County, covering approximately 5,800 miles. Merced ID (Figure 6-11) is in the Merced groundwater subbasin, situated between the Chowchilla River to the south and the Merced River to the north. Merced ID is expected to transfer water to the EWA Project Agencies via groundwater purchase.

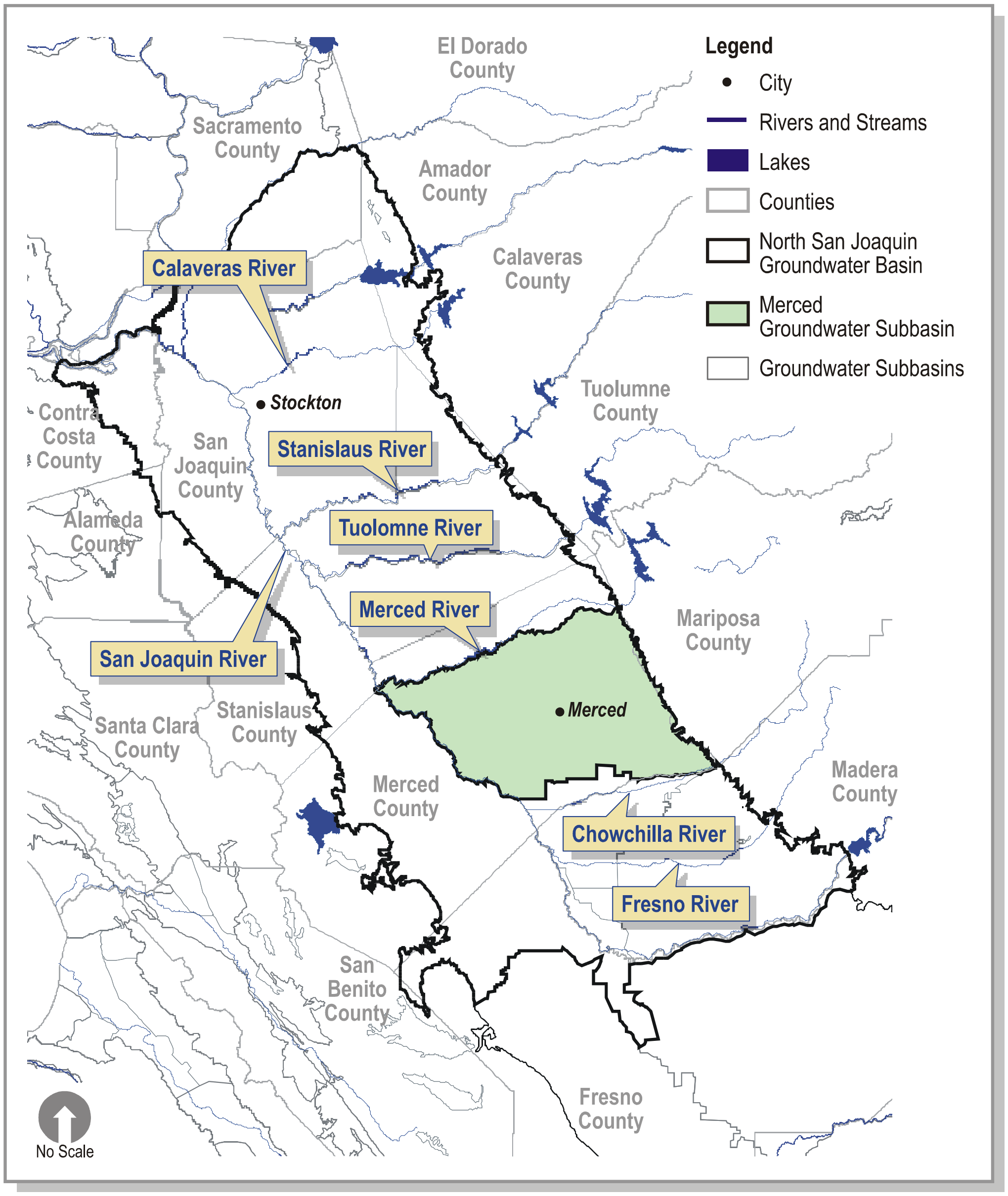
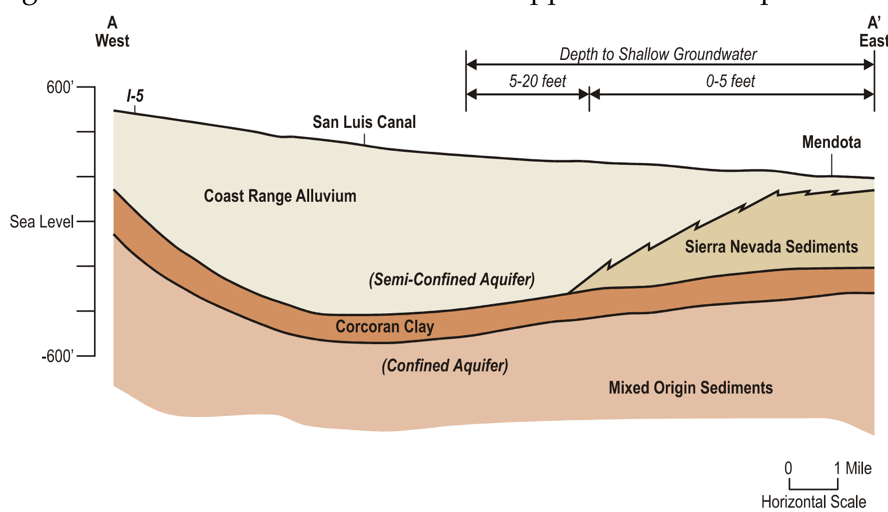


Figure 6-11
North San Joaquin Groundwater Basin

6.1.3.3.1 Geology, Hydrogeology, and Hydrology

The North San Joaquin Groundwater Basin is geometrically similar to the Sacramento Groundwater Basin and was formed by the deposition of several miles of sediment in a north-northwestern trending trough. On the eastern side of the basin is the Sierra Nevada, and on the western side is the Coast Ranges.

The aquifer system in the North San Joaquin Groundwater Basin comprises up to 6 miles of continental and marine deposits, of which the upper 2,000 feet generally contain freshwater (Page 1986). A significant hydrogeologic feature in the basin is the Corcoran Clay. This clay layer divides the aquifer system into two distinct aquifers, an unconfined to semi-confined upper aquifer and a confined aquifer below.[8] Both aquifer systems are composed of formations derived from the deposition of Sierra Nevada sediment in the eastern portions of the basin, and from deposition of Coast Range sediments in western portions of the basin. Overlying these formations are flood plain deposits. The formations in the eastern portions of the basin are derived from the granitic Sierra Nevada and are generally more permeable than the sediments derived from western marine formations. Sediments derived from marine rocks generally contain more silt and clay and also contain higher concentrations of salts. The lower confined aquifer system contains sediments of mixed origin. Historically, these aquifers were two separate systems; however, deep wells have penetrated both aquifers, resulting in groundwater interaction between the upper and lower aquifer in some localized areas (Reclamation 1990). Figure 6-12 shows a generalized geologic cross section of the North San Joaquin Groundwater Basin.

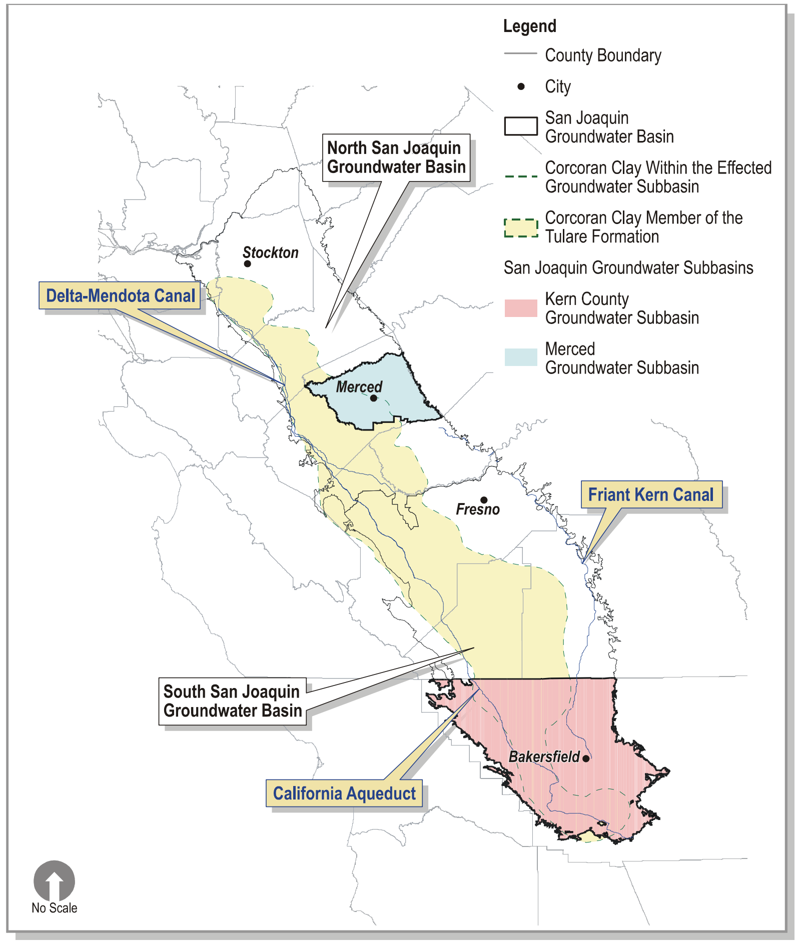


Source: Reclamation 1997

Figure 6-12
Geologic Cross Section of the North San Joaquin Groundwater Basin

8 Confined aquifers lie between two aquitards (strata within a geologic sequence that are of low permeability, impeding groundwater flow).

The Corcoran Clay, the most extensive of several clay layers, is formed by the periodic filling and draining of ancient lakes in the San Joaquin Valley. Six laterally extensive clays, designated clays A through F, have been mapped (Page 1986). The Modified E clay includes the Corcoran Clay, which is between 0 and 160 feet thick at depths between 100 and 400 feet below ground surface. Figure 6-13 shows the lateral extent of the Corcoran Clay layer.



Source: CALFED 2000

Figure 6-13
Corcoran Clay Member in the San Joaquin Valley

Historically, groundwater in the unconfined to semi-confined upper aquifer system was recharged by streambed infiltration, rainfall infiltration, and lateral inflow along the basin boundaries. Average annual precipitation in the area is significantly less than in the Sacramento Groundwater Basin and ranges from 6 to 18 inches, although the majority of the basin receives between 9 and 13 inches (California Spatial Library/DWR statewide isohyet map). The percolation of applied agricultural surface water has supplemented natural groundwater replenishment. The lower confined aquifer is recharged primarily from lateral inflow from the eastern portions of the basin, beyond the eastern extent of the Corcoran Clay Member. Precipitation in the Sierra Nevada to the east of the basin can be as high as 65 to 75 inches, although much of it is in the form of snow. Peak runoff in the basin generally lags precipitation by 5 to 6 months (Bertoldi 1991).

The main surface water feature in the North San Joaquin Groundwater Basin is the San Joaquin River, which has several major tributaries draining the Sierra Nevada, including the Fresno, Chowchilla, Merced, Tuolumne, and Stanislaus Rivers. Historically, these streams were "gaining" streams (they had a net gain of water from groundwater discharge). With the decline of groundwater levels in the basin, areas of substantial pumping have reversed the local groundwater flow, and reaches of streams now lose water to the aquifer system.

6.1.3.3.2 Groundwater Production, Levels, and Storage

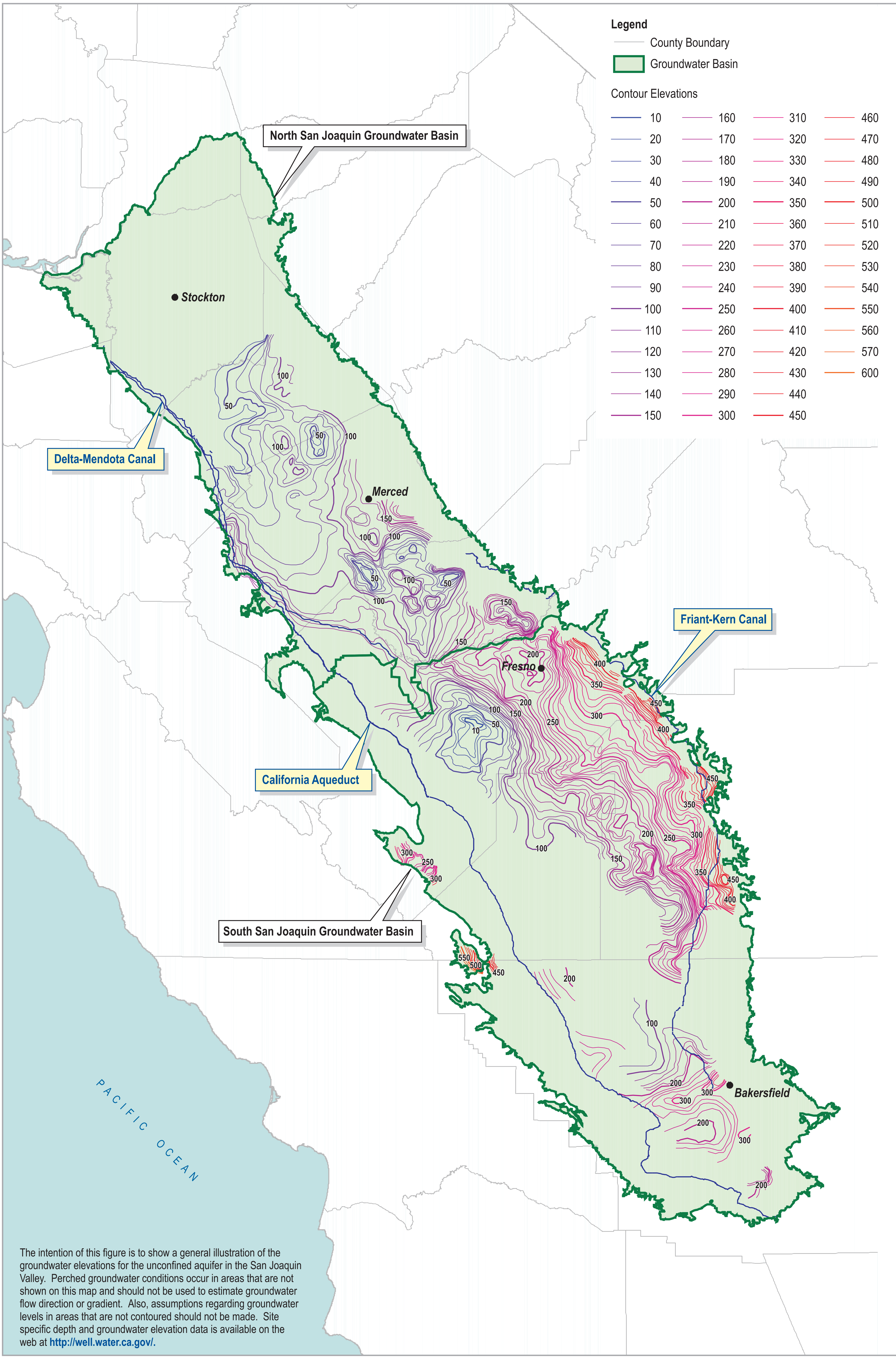
Irrigated agriculture in the North San Joaquin Groundwater Basin rose from about 1 million acres in the 1920s to more than 2.2 million acres by the early 1980s (Reclamation 1997). Groundwater production to support agriculture rose from approximately 1.5 MAF per year in the 1920's to more than 3.5 MAF per year for 1990 (Reclamation 1997).

Prior to the large-scale development of irrigated agriculture, groundwater in the basin generally flowed from the edges of the basin toward the San Joaquin River and ultimately to the Delta. Extensive groundwater pumping and irrigation (with imported surface water) have modified local groundwater flow patterns and in some areas, groundwater depressions are evident. Figure 6-14 shows springtime groundwater elevations, and Figure 6-15 shows the average depth to groundwater for both the North and South San Joaquin Valley Groundwater basins.

6.1.3.3.3 Land Subsidence

From the 1920s until the mid-1960s, the use of groundwater for irrigation of crops in the San Joaquin Valley increased rapidly, causing land subsidence throughout the west and southern portions of the valley. From 1920 to 1970, almost 5,200 square miles of irrigated land in the San Joaquin River Watershed registered at least one foot and as much as 30 feet of land subsidence in northwest Fresno County. Land subsidence is concentrated in areas underlain by the Corcoran Clay Member. Figure 6-16 shows areas of subsidence in the San Joaquin Valley from 1926 to 1970. Substantial land subsidence was observed in the Los Banos-Kettleman City area, the Tulare-Wasco area, and the Arvin-Maricopa area during this period (CALFED 2000).

Land subsidence studies conducted during the 1950s and 1970s focused on the vicinity of the California Aqueduct. During this period, the State was considering construction of the California Aqueduct, and subsidence due to the large amount of groundwater extraction in the area was a major concern. Following construction, delivery of surface water conveyed by the aqueduct reduced the irrigators' need to extract groundwater, thus reducing the rate of subsidence. Relatively little data have been gathered in the area since the 1970s (Steele 2002).



The intention of this figure is to show a general illustration of the groundwater elevations for the unconfined aquifer in the San Joaquin Valley. Perched groundwater conditions occur in areas that are not shown on this map and should not be used to estimate groundwater flow direction or gradient. Also, assumptions regarding groundwater levels in areas that are not contoured should not be made. Site specific depth and groundwater elevation data is available on the web at **http://well.water.ca.gov/.**

No Scale

Figure 6-14
San Joaquin Spring 2000 Groundwater Level Elevations in the Unconfined Aquifer
Contours Provided by: DWR San Joaquin District

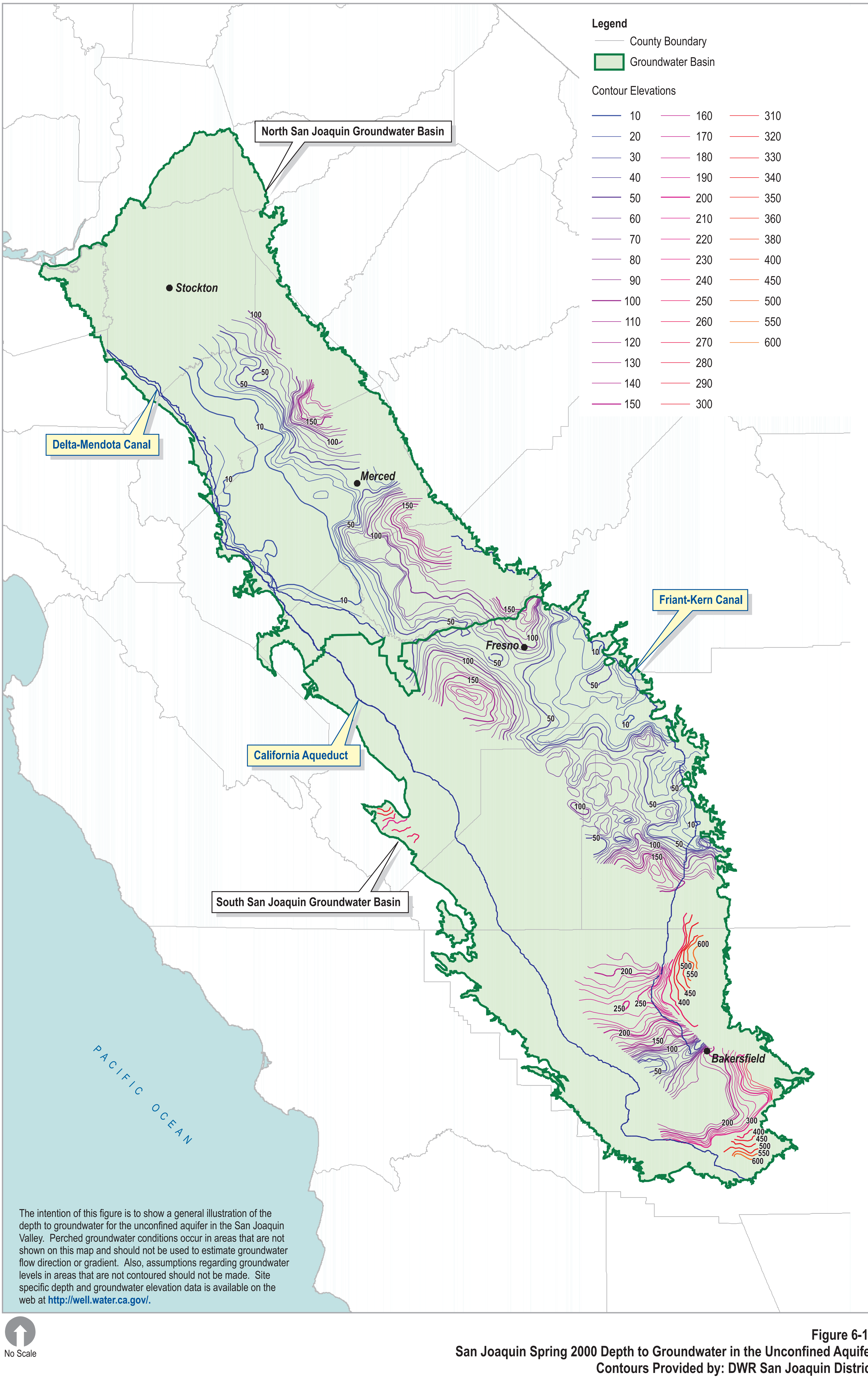
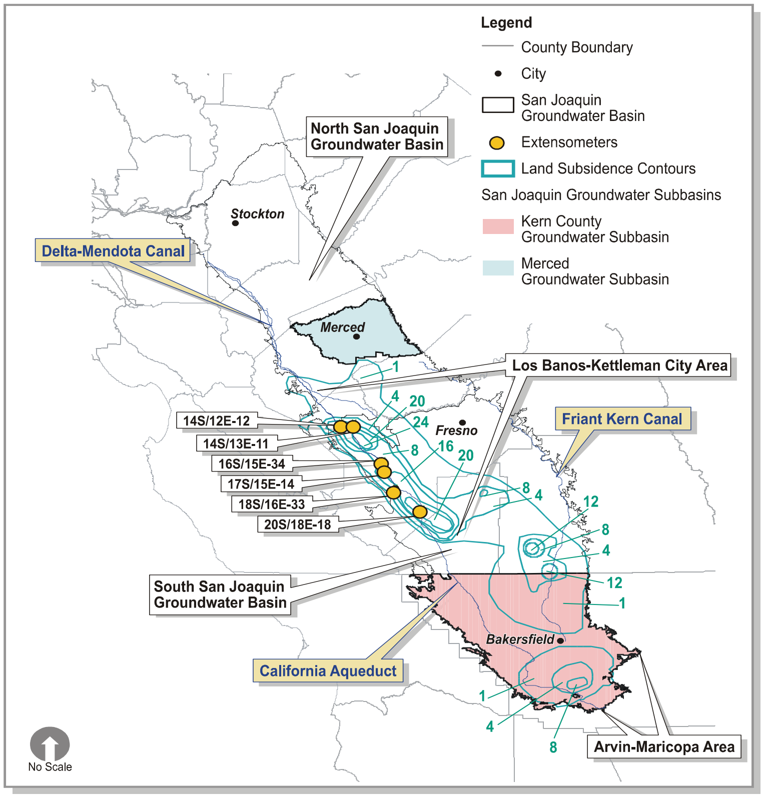


Figure 6-15
San Joaquin Spring 2000 Depth to Groundwater in the Unconfined Aquifer
Contours Provided by: DWR San Joaquin District



Source: CALFED 2000

Figure 6-16
Historical Land Subsidence in the San Joaquin Valley (1926 to 1970)

Land subsidence measurements have shown that an increase in groundwater pumping during 1984 -1996 resulted in land subsidence of up to 2 feet along the Delta-Mendota Canal (CALFED 2000). Similarly, increased pumping caused Westlands WD to experience up to 2 feet of subsidence between 1983 – 2001, with most of the subsidence occurring after 1989 (Westlands WD 2000). DWR has 6 extensometers near to the California Aqueduct that also measure subsidence. Figure 6-16 shows the locations of these extensometers, and Figure 6-17 shows the extent of subsidence from 1983 to 1998. Land subsidence would continue to be a potentially adverse effect if overdraft of the underlying aquifers continues.

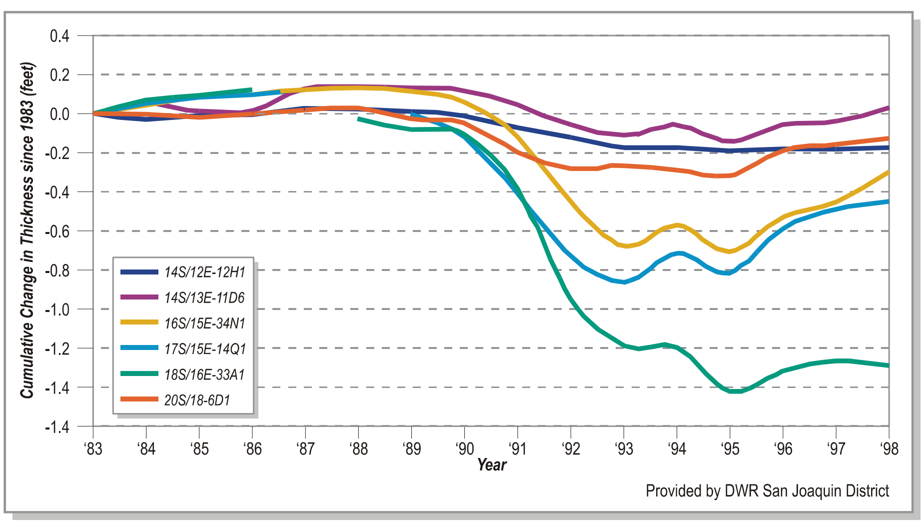


Figure 6-17
Extensometer Land Subsidence Monitoring in the San Joaquin Valley

6.1.3.3.4 *Groundwater Quality*

Groundwater quality varies throughout the North San Joaquin Groundwater Basin. TDS concentrations in the North San Joaquin Groundwater Basin are generally higher than in the Sacramento Basin, and concentrations along the east side of the Basin are generally lower than along the west side, because of the higher quality of aquifer recharge and soil types. TDS concentrations east of the San Joaquin River are generally less than 500 mg/L, whereas west of the river, concentrations are typically greater than 500 mg/L (Bertoldi 1991). The marine origin of the west-side formations is the primary reason for this difference. The accumulation of salts from imported surface irrigation water has also contributed to the problem, resulting in TDS concentrations in shallow drainage water exceeding 2,000 mg/L. Local agriculture is impaired[9] by high levels of boron, arsenic, selenium, and pesticides throughout the valley (CALFED 2000). High boron concentrations have been reported in the northwestern part of the basin, extending south toward the Kings-Fresno County line (Bertoldi 1991). Agricultural use of groundwater is impaired by elevated boron concentrations in eastern Stanislaus and Merced counties (SWRCB 1991).

6.1.4 Delta Region

No groundwater transfers related to the EWA Program are anticipated in the Delta Region; thus, groundwater resources would not be affected. Consequently, this chapter does not discuss the Delta Region.

6.1.5 Export Service Area/ South San Joaquin Groundwater Basin

Potential groundwater acquisition areas in the Export Service Area are in the South San Joaquin Groundwater Basin. The following section provides information on the geology, hydrogeology, and hydrology; groundwater production, levels, and storage; land subsidence, and groundwater quality in this area.

The South San Joaquin Groundwater Basin is in the southern half of the San Joaquin Valley, an area called the Tulare Lake Region. Covering approximately 8,000 square miles, the South San Joaquin Groundwater Basin (Figure 6-18) extends from the Fresno-Madera County line south through Kings and Tulare counties, and into Kern County. DWR Bulletin 118 divides the basin into six subbasins: Kings, Westside, Tule, Tulare, Kaweah, and Kern. A number of agencies participating in groundwater banks in Kern County may be potential EWA sellers to the EWA Program.

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[9] Poor groundwater quality inhibits the intended beneficial use of the water.

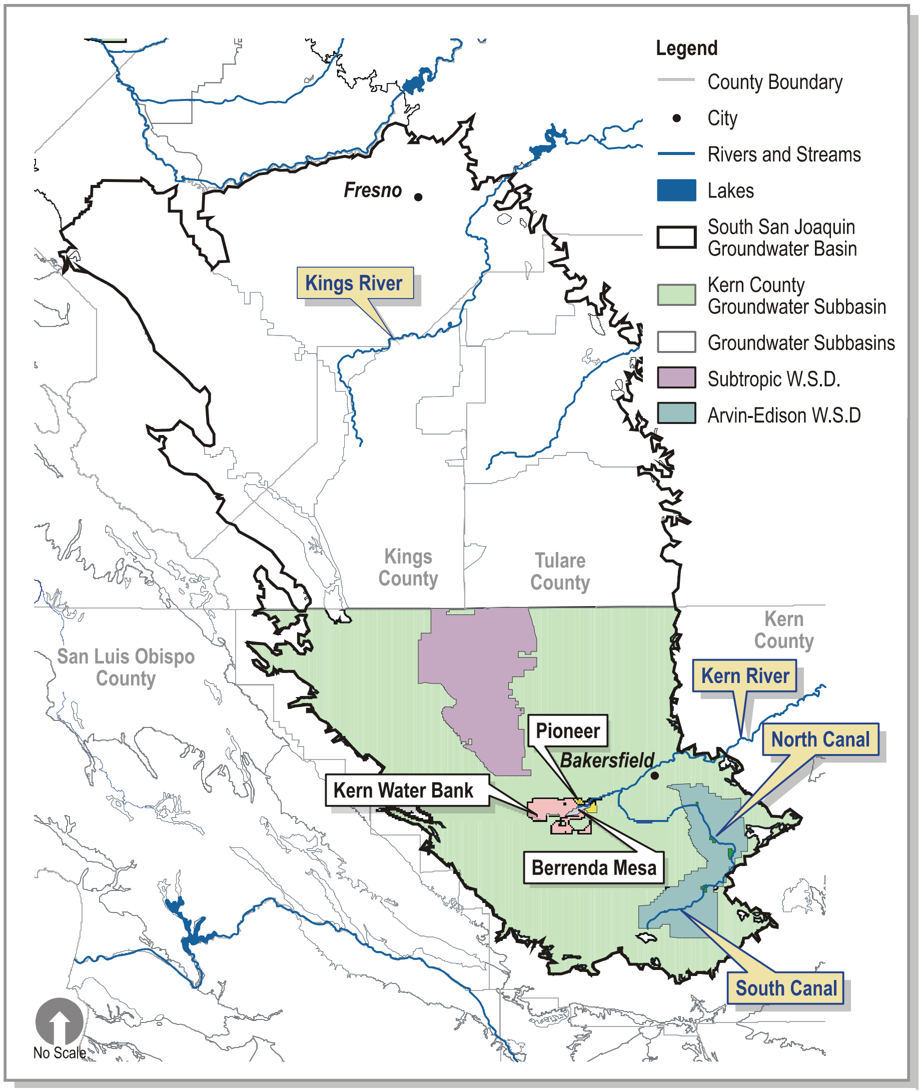

Figure 6-18
South San Joaquin Groundwater Basin

6.1.5.1 Geology, Hydrogeology, and Hydrology

The geology and hydrogeology of the South San Joaquin Groundwater Basin is similar to the North San Joaquin Basin; this section includes only additional relevant information.

In addition to the hydrogeologic features described for the North San Joaquin Groundwater Basin (Section 6.1.3.3), the South San Joaquin Basin contains the Tulare Lake sediments along the axis of the basin (Reclamation 1997). Figure 6-19 shows a generalized cross section of the basin**.** The Tulare Lake sediments are estimated to be more than 3,600 feet thick, with a lateral extent of more than 1,000 square miles (Page 1986). The Corcoran Clay layer, which is present almost to the west side of the San Joaquin Valley, is considered geologically to be part of the Tulare Formation. On the east and west sides of the basin semi-confined aquifer conditions exist; below the Corcoran Clay, confined aquifer conditions exist.

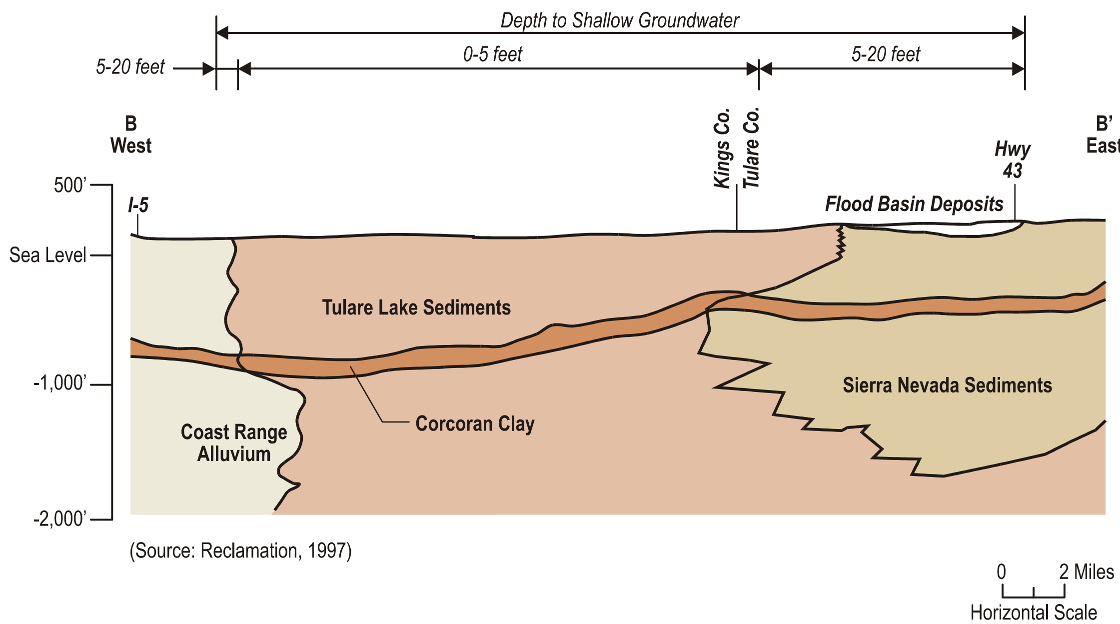

Figure 6-19
Geologic Cross Section of the South San Joaquin Groundwater Basin

Historically, the semi-confined upper aquifer system was recharged by streambed infiltration and lateral inflow along the basin boundaries. Average annual precipitation in the area is 5 to 11 inches and precipitation in the surrounding mountains can be as high as 65 to 75 inches, although much of it is in the form of snow. In general, peak runoff in the basin lags precipitation by 5 to 6 months (Bertoldi 1991). Natural groundwater replenishment has been supplemented by the percolation of applied agricultural water. The lower confined aquifer is recharged primarily from lateral inflow from the eastern portions of the basin, beyond the eastern extent of the Corcoran Clay. However, in localized areas, recharge also occurs through wells that are perforated above and below the Corcoran Clay, hydraulically connecting the upper and lower aquifers.

The main surface water features in the South San Joaquin Groundwater Basin are the Kern, Kaweah, and Kings Rivers. The agricultural development in the area along with the resultant decline in groundwater levels has caused the majority of the rivers and streams to lose water to the aquifer system.

6.1.5.2 Groundwater Production, Levels, and Storage

Agricultural development began earlier in the South San Joaquin Groundwater Basin than in other parts of the Central Valley. Irrigated agriculture rose to about 1.2 million acres by 1922 and to more than 3.5 million acres by the early 1980s (Reclamation 1997). Groundwater production to support agriculture rose from approximately 3.0 MAF per year in the 1920s to more than 5.0 MAF per year by 1980, although peak groundwater pumping was as high as 8.0 MAF in the late 1950s (Reclamation 1997).

Prior to the large-scale development of irrigated agriculture, groundwater elevations in the South San Joaquin Groundwater Basin ranged from 350 to 400 feet above mean sea level (msl) on the boundaries of the basin, to approximately 200 feet msl in the center of the basin. Groundwater flow converged in the center of the valley and ultimately discharged to Tulare Lake (Williamson 1989). The extensive agricultural development has caused changes in groundwater levels and flow direction. Groundwater levels in the western portion of the basin declined by as much as 400 feet by the 1960s relative to predevelopment conditions. Groundwater levels declined by as much as 100 feet in the southern and central portions of the basin, as far south as Bakersfield. Friant-Kern Canal water was imported to the area in 1949, and CVP and SWP water in the 1960s. Additional CVP water was imported in the mid-1970s. As a result of decline in groundwater use, groundwater levels in some areas have begun to recover. Reductions in surface water deliveries during droughts result in increased groundwater pumping and a corresponding decline in groundwater levels.

In many areas, wells must be screened below the Corcoran Clay layer to extract groundwater from the confined aquifer. The unconfined aquifer above the Corcoran clay layer is not of adequate quality for beneficial use. In Tulare Lake Water Storage District (WSD) in Kings County, for example, it is economical to produce groundwater only from the northeast third of the service area, because of the poor groundwater quality and poor well yields (resulting from the clay layers) in the remaining two-thirds of the district. Even in the third of the district that is productive, wells must be drilled to 1,500 to 2,000 feet bgs to produce quality water. Poor well yields and poor water quality occur in the remaining two-thirds of the district (Tulare Lake 1981).

Figures 6-14 and 6-15 show the 2000 groundwater elevations and the depth to groundwater in the South San Joaquin Groundwater Basin, respectively. Following a period of wet years, groundwater levels in 2000 recovered to 1970 levels throughout the basin. These levels fluctuated substantially between 1970 and 2000 as a result of pumping, drought, groundwater banking, and replenishment projects. Surface water importing and groundwater pumping reductions have caused groundwater levels to rise by over 30 feet since 1970 along the southeast valley margin and in the Lost Hills/Buttonwillow areas. In contrast, excess pumping has resulted in groundwater declines of over 25 feet (relative to 1970 levels) within the vicinity of Bakersfield. Groundwater level declines of 50 feet (relative to 1970 levels) in the McFarland/Shafter areas have been observed (DWR 2002). During 1998 and 1999, groundwater levels in the portion of the Kern Fan Element rose by 30 to 50 feet. This increase is attributed mainly to the local groundwater banking projects in the Kern Fan Element (KCWA 2002).

6.1.5.3 Facilities and Banking Projects in Kern County

Kern County WA is the largest agricultural SWP contractor and the third largest municipal and industrial (M&I) SWP contractor in California. The agency was formed in 1961 and serves as an "umbrella organization" that acquires water from the SWP and sells the water to agencies within the county. Kern County WA must approve of all water that enters or leaves the county and also reserves the right to control flood and storm water, drain and reclaim land, store and reclaim water, protect groundwater quality, and conduct investigations involving water resources. The agency serves as an important intermediate link and resource organization for representing local interests at the State level. Its 13 member agencies include: Berrenda Mesa WD, Lost Hills Water District, Belridge Water Storage District, Semitropic ID, Cawelo WD, Rosedale Rio-Bravo WSD, Buena Vista WSD, Kern Delta WSD, Henry Miller WD, West Kern WD, Wheeler Ridge-Maricopa WSD, Tehachapi Cummings County WD, and Tejon Castaic WD (KCWA 2002).

A complex system of drains, pumps, pipelines, and conveyance facilities within Kern County provides a broad array of options for conveying water. These facilities are used not only for transfers within the county's boundaries, but also as key transport facilities for external water transfers throughout the State of California. The main surface water conveyance facilities in Kern County include the Kern River, California Aqueduct, Friant-Kern Canal, Cross Valley Canal, the Arvin-Edison Canal and Pipeline, and the Kern River-California Aqueduct Intertie. In general, the Friant-Kern Canal transports CVP water from Millerton Lake in Fresno County to the Kern River channel. The Arvin-Edison Canal further conveys Kern River flows and CVP water originating in the Friant-Kern Canal downstream to Arvin-Edison WSD. The Arvin-Edison pipeline conveys water bi-directionally between the District and the California Aqueduct. The Cross Valley Canal, a bi-directional conveyance system, connects the Friant-Kern Canal with the California Aqueduct (Bucher 2002).

Several groundwater banking projects have been established in Kern County and more are planned. The main objectives of the groundwater banking projects are to improve water supply reliability for users within the county and provide storage for partner agencies outside the county. Kern County water agencies store surplus water during wet years and recover the water, if needed, during dry years. The banked water consists primarily of water from the SWP, Friant-Kern water (CVP deliveries), and captured surface flows or flood flows from the Kern River (Bucher 2002).

Groundwater banks that could manage EWA assets in the Kern Fan Element consist of the Berrenda Mesa, Kern Water Bank, and Pioneer Banking Projects. (See Figure 6-18.) These projects are along the Kern River alluvial fan southwest of Bakersfield. The alluvial fan is highly suitable for banking purposes, as it generally consists of permeable river deposits with high well yields that allow quick recovery. These water banks are also near three water sources, the Kern River, the California Aqueduct, and the Friant-Kern Canal.

The Kern Fan Element water banks are operated solely for storing water delivered to participating agencies within Kern County. Banked groundwater in Berrenda Mesa and the Kern Water Bank may be sold to external agencies or acquisition programs such as the EWA at the discretion of the participating agencies listed in Table 6-3**.** Based on the original established operating rules, water stored in the Pioneer Bank may be used only within the county, with the exception of the 25 percent allotment that Kern County WA owns and reserves the right to use at its own discretion (Bucher 2002). Kern County WA has the option of selling a share of this 25 percent to the EWA Project Agencies.

The Semitropic and Arvin-Edison water banks store water from within Kern County, and for agencies outside Kern County. Storage agreements provide benefits to both the bank owner and to the external agency. The water banks provide storage space and facilities for its participating agencies and receive payments in exchange. Storing water in the banks helps alleviate overdraft in the basin. Semitropic is planning to expand its banking operations to the northwest of its current banking facilities and to add another wellfield that would provide an additional 200,000 acre-feet of total annual recovery capacity (Semitropic WSD 2000a). Currently, both Santa Clara Valley WD and Metropolitan WD have water stored in the Semitropic water bank. Arvin-Edison WSD has an agreement with Metropolitan WD in which Arvin-Edison provides Metropolitan WD an allocation of storage space in its groundwater bank for a 25-year period, and in exchange Metropolitan WD has agreed to pay for additional banking facilities. Arvin-Edison's facilities consist of 1500 acres of spreading basins, with over 70 wells concentrated in the central portion of the district along the Arvin-Edison Canal (Lewis 2002).

Table 6-3 lists the operating water banks, associated agencies, and the percent allocation for each participating agency. Table 6-4 lists the maximum operating capacities for each water bank and Table 6-5 lists the amount of groundwater bank water that was in storage as of July 31, 2000.

Table 6-3
Participants and Sponsors of Existing Groundwater Banks

Water Bank	***Date of Operation***	***Owner/ Sponsor***	***Participants***	***Allocation***
Berrenda Mesa	1983	Berrenda Mesa ID	Belridge WSD Berrenda Mesa WD Lost Hills WD Wheeler Ridge-Maricopa WSD	11.45% 60.90% 9.87% 16.78%
KWB	1995	Kern County WA Joint Powers Authority	Dudley Ridge WD Improvement District 4 Semitropic WSD Tejon-Castaic WD Westside Mutual Water Co. Wheeler Ridge-Maricopa WSD	9.62% 9.62% 6.67% 2.00% 48.06% 24.03%
Pioneer	1995	Kern County WA	Recovery Priority: Belridge WSD Berrenda Mesa WD Improvement District No. 4 Kern County WA Lost Hills WD Semitropic WSD Tejon Castaic WD Wheeler Ridge Maricopa WSD Recharge Priority: Buena Vista WSD Henry Miller WD Kern County WA Kern Delta WD Rosedale Rio Bravo WSD	 12.75% 12.75% 6.50% 25.00% 11.25% 10.50% 0.75% 19.50% 18.75% 18.75% 25.00% 18.75% 18.75%
Arvin-Edison/MWD	1998	Arvin-Edison	MWD[1]	<<TBD>> <<TBD>>
Semitropic	1990	Semitropic	MWD[2] SCVWD Vidler Water Company, Inc. Zone 7 Alameda County WD	35.00% 35.00% 18.50% 6.50% 5.00%

Source: KCWA 2000

[1] EWA acquisition would either entail the purchase of MWD or Arvin-Edison banked groundwater (not CVP water) or the purchase/lease of storage space to bank EWA water. The acquisition of water must comply with the banking operation agreements among the participating agencies.

[2] EWA acquisition would either entail the purchase of project participant banked groundwater or the purchase/lease of storage space to bank EWA water.

Table 6-4
Summary of Groundwater Bank Project Recovery, Recharge, and Storage Capacities

Project	***Area (acres)***	***Capital cost (1000 $)***	***Maximum Annual Recovery (AF)***	***Maximum Annual Recharge (AF)***	***Estimated Defined Storage (AF)***
Berrenda Mesa	369	3,318	46,000	58,000	200,000
COB 2800 Acres	2760	8,350	46,000	168,000	800,000
KWB	19,900	77,100	287,000	450,000	1,000,000
Pioneer	2,253	19,902	98,000	146,000	400,000
Arvin-Edison	130,000	25,000	40,000	140,000	250,000
Semitropic	221,000	134,000	223,000	315,000	1,000,000

Source: KCWA 2000

Table 6-5
Summary of Groundwater Banking and Cumulative Storage as of July 31, 2000

Project	Estimated Maximum Storage (AF)	Current Storage				Remaining Storage Capacity (AF)
		SWP (AF)	Friant - Kern (AF)	Kern River (AF)	Total (AF)	
Direct Recharge						
Berrenda Mesa	200,000	51,000	17,000	34,000	102,000	98,000
COB 2800 Acres	800,000	266,000	161,000	309,000	736,000	64,000
Kern Water Bank	1,000,000	520,000	80,000	291,000	891,000	109,000
Pioneer	400,000	148,000	26,000	82,000	256,000	144,000
Subtotal	2,650,000	1,213,000	284,000	716,000	2,213,000	437,000
District Direct Recharge						
Arvin-Edison WSD/ MWD	250,000	167,000	-	-	167,000	83,000
Semitropic/MWD et all	1,000,000	684,000	-	-	684,000	316,000
Total	3,900,000	2,064,000	284,000	716,000	3,064,000	836,000

Source: KCWA 2000

6.1.5.4 Land Subsidence

As a result of considerable declines in groundwater levels and the hydrogeologic nature of the South San Joaquin Groundwater Basin, land subsidence has been a significant issue in localized areas. In addition to the subsidence observed in the Los Banos-Kettleman City area, discussed in Section 6.1.2.3 North San Joaquin Groundwater Basin, subsidence has been recorded in the Tulare-Wasco area, and the Arvin-Maricopa area (CALFED 2000). Figure 6-16 shows areas of historical subsidence in the South San Joaquin River Valley from 1926 to 1970 and depicts the current monitoring locations.

6.1.5.5 Groundwater Quality

Groundwater quality in the South San Joaquin Basin is comparable to quality in the North San Joaquin Basin. Total dissolved solids concentrations along the east side of the Basin are generally lower than along the west side, where concentrations can exceed 1,500 mg/L (Bertoldi 1991). Portions of the shallow, unconfined aquifer in the western portion of Fresno, Kings, and Kern Counties have been impaired by high TDS concentrations. High boron concentrations have been reported in the north and western portions of the basin, potentially originating from the Diablo Range (Bertoldi 1991). Inadequate drainage is an additional contributing factor. Local agricultural impairments due to high levels of boron, arsenic, selenium, and pesticides occur throughout the Basin (CALFED 2000). Areas north and south of Bakersfield and around the Fresno area have reported nitrate concentrations in excess of 10 mg/L. Municipal use of groundwater is impaired due to high nitrate concentrations in areas throughout the South San Joaquin Basin (Reclamation 1997).

6.2 Environmental Consequences/Environmental Impacts

EWA Project Agency acquisitions and management of EWA assets could affect groundwater resources. To minimize or avoid adverse effects, EWA groundwater-related transfers must comply with three levels of conditions: 1) State regulations, 2) local groundwater management and county ordinances, and 3) the EWA Project Agencies' groundwater purchasing process. Section 6.1.2 described the State regulations and listed local groundwater management plans. This section describes the EWA purchase process, including purchasing agencies review (Section 6.2.7.1) and the groundwater mitigation measures (Section 6.2.7.2).

EWA actions that could affect groundwater resources include the acquisition of water through groundwater substitution, groundwater purchase, and crop idling, in addition to the storage of acquired EWA water in groundwater banking facilities. These actions could alter the existing subsurface hydrology and thus result in a variety of effects in the following categories:

- Groundwater level change;
- Alteration of the existing hydrologic interaction between surface water and groundwater;
- Land subsidence; and
- Degradation of groundwater quality.

Groundwater Levels: Changes in groundwater levels could cause multiple secondary effects. Declining groundwater levels could result in: 1) increased groundwater pumping cost due to increased pumping depth, 2) decreased yield from groundwater wells due to reduction in the saturated thickness of the aquifer, 3) reduced groundwater in storage, and 4) decrease of the groundwater table to a level below the vegetative root zone, which could result in environmental effects.

Surface Water and Groundwater: Groundwater pumping within the vicinity of a surface water body could change the existing interactions between surface and groundwater, potentially resulting in decreased stream flows and levels, with potential adverse effects to the riparian habitat and downstream users. The pumping of groundwater near wetland habitats could also result in adverse environmental effects.

Land Subsidence: Excessive groundwater extraction from confined and unconfined aquifers could result in a lowering of groundwater levels and, in confined aquifers, a decline in water pressure. The reduction in water pressure results in a loss of support for clay and silt beds, which subsequently compress, causing a lowering of the ground surface (land subsidence). The compaction of fine-grained deposits, such as clay and silt, is permanent. The possible consequences of land subsidence are 1) infrastructure damage and 2) alteration of drainage pattern.

Groundwater Quality: Changes in groundwater levels or in the prevailing groundwater flow regime could cause a change in groundwater quality through a number of mechanisms. One mechanism is the potential mobilization of areas of poorer quality water, drawn down from shallow zones, or drawn up into previously unaffected areas. Changes in groundwater gradients and flow directions could also cause (or speed) the lateral migration of poorer quality water. Artificial or enhanced recharge of the aquifer with water of poorer quality, or even different geochemical constituents, could also have an adverse effect on existing conditions. Geochemical differences between the recharged water and groundwater could affect resultant groundwater quality through geochemical processes such as precipitation, bacterial activity, ion exchange, and adsorption.

6.2.1 Assessment Methods

Under each alternative, the EWA Project Agencies would negotiate contracts with willing sellers based on a number of factors, including price, water availability, and location. These factors could change from year-to-year; therefore, the EWA Project Agencies may choose to vary their acquisition strategy in each year. To provide maximum flexibility, this analysis includes many potential transfers when the EWA Project Agencies could likely not need all transfers in a given year. Chapter 2 defines the transfers that are included in this analysis.

A systematic assessment of potential groundwater effects is an important aspect of the implementation of conjunctive use and transfer programs like the EWA. However, such assessments may not be straightforward because several factors complicate quantitative evaluation of groundwater resources. Groundwater resources are not readily visible and are not easily characterized. In addition, most groundwater production is local, self-supplied, and often unmeasured, making it difficult to assess groundwater use in a particular area. Local groundwater management is still evolving with some local agencies actively managing the resource while others are still largely disengaged. The technical and financial resources available to local agencies for implementation of management programs also vary widely.

Transfer programs, such as the EWA, could provide the opportunity to improve local understanding and management of groundwater through additional studies and monitoring that would not have been undertaken in the absence of the transfer. They also could provide the seller with additional financial resources. Although a comprehensive quantitative assessment of groundwater effects is not always possible, available data are generally sufficient for developing a broad understanding of the potential effects of groundwater transfers. This broad understanding, when combined with local management and planning activities, could provide an adequate picture of anticipated effects and help to define potential mitigation needs.

An issue regarding use of groundwater is the extent that groundwater pumped in-lieu of surface water is truly an alternative source to surface water. The close hydrologic interaction of surface water and groundwater makes this determination difficult because increased pumping of groundwater may induce increased recharge from a surface water body, and thereby reduce the amount of surface water that is actually available to downstream users.

Recognizing the limitations of both data availability and the lack of specific details regarding likely EWA Program actions, this analysis is primarily a qualitative one. This analysis assesses potential groundwater effects using two methods: 1) a review of regional groundwater level decline estimates and 2) identification of potential effects and discussion of the existing activities, including application of the EWA groundwater mitigation measures, that would address potential significant impacts. Sections 6.2.1.1 and 6.2.1.2 describe these assessment methods.

6.2.1.1 Regional Groundwater Level Declines

This assessment method includes estimation of the potential regional groundwater levels declines in areas where pumping is expected to be concentrated. These estimates factor in the maximum amount of water that a selling agency could reasonably transfer to the EWA Project Agencies.[10] This analysis compares these groundwater level declines to the average historical and seasonal fluctuations and existing well infrastructure within the selling agency's boundaries. A discussion of groundwater transfers, previous groundwater effects that agencies experienced, and how the agencies managed the effects is also included with this method.

Because a limited amount of site-specific information was available, this analysis method requires a number of assumptions to calculate the potential regional declines. This analysis assumes that: 1) aquifers are unconfined, 2) additional groundwater pumping comes from water in storage, and 3) no change to aquifer inflows occurs as a result of new pumping.

The groundwater declines were calculated using the following equation:

$$\text{Change in Groundwater Level} = \frac{V}{A\,n}$$

where: V = Volume of groundwater extracted
n = Specific yield
A = Area where pumping is to be concentrated

The resulting estimates are intended to illustrate, on a regional basis, the potential decline in groundwater levels. They do not characterize localized effects near the well or direct hydraulic effects in areas near additional groundwater withdrawals, nor do they incorporate any of the local hydrogeological or hydrological characteristics that ultimately determine the drawdown and account for changes to inflows or outflows.

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10 Table 2-5 in Chapter 2 Alternatives provides these amounts.

Regional groundwater level declines are provided here to illustrate the magnitude of regional storage reduction and are not intended to measure significance. This analysis method also does not estimate potential effects related to groundwater quality, local land subsidence, or interaction with surface water. An alternative method, the groundwater mitigation measures, was necessary to address the potential for local groundwater effects.

6.2.1.2 Local Effects and Groundwater Management

The assessment methods examine how local groundwater management would address potential effects to groundwater resources. It is a qualitative analysis intended to address the potential effects on a more local scale than the estimates of regional groundwater level decline described above. For each potential selling agency, this method addresses likely groundwater effects, including groundwater level declines, interaction with surface water, land subsidence, and groundwater quality degradation. This assessment discusses applicable local management plans, county ordinances, and existing monitoring, which selling agencies may use to address potential effects related to EWA groundwater transfers.

6.2.2 Significance Criteria

The following criteria establish the significance of a local adverse groundwater effect. Similar to the CALFED plan programmatic EIS/EIR, groundwater effects would be considered significant at a local level if EWA-related actions would cause one or more of the following:

- A net reduction in groundwater levels that exceeds basin management objectives established for the basin in question, resulting in adverse third party and/or environmental effects;
- Degradation in groundwater quality that threatens to exceed regulatory standards or would substantially impair reasonably anticipated beneficial uses of groundwater; and
- Permanent land subsidence caused by water level declines.

Because of the analysis limitations mentioned below, this document cannot accurately measure the significance of potential adverse effects according to these significance criteria on a site-specific level. Consequently, these effects would be assessed on a site-by-site basis when a transfer to the EWA Project Agencies is to take place. Application of this local assessment should adhere to the framework set forth in the groundwater mitigation measures and in local management policies.

6.2.3 Environmental Consequences/Environmental Impacts of the No Action/No Project Alternative

An analysis of the groundwater resources presented in Section 6.1 indicates that groundwater development would continue to occur during the Stage 1 period of the CALFED plan analyzed in this EIS/EIR. The No Action/No Project Alternative would not change this trend. As water demand continues to increase throughout California, the development of groundwater resources, both through extraction and groundwater banking, would likely increase. As described in the Affected Environment/Existing Conditions (Section 6.1), water agencies are taking initiative to manage their groundwater resources. The No Action/No Project Alternative would result in the same conditions as those described in the Affected Environment.

6.2.4 Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative

The Flexible Purchase Alternative allows transfers up to 600,000 acre-feet and does not specify transfer limits for the Upstream from the Delta Region or the Export Service Area. The transfer from areas Upstream from the Delta Region would range between 50,000 and 600,000 acre-feet, limited by hydrologic year and conveyance capacity through the Delta. Although potential transfers would not all take place in one year, this section discusses maximum transfers to the EWA from all agencies to provide an effect analysis of the maximum transfer scenario. Similarly, the evaluation includes an analysis of up to 540,000 acre-feet in the Export Service Area to cover the maximum transfer scenario for that region. The following text presents evaluations of the effects of the Flexible Purchase Alternative by each of the groundwater subbasins.

6.2.4.1 Upstream from the Delta Region

EWA Project Agency acquisitions that could affect groundwater resources Upstream from the Delta Region include groundwater substitution, groundwater purchase, and crop idling. The effects associated with each of these acquisitions are groundwater level declines, alteration of surface and groundwater hydrology, land subsidence, and changes in groundwater quality.

This discussion covers the effects of crop idling at a regional scale and the potential effects of groundwater substitution and groundwater purchase at the local scale. Section 6.2.4.1.1 covers the Redding Groundwater Basin. Section 6.2.4.1.2 covers the Sacramento Groundwater Basin, which includes the Colusa, East Butte, West Butte, East Sutter, North Yuba, South Yuba, and North American subbasins.

6.2.4.1.1 Redding Groundwater Basin

EWA acquisition of Sacramento River Contract water in the Redding groundwater subbasin via groundwater substitution could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Anderson-Cottonwood ID.

Groundwater Levels: Groundwater substitution for the EWA asset acquisition could result in temporary declines of groundwater levels in excess of seasonal fluctuations. Historically, groundwater levels within Anderson-Cottonwood ID have remained relatively stable, as shown on Figure 6-20. The most noticeable declines in some wells occurred during the droughts of 1976-1977 and 1986-1994. These declines were followed by groundwater recovery to pre-drought levels. Because of the aquifer's relatively short recovery period, an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends (DWR Northern District 2002).

Figure 6-20 also shows the area in which the potential seller, Anderson-Cottonwood ID, would most likely pump water using agency owned wells. The selection of this area was based on the wells that were proposed by Anderson-Cottonwood ID for the Forbearance transfer in 2001 (although a proposal was made, the transfer did not occur). Table 6-6 compares the estimated potential drawdown caused by an EWA Project Agency one-year groundwater transfer with historical fluctuations.

Table 6-6
Flexible Alternative Estimate of the Groundwater Drawdown for the Redding Basin

EWA Acquisition Range	10,000 to 40,000
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition	5 to 19 feet
Normal Year Seasonal Fluctuations	2-3 feet (unconfined) 2 – 5 feet (semi confined – confined)
Drought Year Seasonal Fluctuations	4-10 feet (unconfined) 4-16 feet (semi-confined and confined)

Source for groundwater level fluctuations: DWR Northern District 2002

In normal and above-normal years, the Redding Groundwater basin recharges fully after the irrigation season, indicating that the basin is not being overdrafted. Seasonal groundwater fluctuations range from 2 to 3 feet in unconfined aquifers and 2 to 5 feet in semi-confined to confined aquifers in normal years. During drought years, unconfined aquifer levels may fluctuate by as much as 10 feet, while semi-confined and confined aquifer levels may fluctuate as much as 16 feet.

As shown in Table 6-6, the potential groundwater level declines resulting from EWA Project Agency acquisitions would range from 5 to 19 feet in addition to seasonal fluctuation. Potential declines associated with the higher end of EWA Project Agency acquisition range would be relatively large when compared to the seasonal fluctuations, indicating the potential for adverse effects. The potential for adverse drawdown effects would increase as the amount of extracted water increased. The potential for adverse effects would be higher still during dry years, when baseline fluctuations are already large and groundwater levels may be lower than normal.

Well data provided in Table 6-7 show that 50 percent of domestic wells are relatively shallow, with a depth of 90 feet or less. Because shallow wells would be affected by drawdown before deeper wells would, the potential for adverse drawdown effects is greater in areas with a greater number of shallow wells.

Table 6-7 ***Well Data for Anderson-Cottonwood Irrigation District***			
Well Type	***Number of Wells***	***Average Well Depth (ft)***	***Depth Distribution***
Domestic	1,718	95	50% - 90 ft depth or less
			20% - 52 ft depth or less
			10% - 36 ft depth or less
Irrigation	49	223	50% - 190 ft depth or less
			20 % - 80 ft depth or less
			10% - 45 ft depth or less
Municipal	21	223	Not calculated
Industrial	29	216	Not calculated
Other	50	212	Not calculated

Source: DWR Northern District 2002

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines would likely be larger than those indicated in Table 6-6, possibly causing effects to wells within the cone of depression.

DWR currently monitors groundwater levels in six wells in Anderson-Cottonwood ID (DWR Northern District 2002). In 2000, CALFED agencies awarded Anderson-Cottonwood ID a grant as part of the Conjunctive Use Program.[11] This grant was for the construction of 12 monitoring wells, followed by the installation of 5 extraction wells. The 12 monitoring wells would be used to evaluate canal seepage; the direction and rate of groundwater flow; changes in water levels; and the economic, institutional, and environmental effects within the extraction area (Swearingen 2002).

EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, the groundwater mitigation measures specify that Anderson-Cottonwood ID establish a monitoring program in addition to existing monitoring within the district prior to an EWA-related groundwater substitution transfer. Furthermore, the groundwater mitigation measures require that if effects are shown or reported to be occurring, Anderson-Cottonwood ID would be responsible for implementing mitigation measures. These mitigation measures would reduce effects to less-than-significant levels.

Past Groundwater Transfers: Anderson-Cottonwood ID proposed to transfer 1,540 acre-feet of water via groundwater substitution to Westlands WD under the 2001 Forbearance Agreement. However, the transfer proposal was not accepted. As shown on Table 2-5 in Chapter 2, Anderson-Cottonwood ID could transfer 10,000 to

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[11] The CALFED Conjunctive Use Grant Program was established to encourage the development of conjunctive use projects, which would improve local water management and ultimately, water supply reliability for the Bay-Delta system.

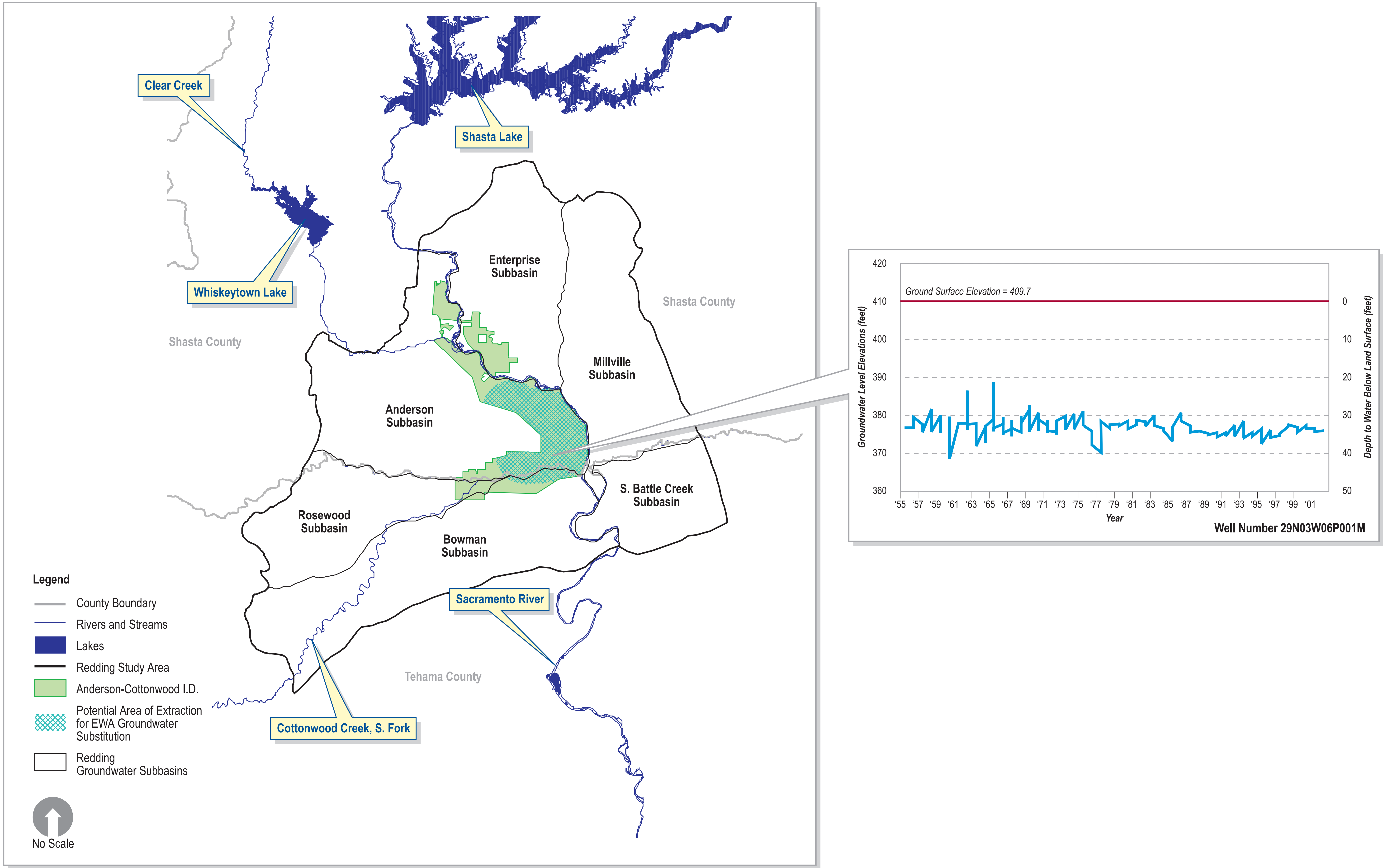

Figure 6-20
Groundwater Levels and Anderson-Cotton I.D. in the Redding Basin

40,000 acre-feet to the EWA Project Agencies. Anderson-Cottonwood ID plans to expand its conjunctive use capabilities, which would furnish the district the capacity to provide up to 40,000 acre-feet. This initial phase of the conjunctive use project is the installation of five extraction wells through the district's 2000 DWR grant, which would add 10,000 acre-foot of supplemental supply to the district (Swearingen 2002).

Interaction with Surface Water: Pumping has the potential to reduce channel flows in Cottonwood Creek, Anderson-Cottonwood Main Canal, and the Sacramento River. The reduction in flows in the Sacramento River could adversely affect riparian and aquatic habitats and downstream water users. Reductions to the Main Canal could adversely affect Anderson-Cottonwood ID's distribution system.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require evaluation of measures to avoid and minimize all such potential effects prior to an EWA-related transfer. Through the Well Review process identified in the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. Production wells within 2 miles of a surface water body would need to meet well depth criteria if there were insufficient data to show that pumping would not result in adverse effects. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the Well Review, the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local effects. These mitigation measures would reduce effects to less-than-significant levels.

Land Subsidence: Groundwater extraction under the Flexible Purchase Alternative would decrease groundwater levels, increasing the potential for localized land subsidence. Although subsidence has never been monitored in the Redding Groundwater Basin and there is no documented evidence of subsidence, it is a potential effect. As mentioned in Section 6.1.3.1, the groundwater basin west of the Sacramento River includes the Tehama Formation, which has exhibited subsidence in Yolo County (Dudley 2002). As long as EWA-related asset transfers would not cause the groundwater to decline below historical levels, the potential for subsidence would be minimized.

EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place to address potential land subsidence effects. The level of monitoring needed to monitor land subsidence may be negotiated between the review team and the selling district prior to the transfer. These mitigation measures would reduce effects to less-than-significant levels.

Groundwater Quality*:* Migration and distribution in water supply systems of reduced quality groundwater would be two potential water quality effects associated with increased groundwater withdrawals from Anderson-Cottonwood ID.

The Migration of Reduced Quality Groundwater. Although groundwater in this area is generally of good quality, elevated levels of iron, manganese, nitrate, and TDS have been detected in some localized areas of the basin. High levels of boron have been detected in the southern portion of the Redding basin and areas of high salinity are prevalent along the basin's margins (DWR 2002 and DWR Northern District 2002). The movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is a relatively slow process, it is not likely to be accelerated significantly or altered by short-term fluctuations in groundwater levels.

Distribution of Reduced Quality Groundwater: The quality of groundwater extracted from the wells of Anderson-Cottonwood ID could be different quality from the surface supply allotment the district normally receives; however, it is of adequate quality for agricultural purposes. If there were to be unanticipated adverse groundwater quality effects as a result of the transfer, the groundwater mitigation measures specify that Anderson-Cottonwood ID be responsible for monitoring this degradation and mitigating the adverse effects. No significant effects related to the distribution of reduced quality water would be likely; however, the mitigation measures would reduce any potential effects to less than significant levels.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, groundwater data indicates that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels would likely decline throughout the dry period and then recover only after several normal or wet years. Historical water-level data illustrates this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to groundwater level declines over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, local county ordinances and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects would be probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal then the transfer could commence. The groundwater mitigation measures further stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management and Monitoring: A variety of activities and local management policies could assist in minimizing effects associated with groundwater transfers. Tehama County and the Redding Area Water Council have developed AB3030 plans for Tehama County and the Redding Basin, respectively. (Table 6-2 shows the basic components included in the plans.) Tehama County's AB3030 plan is unique in that the plan proposes management levels based on "trigger levels" for each subbasin. These levels entail a passive, limited, or active level of management, depending on the degree to which the trigger level is exceeded. The objective of this strategy is to limit groundwater management to the level that is least intrusive to the local landowner while still managing groundwater resources effectively (Keppen 1996). Tehama County is working to implement its plan, but has not yet started developing trigger levels (DWR Northern District 2002). Table 6-2 summarizes the components in each plan. In addition to these groundwater management plans, both Shasta County and Tehama County have ordinances addressing groundwater transfers.

- *Shasta County Ordinance No. SCC 98-1, 1998:* This county ordinance requires permits prior to the extraction of groundwater for direct or indirect use. Except in certain outlined circumstances, this ordinance includes all groundwater that could be substituted for surface water and exported from the county. Permit applicants must fund the necessary environmental reviews. The public is notified of the permit filing, and notices are sent to all interested parties and to the owners of overlying or adjacent lands. A Commission, consisting of nine appointed representatives of Shasta County, decides whether to approve the permit if the environmental review determines that the proposed action would not result in any significant adverse impacts (DWR Northern District 2002).

- *Tehama County Urgency Ordinance No. 1617:* This county ordinance requires a permit for groundwater extraction for transfers within the county or outside of county borders. Permits would be granted only after review of potential effects have shown that well operation would not result in overdraft, saltwater intrusion, or water mining, and the operation would not cause adverse effects on the transmissivity of the underlying aquifer or the water table. The ordinance also prohibits the operation of wells constructed after 1991 if the radius of influence extends beyond the boundaries of the property or beyond the boundaries of the owner's adjacent properties (Board of Supervisors of the County of Tehama, 1994).

In addition to the ordinances and plans mentioned above, in 2000 and 2001, the Redding Area Water Council, in conjunction with the Shasta County Water Agency, developed a groundwater model for the Redding Groundwater Basin. This model simulates the changes in groundwater levels and stream stage in response to various hydrologic stresses and land use for the area. The model was calibrated to a given set of land use and groundwater level data from monitoring wells. The Redding Area Water Council uses the model to simulate groundwater responses to planning scenarios in the Redding basin-wide water resources plan. The model serves as a regional planning tool and assists in planning and predicting the potential effects of smaller scale projects (Wedemeyer 2002).

The EWA Project Agencies would not make purchases that interfere or conflict with the local management efforts described above, and would not purchase water from an agency unless that agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to take place, Anderson-Cottonwood ID would implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the Redding groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

6.2.4.1.2 Sacramento Groundwater Basin Crop Idling

EWA acquisition of Sacramento River contractor water via crop idling of rice could decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

Figure 6-21 shows the areas of rice production that could be idled in counties Upstream from the Delta Region. The economic analysis in this EIS/EIR (Chapter 11) limits EWA crop idling transfers to 20 percent of the land within each county that would have been cropped with rice. Reducing applied water would result in a loss of recharge to the Sacramento Groundwater Basin. This loss, however, would be relatively small when compared to the total of amount of water that recharges the Sacramento Groundwater Basin. A large portion of the total recharge to the Basin occurs through precipitation and runoff over the spring and winter months. As illustrated by the hydrographs in Figures 6-22 through 6-27, groundwater levels generally recover during the rainy winter season. A 20 percent reduction in applied water recharge would result in a much smaller reduction of overall Basin recharge and would be well within the variability of annual recharge.

Furthermore, the land used for rice production consists of low permeable soils. A substantial portion of the applied water does not percolate to the underlying aquifer, but rather discharges to the farmer's surface drainage system.

A reduction in applied recharge because of idled rice fields could have effects on groundwater recharge and levels; however this action would probably not substantially reduce the percentage of applied water that recharges the underlying Basin. *Consequently, the reduction in groundwater recharge as a result of rice idling would be less than significant.*

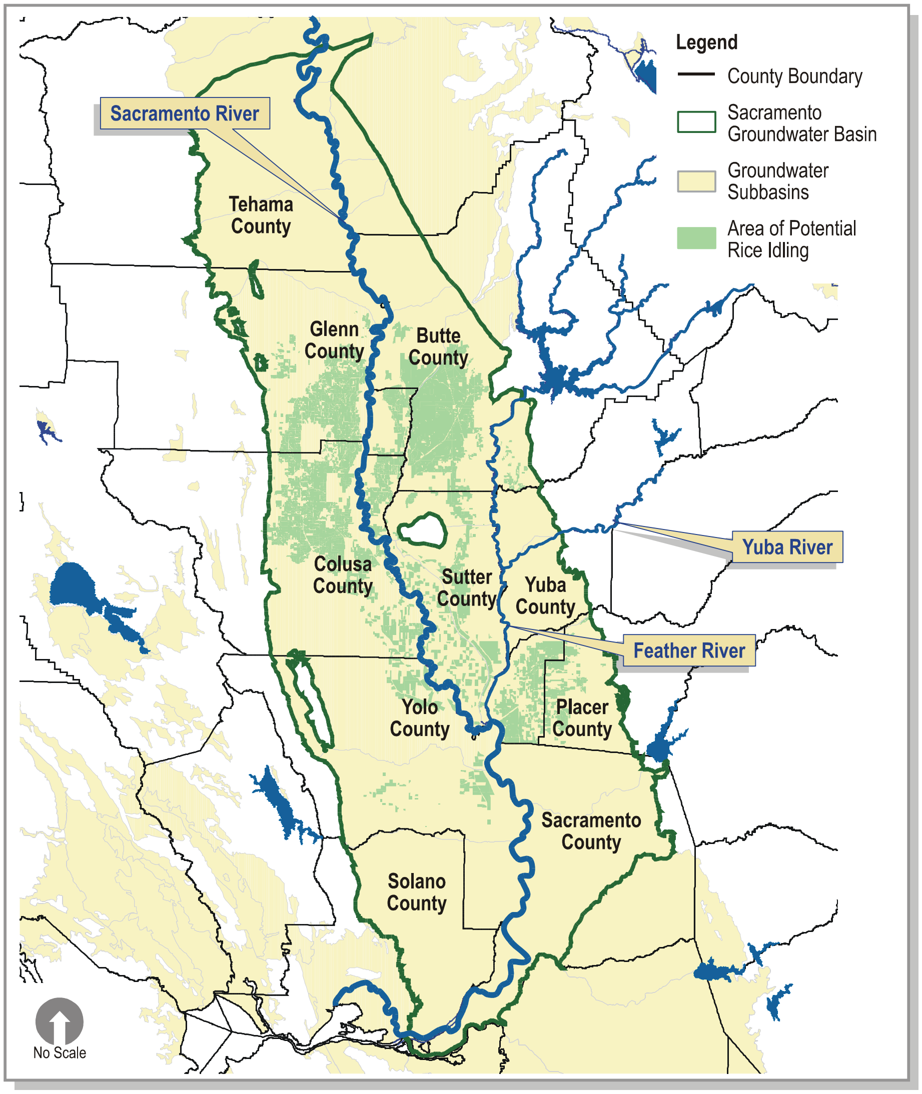

Figure 6-21
Potential Areas of EWA Rice Idling in the Sacramento Valley

<u>Colusa Groundwater Subbasin Groundwater Substitution</u>

EWA Project Agency acquisition of Sacramento Contractor water in the Colusa groundwater subbasin via groundwater substitution could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Glenn-Colusa ID and Reclamation District 108 (RD 108).

Groundwater levels*:* Groundwater substitution may result in temporary declines of groundwater levels. Historically, groundwater levels have remained relatively stable within Glenn Colusa ID and RD 108, as shown on Figure 6-22**.** In some areas, groundwater levels decreased during the droughts of 1976-1977, and 1987-1994 but rebounded in the following wet years (DWR 2002). Groundwater levels tend to decrease during the irrigation season and rebound in the wet winter months. A large portion of recharge in the basin is likely through percolation of natural runoff and the percolation of applied water and irrigation water in unlined canals (DWR Northern District 2002). Because of the aquifer's relatively short recovery period, an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends. It is also likely that groundwater substitution pumping would be concentrated in the northern portion of Glenn Colusa ID, near the Stony Creek Fan area, which recharges relatively rapidly in winter.[12]

Groundwater substitution for EWA asset acquisition could result in temporary drawdown that exceeds historical seasonal fluctuations. Table 6-8 compares the estimated potential drawdown resulting from a one-year EWA transfer with historical fluctuations for the Glen-Colusa ID and RD 108. Figure 6-21 shows the areas for which the regional declines are estimated**.** These areas were selected based on the wells used for the 2001 Forbearance Agreement transfer. Groundwater substitution pumping within Glenn Colusa ID was allocated proportionally according to the number of wells in each area – north, central, and south. The majority of the wells are concentrated in the northern part of the district.

Table 6-8
Flexible Alternative Estimate of the Groundwater Drawdown in the Colusa Subbasin

	Reclamation District 108	***Glenn Colusa ID***		
EWA Acquisition Range	5 TAF	20-60 TAF		
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition (feet)	3	North area	Central area	South area
		3 to 10	1 to 3	1 to 2
Normal Year Fluctuations	2 to 5 feet (unconfined) 6-12 feet (semi-confined)	1 to 6 feet (unconfined) 2-20 feet (confined)		
Drought Year Fluctuations:	8-12 feet (unconfined)	2 to 12 feet (unconfined) 3-30 feet (confined)		

Source for annual fluctuations: DWR 2001

As shown in Table 6-8, the potential groundwater level declines resulting from the EWA acquisitions would range from one to ten feet in addition to seasonal fluctuation. The magnitude of this potential drawdown is within the range of seasonal fluctuations. According to well data for Glenn Colusa ID (Table 6-9), 60 percent of the district's domestic wells and 10 percent of their agricultural wells are 110 feet deep, or shallower. It is unlikely that the transfers would result in regional effects to existing wells.

[12] The Stony Creek Fan system is in the northern portion of the Colusa subbasin, extending from the Black Butte Reservoir to the City of Willows, northeast from the City of Willows to the Sacramento River, and north beyond the Tehama County border. This system comprises sandy alluvial deposits with higher permeability and recharge rates than the less permeable, clay-type soils in the southern portions of the subbasin.

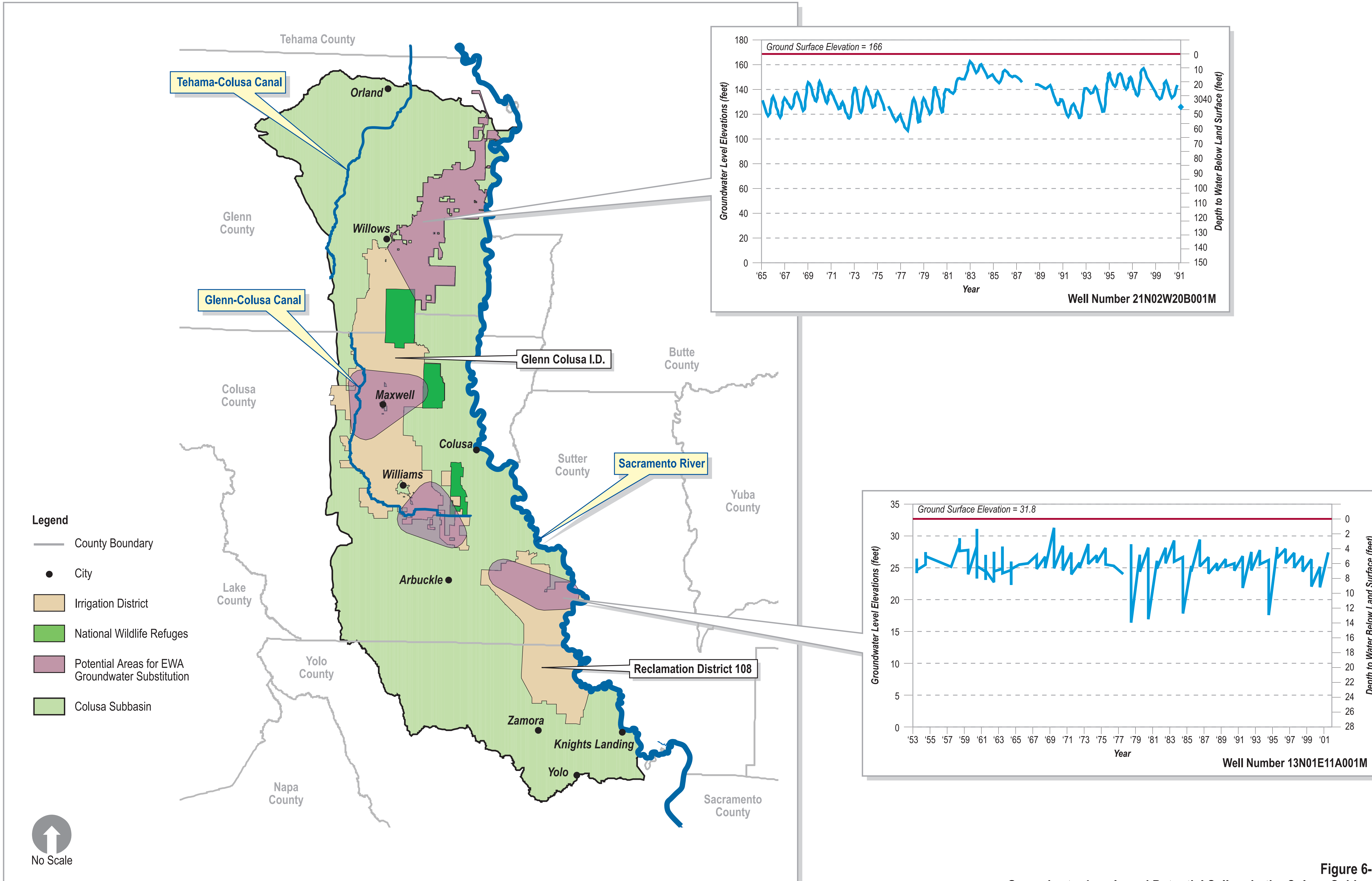

Figure 6-22
Groundwater Levels and Potential Sellers in the Colusa Subbasin

Table 6-9
Glenn Colusa ID and Reclamation District 108 Well Information

Type of Well	Number of Wells/Average Depth in feet		Depth Distribution of GCID Wells
	Glenn Colusa ID	RD 108	
Domestic	414 wells Average 136 ft	20 wells Average 194 ft	50% - 110 ft depth or less 20% - 70 ft depth or less 10% - 55 ft depth or less
Irrigation	301 wells Average 285 ft	23 wells Average 461 ft	50% - 250ft depth or less 20 % - 160 ft depth or less 10% - 110 ft depth or less
Municipal	14 wells Average 502 ft	1 well Average 223 ft	Not calculated
Industrial	17 wells Average 317 ft	2 wells Average 288 ft	Not calculated
Other	148 wells Average 163 ft	73 wells Average 104 ft	Not calculated

Source: DWR Well Completion Reports (DWR Northern District 2002)

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines could be larger than those indicated in Table 6-8, possibly causing effects to wells within the cone of depression.

EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, the groundwater mitigation measures specify that Glenn Colusa ID and RD 108 establish monitoring programs for an EWA groundwater substitution transfer. The programs would monitor groundwater level fluctuations within the local pumping area and if effects were to be reported, Glenn Colusa ID and RD 108 would implement appropriate mitigation measures. These mitigation measures would reduce effects to less-than-significant levels.

Past Groundwater Transfers: Table 6-10 summarizes the past transfers conducted by Glenn Colusa ID and RD 108. During the Forbearance Agreement groundwater substitution transfer in 2001, a landowner outside the Glenn Colusa ID border claimed that his well was affected. Technical evaluation, conducted in accordance with Glenn County's Basin Management Objective (BMO) ordinance (see Groundwater management sections below) and financed by Glenn Colusa ID, indicated that the effect was not due to the Forbearance transfer but rather due to pumping by a groundwater users upgradient of the affected well as well as a reduction in applied surface water.

Table 6-10
Groundwater Transfers in Glenn-Colusa ID and Reclamation District 108

	Reclamation District 108		Glenn Colusa ID	
	Mechanism	**Amount**	**Mechanism**	**Amount**
Potential EWA Acquisition	3 district wells	5 TAF	Voluntary	20-60 TAF
1991 State Drought Water Bank	3 district wells	6.8 TAF	–	–
1992 State Drought Water Bank	–	–	Voluntary	5 TAF
2001 Forbearance Agreement[1]	3 district wells	14.8 TAF	Voluntary	38.2 TAF

[1] During the 2001 Forbearance Agreement 32,705 AF and 5,000 AF was transferred via crop idling for Glenn Colusa ID and RD 108, respectively.

RD 108 transferred a larger amount of water during the 2001 Forbearance Agreement than the amount proposed under the Flexible Purchase Alternative. No impacts were identified as a result of the 2001 transfer. Glenn Colusa ID's maximum amount under the Flexible Purchase Alternative of 60,000 acre-feet would exceed historical transfer amounts.

Interaction with Surface Water: Pumping close to the Sacramento River, along the eastern border of the subbasin, and close to tributaries could reduce channel flows. This reduction in channel flows could adversely affect the riparian and aquatic habitats as well as downstream water users. Three wildlife refuges occur in the Colusa subbasin. Pumping activities could drain or interrupt the water supply, adversely affecting these habitats.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require assessment of measures to avoid and minimize all such potential effects prior to an EWA asset transfer. Through the Well Review process of the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. Production wells within 2 miles of a surface water body would need to meet well depth criteria if there were insufficient data to show that pumping would not result in adverse effects. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, in order to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review, the groundwater mitigation measures also provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less-than-significant levels.

Land Subsidence: Groundwater extraction for the EWA asset acquisition would decrease groundwater levels, increasing the potential for subsidence. As shown on Figure 6-9, the majority of the Colusa subbasin has areas of documented historical subsidence and areas of possible historical subsidence. As discussed in Section 6.1.3.2, land subsidence monitoring just south of RD 108 has detected localized subsidence. The southern portions of Glenn-Colusa ID and RD 108 may have also experienced local subsidence (Figure 6-9). Recently, one of RD 108's southern canals required repair because of a loss of freeboard that was linked to subsidence (Bair 2002).

Land subsidence monitoring within the vicinity of the Colusa subbasin includes Yolo County's countywide global positioning system. Additional subsidence monitoring may be necessary, depending on the hydrology, expected groundwater use for an irrigation season, and the planned extraction by Glenn-Colusa ID and RD 108 for the Flexible Purchase Alternative. EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place to address potential land subsidence effects. The level of monitoring for land subsidence would be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less-than-significant levels.

Groundwater Quality: The migration of reduced quality water, agricultural use of reduced quality water, and the distribution of reduced quality water are three types of potential water quality impacts associated with increased groundwater withdrawals related to EWA asset acquisition and management.

Migration of Reduced Quality Groundwater. Although groundwater quality in the area is sufficient for most agricultural and municipal purposes, elevated levels of manganese, fluoride, boron, magnesium, sulfate, sodium, iron, nitrates, TDS, ammonia, and phosphorus have been detected in localized areas throughout the Colusa subbasin (DWR 2002 and DWR Northern District 2002). Inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction would be limited to short-term withdrawals during the irrigation season and EWA extraction near areas of reduced groundwater quality concern would be avoided through the groundwater mitigation measures Well Review process. (See Section 6.2.7.2 for more details.) Consequently, adverse effects from the migration of reduced groundwater quality would be anticipated to be minimal.

On-farm Use of Reduced Quality Groundwater: Glenn-Colusa ID farmers that may participate in any EWA groundwater substitution transfers could experience changes in water quality as they switch from surface water to groundwater. However, groundwater quality is good for most agricultural and municipal purposes throughout the subbasin and potential regional impacts would be minimal.

Distribution of Reduced Quality Groundwater: Groundwater extracted from RD 108's three wells may be of reduced quality relative to the surface supply allotment the district normally receives. However, groundwater quality is normally adequate for agricultural purposes. Glenn-Colusa ID and RD 108's monitoring programs for an EWA groundwater substitution transfer would monitor groundwater quality within the local pumping area. If adverse effects related to the degradation of groundwater quality from the transfer occurred, the groundwater mitigation measures specify that Glenn Colusa ID and RD 108 would be responsible for monitoring this degradation and mitigating any adverse effects. No significant impacts related to the distribution of reduced quality water would therefore be likely.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, in many areas that may participate in the EWA Program, groundwater data indicates that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels are likely to decline throughout the dry period and then only recover after several normal or wet years. Historical water-level data illustrates this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to the groundwater levels declining over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects , local county ordinances and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects would be probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal then the transfer could commence. All sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management and Monitoring: A variety of activities and local management policies could assist in minimizing effects associated with groundwater transfers. DWR monitors groundwater levels semiannually in 98 wells and groundwater quality in 30 wells throughout the Colusa subbasin. The Department of Health Services also monitors for groundwater quality in 134 wells throughout the subbasin (DWR 2002). Furthermore, Glenn Colusa ID and RD 108 have AB3030 Groundwater Management Plans (Table 6-2 shows the components included in the plans) and Glenn, Yolo, and Colusa Counties have adopted county ordinances that requires permits for groundwater transferred out of county borders. These ordinances are discussed below.

The Colusa County Ordinance No. 615 adds Chapter 43, Groundwater Management, to the county code. The ordinance prohibits direct or indirect[13] extraction of groundwater for transfer outside county boundaries without permit approval, except in certain circumstances. The ordinance does have an exemption process that would allow transfers to occur without obtaining a permit. The permit approval process includes a public and environmental review. Permits would only be approved after the environmental review determines that the proposed action would not result in the following: 1) overdraft or increased overdraft, 2) damage to aquifer storage or transmissivity, 3) exceedance of the annual yield or foreseeable injury to beneficial overlying groundwater users and property users, 4) injury to water replenishment, storage, or restoration projects, and 5) noncompliance with Water Code Section 1220. Three-year permits may also impose additional conditions to avoid adverse effects. Violators of this permitting process may be subject to a fine (Colusa County 1999).

Yolo County Export Ordinance No. 1617 is similar to the Colusa County Ordinance described above. Indirect or direct export of groundwater outside Yolo County requires a permit. The Director of Community Development may review the permit application with the affected county department, DWR, RWQCB, and any other interested local water agency neighboring the area of the proposed action. Following a CEQA environmental review and a public review, the Board of Supervisors of Yolo County may grant the permit as long as the evidence supports that the extraction would not cause 1) adverse effects to long-term storage and transmissivity of the aquifer, 2) exceedance of safe yield unless it is in compliance with an established conjunctive use program, 3) noncompliance with Water Code section 1220, and 4) injury to water replenishment, storage, or restoration projects. The board may impose additional conditions to the permit to ensure compliance with the aforementioned criteria. This ordinance, like the Colusa Ordinance, subjects violators to fines (Yolo County 1996).

Glenn County Ordinance No. 1115 calls for the development of BMOs and a monitoring network designed to detect changes in groundwater level, quality, and land subsidence. This strategy defines the acceptable range of groundwater levels,

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[13] In an indirect groundwater extraction, water users transfer their surface water supplies and substitute groundwater to meet their needs.

groundwater quality, and inelastic land subsidence that could occur in a local area without causing significant adverse effects. If the Technical Advisory Committee detects noncompliance, it is to report the noncompliance to the Water Advisory Committee and inform the public. The Technical Advisory Committee then conducts a technical evaluation to determine why the BMO was exceeded and, following negotiation with all parties involved, makes recommendations for resolving the issue. If negotiations to re-establish BMO compliance do not result in a timely resolution, the Water Advisory Committee may provide recommendations to the Board of Supervisors of Glenn County that the pumping should be terminated until compliance is obtained (Glenn County Board of Supervisors 1999).

According to the Glenn County Ordinance, groundwater level monitoring is to be done at least three times a year: once prior to the irrigation season, once during peak groundwater pumping, and once following the irrigation season. The ordinance also requires water quality monitoring at least once a year during peak groundwater use using a network of wells that adequately represent groundwater quality conditions throughout the county and that provide a suitable amount of information to demonstrate compliance with the BMO. The land subsidence monitoring network would consist of selected benchmarks throughout the county that are surveyed at least every five years. In heavy groundwater use areas, extensometers may be required to provide continuous subsidence monitoring (Glenn County Board of Supervisors 1999).

Glenn County has developed a set of groundwater level BMOs in 17 subareas within the county. These BMOs are based on local input and available monitoring data. The county is acquiring and analyzing the monitoring data to be used in developing the water quality and land subsidence BMOs (Glenn County Board of Supervisors 2001).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from a district unless the district has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, Glenn Colusa ID and RD 108 should implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers conducted in the Colusa groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7 that will reduce these impacts to less than significant.*

East Butte and West Butte Groundwater Subbasins Groundwater Substitution

EWA acquisition of Feather River Contractor water in the East Butte and West Butte groundwater subbasins via groundwater substitution could affect groundwater hydrology. The potential effects could be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater substitution would be concentrated in the Joint Water Districts and Western Canal WD.

***Groundwater Levels**:* Groundwater substitution could result in temporary declines of groundwater levels. Figure 6-23 shows groundwater level fluctuations in wells in the West and East Butte subbasins. Historically, groundwater levels have remained relatively stable, from 1950 to present, with the exception of several localized areas. Declines of 10-15 feet in groundwater levels (since the 1950s) have been recorded in portions of the West Butte Subbasin, and isolated areas of groundwater depression resulting from year-round pumping of groundwater for municipal use exist near the City of Chico. Groundwater levels declined in other areas in response to the 1976-1977 and 1987–1994 droughts, but have since recovered (DWR 2002 and CDM 2001). Because of the aquifer's relatively short recovery period, an EWA asset acquisition via groundwater substitution would likely have a minimal effect on long-term groundwater level trends.

Groundwater levels fluctuate seasonally. The basin generally recharges in the winter and groundwater elevation depressions occur during the summer in the vicinities of Chico, Durham, and Honcut. Increased groundwater use within the northern portion of the East Butte subbasin has resulted in greater seasonal water table fluctuations in the northern portion than in the southern portion of the basin, as shown in Table 6-11 (DWR 2002).

Seasonal fluctuations recorded from wells in the north of the East Butte subbasin range from 4 feet in normal years to 10 feet during dry years. Fluctuations in the southern portion of the East Butte subbasin are approximately 4 feet during normal years and 10 feet during drought years. Average fluctuations in the West Butte Sub-basin are 15 to 25 feet during the normal years and about 30 feet during drought periods (DWR 2002).

Groundwater substitution under the Flexible Purchase Alternative could result in temporary drawdown that exceeds historical seasonal fluctuations. Table 6-11 compares the estimated potential drawdown that could result by a single year EWA-related groundwater transfer with historical fluctuations. Figure 6-23 shows the areas for which the regional declines are calculated. Groundwater may be extracted throughout the districts; consequently, this analysis used the entire area within the districts' boundaries to estimate drawdown.

Table 6-11
Flexible Alternative Estimate of the Groundwater Drawdown for the Butte Subbasins

	West Butte Subbasin	East Butte Subbasin	
EWA Acquisition Range	Western Canal – 10-35 TAF[1]	Joint Water Districts – 20-60 TAF[2] Western Canal WD – 10-35 TAF[1]	
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition	Western Canal WD – 3 to 10 feet	Joint Water Districts – 3 to 8 feet Western Canal WD – 3 to 10 feet	
Normal Year Fluctuations	15 - 25 feet (semi-confined, confined)	North 15 feet (composite wells[3])	South 4 feet (composite wells) 4 feet (confined and semi-confined)
Drought Year Fluctuations	Up to 30 feet (semi-confined, confined)	North 30 -40 feet (composite wells[1])	South 10 feet (composite wells) 5 feet (confined and semi-confined)

Source of the normal and drought-year fluctuations: DWR 2002
[1] This acquisition range applies to the entire Western Canal WD, both in the West and East Butte subbasin.
[2] This estimate assumes that 75 percent of the acquisition range of 20-60 TAF, is allotted to the three of the Joint Water Districts, Biggs-West Gridley, Richvale, and Butte WD, in the East Butte subbasin. The remaining 25 percent is allotted to Sutter Extension WD in the Sutter subbasin. This partitioning was based on the density of potential pumping wells in each subbasin.
[3] Composite wells represent groundwater fluctuations that combine confined and unconfined portions of an aquifer

As shown in Table 6-11 , the potential regional groundwater level declines resulting from an EWA-related transfer could cause an additional 3 to 10-foot decline in the West Butte subbasin. This would not be a substantial decline when compared with the normal year fluctuations. In the East Butte subbasin, estimates indicate a potential 3- to 10-foot decline in Western Canal WD - declines similar to groundwater fluctuations observed during drought years. The service areas of the Joint Water Districts could experience regional declines of 3 to 8 feet, which could exceed normal year fluctuations by 4 feet in the southern portion of the East Butte subbasin. The potential for adverse drawdown effects would increase as the amount of extracted water increased. The potential for adverse effects would be higher still during dry years, when baseline fluctuations are already large and groundwater levels may be low.

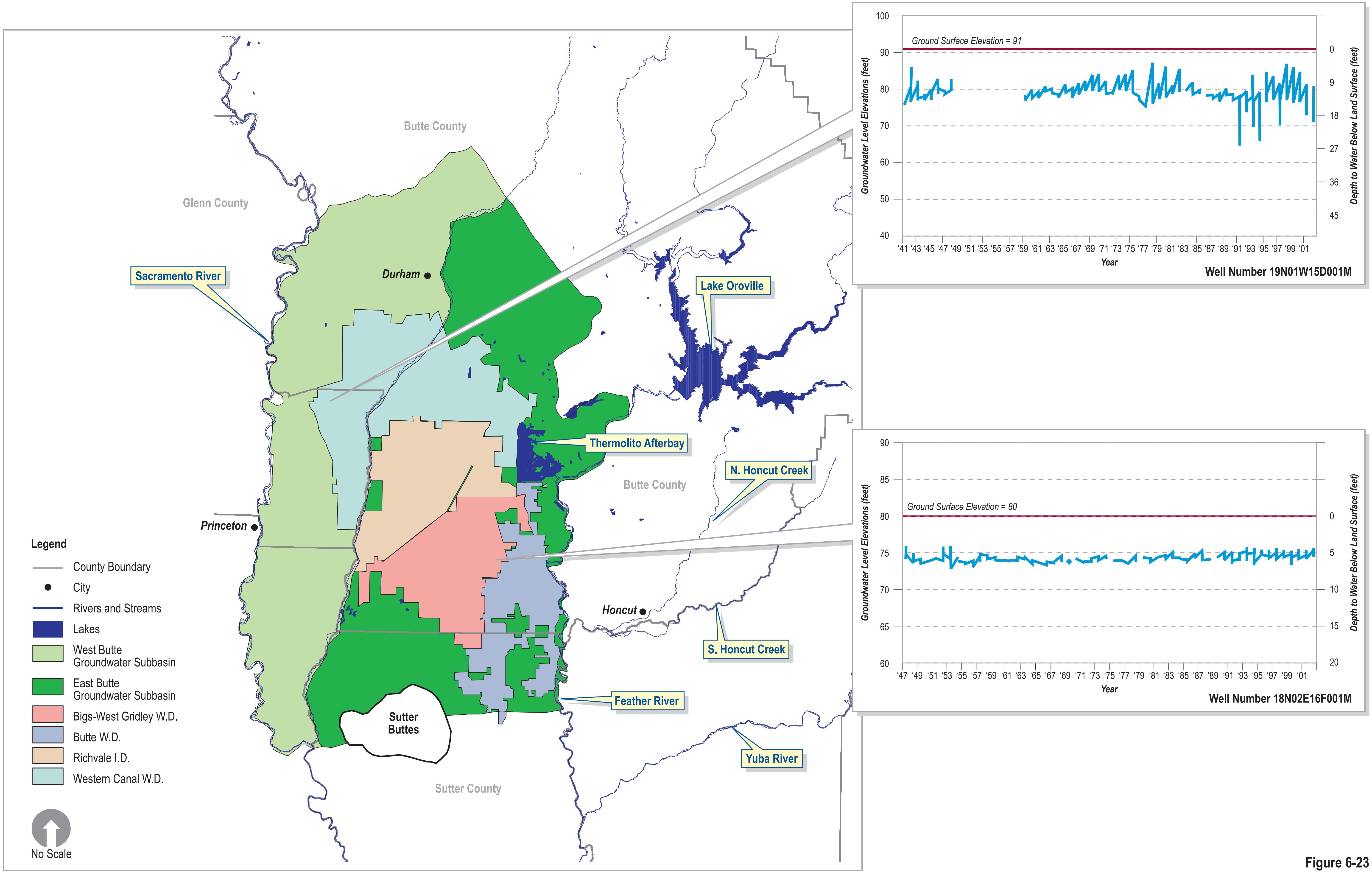

Figure 6-23
Groundwater Levels and Potential Sellers in the Butte Subbasins

Although there are exceptions,[14] the Joint Water Districts members and Western Canal WD rely primarily on surface water diverted from the Feather River. During normal years, groundwater transfers would be less likely to affect wells throughout the majority of the districts because local users rely extensively on surface water. During dry years, however, DWR has the option to reduce supplies to the Joint Water Districts .[15] Table 6-12 shows the number of wells within each district and the average depth of wells. Wells within the potential sellers' districts are relatively shallow. During dry years, groundwater may be an important supplement to surface water in some areas, and additional declines caused by groundwater substitution transfers would be more likely to result in adverse effects.

Table 6-12
Well Information for the Butte Groundwater Subbasins

Type of Well	***Number of Wells/Average Depth in feet***			
	Richvale	**Biggs-West Gridley**	**Butte WD**	**Western Canal WD**
Domestic	87 wells Average 114 ft	246 wells Average 92 ft	571 wells Average 83 ft	47 wells Average 145 ft
Irrigation	72 wells Average 303 ft	92 wells Average 221 ft	183 wells Average 165 ft	112 wells Average 470 ft
Municipal	0 wells	4 well Average 228 ft	8 wells Average 228 ft	0 wells
Other	21 wells	33 wells	115 wells	0 wells

Source: DWR Well Completion Reports (CDM 2001)

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines are likely to be larger than those indicated in Table 6-11, possibly causing effects to wells within the cone of depression.

DWR monitors groundwater levels semi-annually in 32 and 43 wells in the West and East Butte subbasins, respectively. EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects could be potentially significant. To reduce these effects, in addition to these monitoring activities, the groundwater mitigation measures specify that sellers establish monitoring programs for the EWA groundwater substitution transfer. The programs would monitor groundwater level fluctuations within the local pumping area and if effects were to occur, the districts within this area would implement appropriate

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14 Such an exception is a portion of the Richvale ID service area, just west of Biggs and adjacent to the Butte Creek and Cherokee Canal. This area does not receive SWP allocation, but relies on groundwater and drainage water.

15 The Joint Water Districts administers 630,000 acre-feet of Feather River water to its member agencies including: Biggs-West Gridley WD, Butte WD, Richvale ID, and Sutter Extension ID. The Board controls, maintains, and operates the joint water distribution facilities for each district but does not own any production wells.

mitigation measures. These measures would reduce effects to less than significant levels.

Past Groundwater Transfers: Western Canal WD participated in the State Drought Water Bank transfers in 1991, 1992, and in 1994 (Table 6-13). Western Canal WD did not experience effects in either 1991 or 1992. However, in 1994, a number of independent pumpers north and east of Western Canal WD reported effects as a result of the 1994 Water Bank Transfers. Consequently, Western Canal WD experienced a temporary cessation in pumping at several wells, and some pumps stopped pumping permanently. This effect may have been partially attributable to the already low groundwater levels as a result of the 1991 and 1992 droughts, including an exceptionally dry 1992 spring, which resulted in an early irrigation season. Furthermore, a large number of the affected wells were shallow, pumping volumes for the State Drought Water Bank were not regulated, and the groundwater system was not well understood. In response to these effects, DWR, Butte County, and Western Canal WD increased monitoring activities and Butte County passed a groundwater protection ordinance.

Table 6-13
Past Groundwater Transfers in the Butte Subbasins

District	*Joint Water Districts*	*Western Canal WD*
1991 State Drought Water Bank	60,000	40,000
1992 State Drought Water Bank		49,600
SAFCA Transfer[1]	60,000	
1994 State Drought Water Bank		82,400

[1] Groundwater substitution transfers to SAFCA in the mid-1990s, compensating CVP for flood protection operations in Folsom Reservoir.

As shown in Table 2-5 in Chapter 2, the Joint Water Districts and Western Canal WD could transfer between 20-60 and 10-35 TAF, respectively, to the EWA Project Agencies. These acquisition ranges are within the range of transfers that have been conducted in the past.

Interaction with Surface Water*:* Pumping close to the Feather River along the eastern border of the East Butte subbasin and close to its tributaries could reduce channel flows. This could adversely affect the riparian and aquatic habitats and the downstream water users. Furthermore, groundwater is forced to the surface near the Sutter Buttes, resulting in wetland habitat along the west side of the Sutter Buttes (CDM 2001). Wetlands are also present in other areas throughout the Butte subbasins, and pumping activities could drain or interrupt the wetlands' water supply, thus adversely affecting these habitats.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require evaluation of measures to avoid and minimize all such potential effects prior to an EWA-related transfer. Through the Well Review process identified in the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. If there were insufficient data to show that pumping would not result in adverse effects, production wells within 2 miles of a surface water body could be required to meet well depth criteria. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review, the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land Subsidence: Groundwater extraction for EWA asset acquisition would decrease groundwater levels, increasing the potential for local subsidence. Land subsidence has not been detected within the potential sellers' service districts; however, if groundwater levels were to be lowered substantially, there would be potential for subsidence. Nevertheless, no subsidence has been detected to date. If transfers under the Flexible Purchase Alternative do not cause groundwater levels to decline below historical levels, the potential for subsidence would be reduced.

Land subsidence monitoring within Butte County includes two extensometers that DWR recently installed. Figure 6-9 shows the location of these extensometers. These extensometers have not yet provided sufficient data to yield conclusive results (DWR Northern District 2002). Additional subsidence monitoring may be necessary, depending on the hydrology, expected groundwater use for an irrigation season, and the extraction the potential sellers in Butte subbasins plan to make under the Flexible Purchase Alternative. EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers have a monitoring and mitigation program in place to address potential land subsidence effects. The level of monitoring for land subsidence would be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality: Migration of reduced quality groundwater and agricultural use of reduced quality water would be the types of potential water quality effects associated with increased groundwater withdrawals providing EWA assets to the Project Agencies.

On-farm use of reduced quality water. Farmers that may participate in any EWA groundwater substitution transfers could experience changes in water quality as they switch from surface water to groundwater. However, groundwater quality is good for most agricultural and municipal purposes throughout the subbasin, and potential regional effects would be minimal.

Migration of Reduced Quality Groundwater: Although groundwater quality is sufficient for most agricultural and municipal purposes, elevated levels of manganese, iron, magnesium, TDS, calcium, nitrates, boron, chloride, bicarbonate, potassium, fluoride, and arsenic have been detected in localized areas throughout the Butte subbasins (DWR 2002 and DWR Northern District 2002). Inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction would be limited to short-term withdrawals during the irrigation season and EWA extraction near areas of reduced groundwater quality concern would be avoided through the groundwater mitigation measures Well Review process. (See Section 6.2.7.2 for more details.)

Additional assurances are provided by the groundwater mitigation measures that stipulate that all sellers have a monitoring and mitigation program that addresses potential adverse groundwater quality effects. If groundwater quality effects do occur, it would be the responsibility of the local selling agency to monitor and mitigate effects. The mitigation measures would therefore reduce any such impacts to less than significant levels.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, in many areas that may participate in the EWA Program, groundwater data indicates that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels are likely to decline throughout the dry period and then only recover after several normal or wet years. Historical water-level data illustrate this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to the groundwater levels declining over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, Butte County ordinances and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal then the transfer could commence. The groundwater mitigation measures further stipulate that all sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management and Monitoring: DWR currently monitors groundwater quality in four wells in the East Butte and eight wells in the West Butte subbasins. The Department of Health Services monitors water quality in 59 wells throughout the two subbasins, and Butte County monitors water quality in 15 wells throughout the county (DWR 2002). In addition to these monitoring activities, the groundwater mitigation measures specify that the potential selling districts' monitoring programs for an EWA groundwater substitution transfer would monitor groundwater quality within the local pumping area. If there were adverse effects on groundwater quality as a result of the transfer, all sellers in the Butte subbasins would be responsible for mitigation.

A variety of local management plans and ordinances may assist in minimizing effects associated with groundwater transfers. Biggs-West Gridley WD, Richvale ID, West Butte WD, and Western Canal WD have AB3030 Plans. Table 6-2 summarizes the components included in these plans. Butte, Glenn, and Colusa Counties have adopted county ordinances that are intended to aid in the protection of groundwater resources. Glenn and Colusa counties' ordinances are described in the Colusa subbasin section. Butte County's ordinances are described below. In addition to the established ordinances and groundwater management plans, a Butte Basin groundwater model has been developed to: 1) assess the groundwater resources of the Butte groundwater basin; 2) develop a quantitative understanding of the groundwater hydrology; and 3) evaluate potential regional hydrologic effects associated with proposed water management alternatives (Butte Basin Water Users Association 1996).

Chapter 33 Groundwater Conservation: This Butte County ordinance authorizes the establishment of a countywide groundwater-monitoring program to be implemented by the Butte County Water Commission in cooperation with the Technical Advisory Committee, the Butte Basin Water Users Association, DWR, and RWQCB. The ordinance requires completion of an annual report disclosing monitoring data from this program (four sampling rounds a year) in addition to data from other cities and agencies. The ordinance also requires a permit for all groundwater extraction that are to be transferred outside the county directly or indirectly via groundwater substitution (Butte County 1999).

Butte County Well-Spacing Ordinance: This ordinance requires the filing of a permit for construction, repair, deepening, or destruction of private or public water supply wells. It also sets restrictions on the spacing of wells based on capacity. This ordinance is intended to ensure that water obtained from wells within Butte County would be suitable for use and would not cause pollution or impairment of the quality of groundwater within the county (DWR Northern District 2002).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, Biggs-West Gridley WD, Richvale ID, Butte WD, and Western Canal WD should implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the East Butte and West Butte groundwater subbasins could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

East Sutter Groundwater Subbasin

EWA acquisition of Feather River Contractor water in the East Sutter groundwater subbasin via groundwater substitution would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater substitution would be concentrated in Sutter Extension ID and Garden Highway MWC.

Groundwater Levels*:* Groundwater substitution may result in temporary declines of groundwater levels in the Sutter subbasin. Figure 6-24 shows the East Sutter subbasin and groundwater level fluctuations in a DWR monitoring well. With the exception of moderate declines in the first half of the 1900s, groundwater levels are generally within 10 feet of the ground surface. Seasonally, levels decrease during the summer irrigation season and rebound following the winter rains. Stream percolation, deep percolation of rainwater, and applied irrigation water are the primary mechanisms for recharge of the aquifer (DWR 2002). Because of the aquifer's relatively short recovery period, an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends.

Groundwater substitution under the Flexible Purchase Alternative could result in temporary drawdown that exceeds historical seasonal fluctuations. The potential drawdown as a result of an EWA-related groundwater transfer for Sutter Extension WD and Garden Highway MWC would be between 3 to 8 feet and 22 feet, respectively. These estimates are based on the assumption for Flexible Purchase Alternative acquisitions of 60 TAF and 3 TAF for Sutter Extension WD and Garden Highway MWC, respectively. This drawdown could adversely affect local wells; however, there are insufficient data to determine typical regional groundwater level fluctuations.

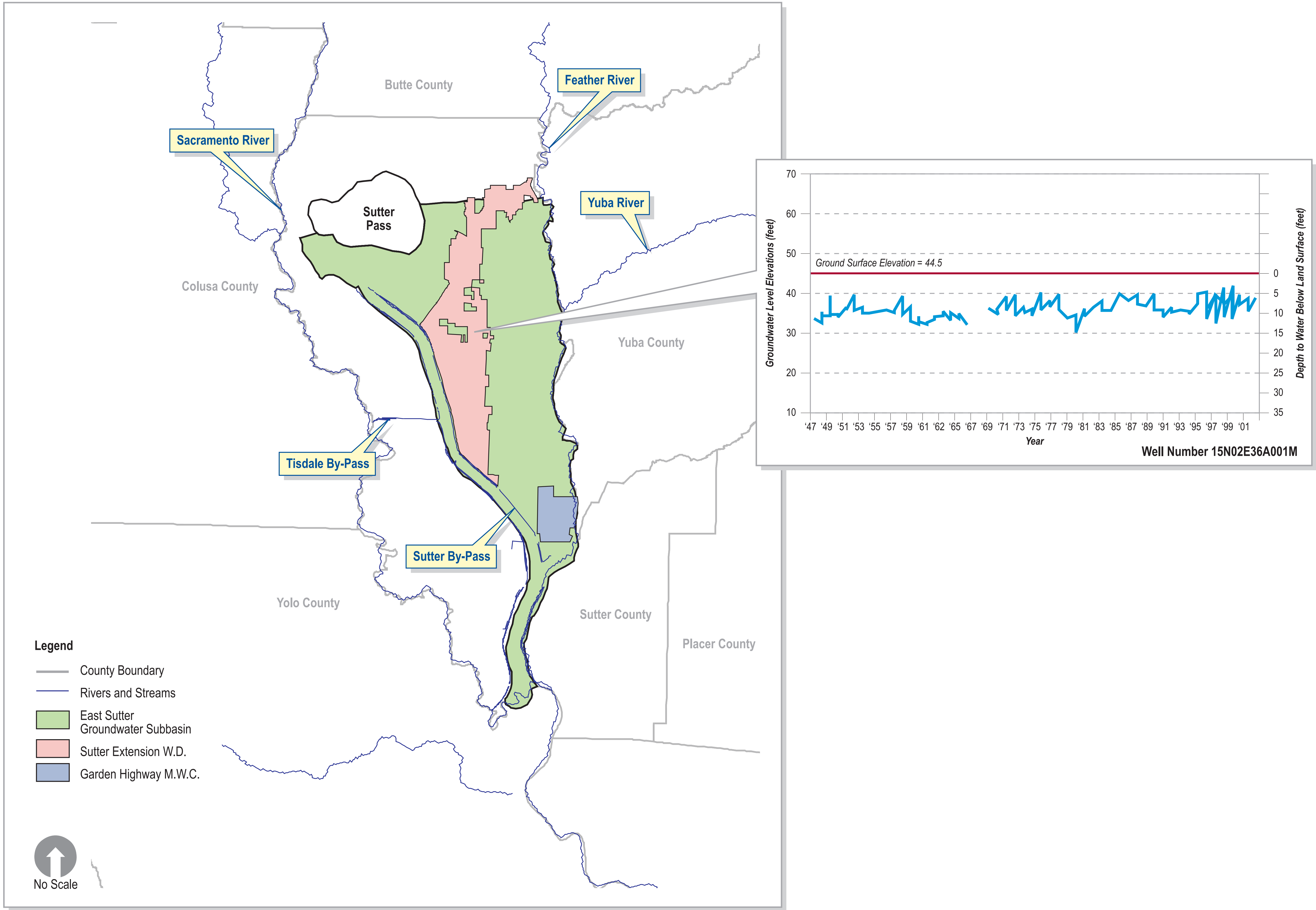

Figure 6-24
Groundwater Levels and Potential Sellers in the East Sutter Subbasin

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines would likely be larger than the regional declines, possibly causing effects to wells within the cone of depression.

DWR and Sutter County WA monitor groundwater levels semi-annually in 22 wells (DWR 2002). EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects could be potentially significant. To reduce these effects, in addition to this monitoring, the groundwater mitigation measures specify that Garden Highway MWC and Sutter Extension WD establish monitoring programs for EWA-related groundwater substitution transfers. The programs would monitor groundwater level fluctuations within the local pumping area and if effects were shown or reported to be occurring, the agencies within this area (Sutter Extension WD and Garden Highway MWC) would implement appropriate mitigation measures. These mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: Sutter Extension WD and Garden Highway MWC have not participated in any groundwater transfers outside their agencies.

Interaction with surface water: Pumping close to the Sacramento River along the eastern border of the subbasin could reduce channel flows. This could adversely affect the riparian and aquatic habitats and the downstream water users.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require assessment of measures to avoid and minimize all potential effects prior to an EWA transfer. Through the Well Review process of the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. If there were insufficient data to show that pumping would not result in adverse effects, production wells within 2 miles of a surface water body could be required to meet well depth criteria. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, in order to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land Subsidence: Groundwater extraction under the Flexible Purchase Alternative would decrease groundwater levels, increasing the potential for subsidence. As shown on Figure 6-9, the majority of the East Sutter subbasin is located in areas of possible historical subsidence, and subsidence has been detected in areas between Arbuckle and Davis, just southwest of the subbasin.

EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place that addresses potential land subsidence effects. The level of monitoring for land subsidence would be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality: The migration of reduced quality groundwater, on-farm use of reduced quality water, and distribution of reduced quality water are the types of potential water quality effects associated with increased groundwater withdrawals related to EWA asset acquisition.

Migration of Reduced Quality Groundwater. Groundwater quality in the Sutter subbasin is variable; TDS concentrations range from 133 to 1,660 mg/L. TDS concentrations in the southern portion of the subbasin are typically higher. Other chemical elements and compounds detected in various wells throughout the subbasin have exceeded drinking water limits (DWR 2002). Inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction would be limited to short-term withdrawals during the irrigation season, and EWA extraction near areas of reduced groundwater quality concern would be avoided through the groundwater mitigation measures Well Review process. (See Section 6.2.7.2 for more details.) Additional assurances are provided by the groundwater mitigation measures that stipulate that all sellers have a monitoring and mitigation program that addresses potential adverse groundwater quality effects. If groundwater quality effects do occur, it would be the responsibility of the local selling agency to monitor and mitigate effects. The mitigation measures would therefore reduce any such impacts to less than significant levels.

Distribution of Reduced Quality Water: The Project Agencies would use the groundwater mitigation measures well review process to ensure that water placed in distribution systems due to EWA asset acquisition actions meets agricultural use requirements.

If adverse effects related to the degradation of groundwater quality from the transfer were to occur, the groundwater mitigation measures stipulate that all sellers have a monitoring and mitigation program in place that addresses potential adverse groundwater quality impacts. The mitigation measures would reduce any such impacts to less than significant levels.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, in many areas that may participate in the EWA Program, groundwater data indicate that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased and percolation from natural runoff is often lower than normal, and groundwater levels would decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels would likely to decline throughout the dry period and then only recover after several normal or wet years. Historical water-level data illustrates this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to the groundwater levels declining over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal then the transfer could commence. The groundwater mitigation measures further stipulate that all sellers to the EWA Project Agencies should will have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Monitoring and Management: DWR currently monitors groundwater quality in 27 wells throughout the subbasin. In addition, the Department of Health Services (including cooperators) monitors water quality in 49 wells (DWR 2002). During the well review process, the Project Agencies would review this and any additional monitoring criteria related to an EWA-related groundwater substitution transfer. If there were to be adverse effects related to the degradation of groundwater quality as a result of the transfer, the Garden Highway MWC and/or Sutter Extension WD would be responsible for mitigation.

Sutter Extension WD has an AB3030 Plan that could help minimize effects associated with groundwater transfers. Table 6-2 summarizes the components included in this plan. Sutter County wrote a county ordinance regarding groundwater, but it was not adopted. Sutter Extension WD has had discussions with neighboring water agencies about developing a countywide plan.

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, Sutter Extension WD and Garden Highway MWC should implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the East Sutter groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant*.

North Yuba and South Yuba Groundwater Subbasins

EWA acquisition of water from Yuba County Water Agency by groundwater substitution in the North Yuba and South Yuba groundwater subbasins could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would be concentrated in the Yuba County Water Agency (WA), member agencies of Browns Valley ID, Brophy WD, Ramirez WD, Hallwood Irrigation Company, South Yuba WD, Dry Creek MWC, and Cordua ID.

Groundwater Levels*:* Groundwater substitution may result in temporary declines in groundwater levels. Historical groundwater levels are different for the North Yuba subbasin and the South Yuba subbasin (Figure 6-25). Groundwater levels in the North Yuba subbasin generally declined prior to the mid-1960's, were relatively stable until about 1980, and have subsequently recovered to near historic high levels. Imposed on these general trends are single year declines that have occurred in dry years with rapid recovery during the following winter season. The South Yuba subbasin experienced long-term declines in water levels, indicative of overdraft, through the early 1980's. Subsequent to the development of the Yuba River Operating Program, deliveries of surface water began with the completion of the initial phase of the South Yuba Canal in 1983. Extension of the canal continues to this day with increasing areas of the South Yuba subbasin receiving surface water with a concomitant reduction in groundwater use. Groundwater levels in the South Yuba subbasin have risen as much as 100 feet in some areas. These water level rises coupled with the experience gained from recent water transfers indicated that significant unmitigated effects of a transfer to EWA would not alter long-term water level trends.

Groundwater substitution under the Flexible Purchase Alternative could, however, result in temporary drawdown that exceeds historical seasonal fluctuations. Estimates of an upper bound for regional water level declines associated with an EWA groundwater transfer could be up to 19 feet for both the North Yuba and South Yuba subbasins. However, the actual water level declines would generally be less than this amount. For example, Grinnell, 2002, indicated regional declines associated with a 65,000 acre-foot transfer from the North Yuba subbasin were on the order of 10 feet. Figure 6-25 shows the areas for which these regional declines were calculated. These areas were selected based on the use of wells for previous transfers to the EWA Project Agencies in 2001 and 2002. The estimate assumes that the north and south subbasins would each pump half of the total 85 TAF acquisition amount.

Extraction from the South Yuba subbasin would be less likely to effect third parties than extraction in the North Yuba subbasin because the potential declines would be within the range experienced during recent water transfers.

Increased groundwater pumping could cause localized declines of groundwater levels, or the development of cones of depression near pumping wells. In order to address these potential local declines, DWR and Yuba County WA implemented a cooperative monitoring program during Yuba County WA's groundwater substitution transfers to the EWA Project Agencies in 2001 and 2002. Monitoring is useful in identifying any effects that could occur as a result of pumping for an EWA transfer. EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, in addition to the monitoring activities discussed above, the groundwater mitigation measures further specify that Yuba County WA would be required to establish monitoring programs for EWA-related transfers. These programs would monitor groundwater level fluctuations within the local pumping area and if significant effects were to occur, Yuba County WA and/or its member agencies would be responsible for mitigation. Therefore, the mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: Table 6-14 summarizes past transfers conducted by Yuba County WA member agencies. Following the 1991 State Drought Water Bank transfer, groundwater levels in the North Yuba subbasin did not fully recover to pre-transfer levels by the following spring, yet subsequently did so (Fielden 2003). During the 2001 Dry Year Purchase Agreement (DYPA) groundwater substitution transfer adverse effects to groundwater levels were experienced along the eastern edge of the North Yuba subbasin. Several domestic wells on a hillside in the Las Quintas residential development experienced unsatisfactory water level declines. These wells were relatively shallow and were near several production wells that were pumping for the DYPA groundwater substitution transfer. Within several days of the incident, Cordua ID had addressed the problem by deepening the affected wells (Grinnel 2002).

In 2002, the EWA groundwater substitution transfer posed the potential of similar effects and following the transfer period, one well was affected. In response, the affected well was deepened and Cordua ID implemented an ongoing stakeholder interaction process that includes routine meetings and surveys of the individual domestic wells within the local area.

Table 6-14
Yuba County WA Past Groundwater Transfers (acre-feet)

Water Agency	Browns Valley ID	Brophy WD	Ramirez WD	Hallwood ID	South Yuba WD	Dry Creek MWC	Cordua ID
1991 State Drought Water Bank	2,700	36,000	13,300	6,500	17,300		6,500
1992 State Drought Water Bank	4,800	-	-	-	-	-	-
SAFCA Transfer[1]	3,681	-	-	-	-	-	-
1994 State Drought Water Bank	3,800	-	12,700	-	-	-	9,600
2001 Dry Year Purchase Agreement[3]	8,000[2]	-	17,000	12,000	9,000	9,100	-
2001 EWA	3,300		17,000	12,000	10,000	9,200	14,000
2002 EWA	5,217	10,901	8,786	7,381	8,193	5,417	9,363

[1]Groundwater substitution transfer that occurred in the mid-1990s to SAFCA.
[2] May include some reservoir release from Collins Reservoir.
[3] Contract Amount

As shown in Table 2-5 in Chapter 2, Yuba County WA could transfer 85,000 acre-feet via groundwater substitution under the Flexible Purchase Alternative. This amount exceeds the total amounts of 54,400 and 55,258 acre-feet transferred to the EWA Program in 2001 and 2002, respectively, yet is close to the amount transferred to the 1991 State Drought Water Bank (82,300 acre-feet). As discussed above, Yuba County WA has experienced and mitigated impacts resulting from previous transfers and has developed a monitoring program for prior EWA-related transfers.

As stipulated by the groundwater mitigation measures, a similar process for responding to alleged effects resulting from the water transfers would occur in the future.

Interaction with Surface Water: River flows could be reduced through pumping close to the Bear River to the south, or the Yuba River that flows through the subbasins. The Feather River borders the area on the west but pumping in support of water transfers does not occur near the river. Pumping could adversely affect the riparian and aquatic habitats and downstream water users. However, effects to riparian and aquatic habitats along the Feather and Yuba Rivers would be unlikely. Large flows would be maintained in these rivers that would continue to support aquatic and riparian resources at levels that would exist in the absence of a transfer to EWA. The portion

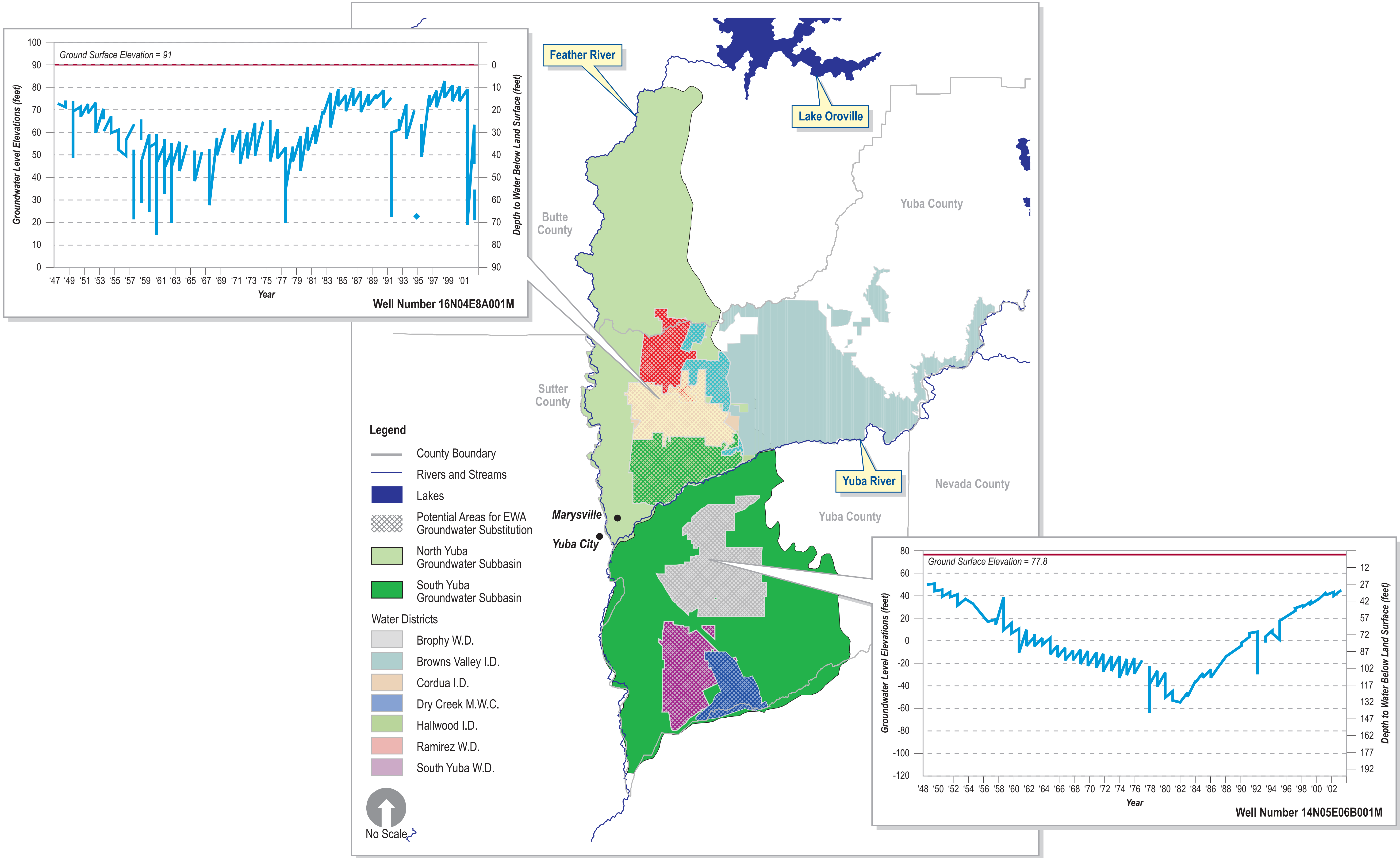

Figure 6-25
Groundwater Levels and Potential Sellers in the Yuba Subbasins

of the Bear River that would most likely be affected by transfers has only limited connection with adjacent groundwater that would be pumped. Limited monitoring suggests that little additional loss from the river occurs in response to transfer pumping. Furthermore, there are wetlands, primarily irrigated rice culture, throughout the area and pumping activities reduce groundwater available as part of the wetlands' water supply. However, the amount of water applied for irrigation and the resulting return flows would be largely unchanged as a result of transfers to the EWA and would continue to support wetlands.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects the groundwater mitigation measures require assessment of measures to avoid and minimize any significant potential effects of an EWA transfer. Through the Well Review process of the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. If data were insufficient to show that pumping would not result in adverse effects, production wells within 2 miles of a surface water body could be required to meet well depth criteria. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, in order to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review , the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

***Land Subsidence**:* Groundwater extraction for obtaining EWA assets would decrease groundwater levels, increasing the potential for local subsidence. Land subsidence has not been detected within the Yuba County WA member service agencies. The South Yuba subbasin has experienced substantial groundwater declines, and no subsidence has been detected in that subbasin. Because the North Yuba subbasin is geologically similar to the South Yuba subbasin, and the South Yuba basin has not experienced subsidence as a result of pumping, the potential for subsidence in the North Yuba subbasin is considered low. However, EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers have a monitoring and mitigation program that would address potential land subsidence effects. Considering the lack of subsidence demonstrated in the South Yuba subbasins, and the geologic similarity of the north and south subbasins, the level of monitoring needed to monitor land subsidence may be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality: Potential groundwater quality effects associated with increased groundwater withdrawals for EWA asset acquisition in the North Yuba and South Yuba subbasins include the migration of reduced quality water. Groundwater underlying Beale Air Force Base on the eastern boundary of the South Yuba subbasin is contaminated and being remediated (Grinnell 2002). In addition, high nitrate levels are present in the boundaries of Dry Creek MWC (Fielden 2003), and the upward migration of saline water from the deeper aquifers is of concern near Wheatland in the southeastern portion of the South Yuba subbasin. Although plans to supply surface water to this area are in the preliminary planning phase, this area currently relies on groundwater, which may cause the upward migration of saline water (Grinnell 2002 and Aikens 2003).

With the exception of these areas, groundwater is of good quality with a median TDS concentration of 277 mg/L and 224 mg/L for the North and South Yuba subbasins, respectively. Groundwater extraction associated with past transfers was a sufficient distance from these problem areas, thus avoiding any adverse groundwater quality effects. Assuming groundwater extraction projects would avoid these areas in the future no significant impacts related to the migration of reduced quality water would be likely; however, the mitigation measures would reduce any such impacts to less than significant levels. (See Section 6.2.7.2 for more details.)

The groundwater mitigation measures specify that if assets are acquired from the Yuba County WA, the agency should monitor groundwater quality within the local pumping area. If there were to be significant adverse effects from the degradation of groundwater quality associated with a transfer, the Yuba County Water Agency or its member agencies would be responsible for mitigating the adverse effects.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, during dry years, groundwater use increases and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels would likely continue to decline until a wet period, when groundwater levels may recover. In addition, groundwater levels may not fully recover from a preceding year's transfer. Groundwater transfers over several consecutive years may increase the potential for adverse effects by causing net groundwater levels declines.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, local ordinances and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal, then the transfer could commence. All sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects should they occur. The mitigation measures would reduce effects to less than significant levels.

Local Groundwater Monitoring and Management: Yuba County WA maintains the largest water rights on the Yuba River, serving as a wholesaler of water to multiple water agencies, irrigation districts, and water companies. These include Brown's Valley ID, Brophy WD, Ramirez WD, Hallwood Irrigation Company, Dry Creek MWC, South Yuba WD, and Cordua ID.

Yuba County WA has regulatory authority regarding the use of groundwater resources within its boundaries; however, the Agency has chosen to exercise its authority by developing cooperative relationships with its member agencies to conjunctively manage the groundwater resource. Yuba County WA is currently developing an AB3030 Plan. This plan would incorporate all twelve elements outlined in AB3030. The plan would also include a description of Yuba County WA's current and planned activities, including: the ongoing development of a conjunctive use program, and the cooperative DWR and Yuba County WA monitoring plan. In addition to the Yuba County WA plan, South Yuba WD and Cordua ID have developed individual AB3030 plans. These two districts, in addition to the remaining Yuba County WA member agencies, would be included in the upcoming Yuba County WA AB3030 plan (Grinnell 2002).

Yuba County Water Agency has a number of water transfer policies that help guide agency operations. These policies specify that groundwater transfers should not result in unmitigated third party effects, or cause overdraft (Grinnell 2002). Brown's Valley ID also has a set of principles and policies addressing groundwater substitution transfers (Cotter 2002).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, Yuba County WA or Yuba County WA member agencies should implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the North Yuba and South Yuba groundwater subbasins could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant*.

North American (River) Groundwater Subbasin Groundwater Substitution

EWA acquisition of American or Sacramento River water in the North American groundwater subbasin via groundwater substitution would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Natomas Central Mutual Water Company.

Groundwater Levels*:* Groundwater substitution could result in temporary declines of groundwater levels. In contrast to the groundwater levels in much of the North American subbasin that have historically varied, historical groundwater levels underlying Natomas Central MWC boundaries have remained relatively stable. (See North American Groundwater Purchase in this section for more details on regional groundwater levels in the subbasin.) However, a cone of depression near McClellan Air Force Base, four miles east of the southeast corner of Natomas Central MWC, influences groundwater flow in the eastern portion of the service area. Groundwater levels are lowest in the eastern portion of the service area, near the pumping depression, and increase westward towards the Sacramento River. Groundwater level declines, resulting from the droughts in 1976-1977 and 1988-1992, have been followed by recovery for the majority of the service area, with the exception of some wells in the eastern portion of the service area following the 1988-1992 drought. Figure 6-26 shows Natomas Central MWC and groundwater levels from two wells in the eastern portion and western portion of the agency. The highest groundwater levels have been observed along the northern boundary of the Natomas Cross Canal. Because of the aquifer's relatively short recovery period, an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends.

Groundwater substitution involving EWA asset acquisitions could result in temporary drawdown that exceeds historical seasonal fluctuations. Table 6-15 compares the historical fluctuations with the estimated potential drawdown caused by EWA-directed groundwater transfers. Figure 6-26 shows the areas for which the regional declines were estimated. These areas were selected based on the wells previously used for the 2001 Forbearance Agreement transfer.

As shown in Table 6-15, the potential groundwater level decline in Natomas Central MWC, assuming a single year acquisition amount of 15,000 acre-feet, could be 9 feet in addition to typical seasonal fluctuations. If the transfer occurred during a normal year, regional declines would most likely not exceed those typically observed in the semi-confined aquifers during drought years. The likelihood of adverse effects to wells would increase with the amount extracted for the EWA transfer and also would increase during dry years. Shallow domestic wells would be most susceptible to adverse effects. Fifty percent of the domestic wells are 150 feet deep or less (Table 6-16).

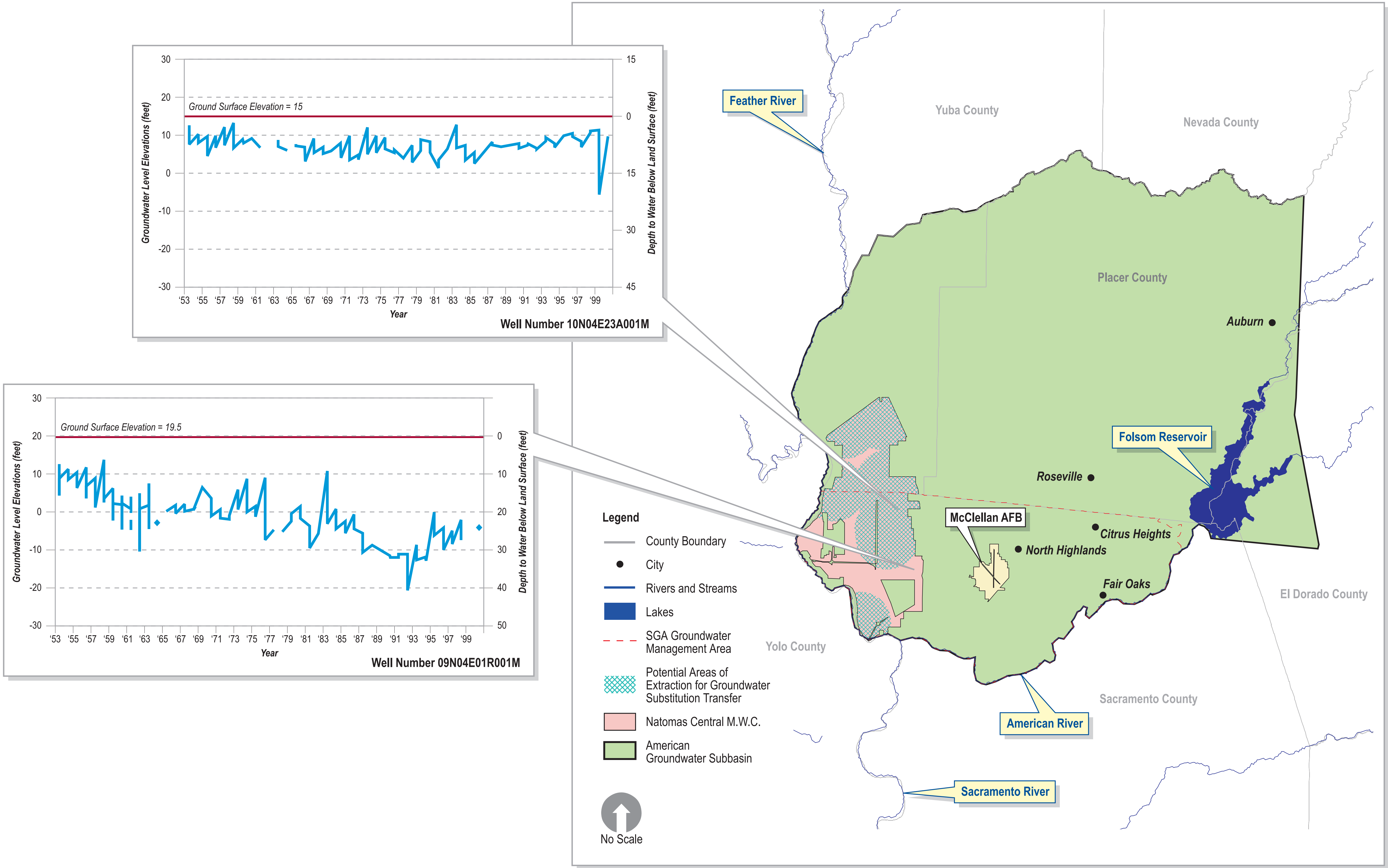

Figure 6-26
Groundwater Levels and Natomas Central M.W.C. in the North American Subbasin

Table 6-15 Flexible Purchase Alternative Estimate of Groundwater Drawdown in Natomas Central MWC	
EWA Acquisition Range	15,000
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition	9 feet
Normal Year Fluctuations	2-6 feet (unconfined) Up to 10 feet (semi-confined)
Fluctuations between drought periods	Up to 10 feet (unconfined) Up to 25 feet (semi-confined)

Source for groundwater fluctuations: (DWR Northern District 2002)

Table 6-16
Natomas Central MWC Well Data

Well	Amount	Average Depth	Depth Distribution
Domestic	125	149	50% - 140 ft depth or less
			20% - 110 ft depth or less
			10% - 100 ft depth or less
Irrigation	94	313	50% - 280ft depth or less
			20 % - 180ft depth or less
			10% - 150 ft depth or less
Municipal	8	308	Not calculated
Industrial	8	378	Not calculated
Other	61	132	Not calculated

Source: Well Completion Reports filed with the DWR (DWR Northern District 2002)

Historically, Natomas Central MWC has relied on surface water diverted from the Sacramento River and consequently, has relatively limited groundwater development. The MWC has used groundwater as a supplement to surface supplies during dry years through the discretion of private landowners. It would be unlikely that EWA-related transfers in the Natomas Central MWC would result in substantial effects to existing wells.

Increased groundwater pumping could cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines could be larger than those indicated in Table 6-15, possibly causing effects to wells within the cone of depression.

Currently, DWR is monitoring groundwater levels in 19 wells throughout the agency (Luhdorff & Scalmanini 2002). EWA groundwater substitution transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, in addition to these monitoring activities, the groundwater mitigation measures specify that Natomas Central MWC establish a monitoring program for EWA-related groundwater substitution transfers. These programs would monitor groundwater level fluctuations within the local pumping area and if effects were shown or reported to be occurring, Natomas Central MWC would implement appropriate mitigation measures. These mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: The Natomas Central MWC has transferred water via groundwater substitution to Westlands WD under the 2001 Forbearance Agreement. The MWC's service area did not experience any significant impacts as a result of the 2001 transfers.

***Interaction with Surface Water**:* Pumping near the Sacramento River, along the western border of the agency, could reduce channel flows and thus adversely affect riparian and aquatic habitats and downstream water users. Furthermore, pumping activities could drain or interrupt the water supply to wetlands in the area and adversely affect wetland habitats.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures involve assessment of measures to avoid and minimize all such potential effects prior to an EWA transfer. Through the Well Review process identified in the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. If date were insufficient to show that pumping would not result in adverse effects, production wells within 2 miles of a surface water body could be required to meet well depth criteria. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review, the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

***Land Subsidence**:* While land subsidence has not been detected within Natomas Central MWC service area, groundwater extraction for EWA asset acquisition could decrease groundwater levels, increasing the potential for local subsidence. Areas of historic subsidence are just west of the service area (Figure 6-9). If transfers under the Flexible Purchase Alternative do not cause the groundwater levels to decline below historical levels, the potential for subsidence would be minimized.

Land subsidence monitoring within the vicinity of the Natomas Central MWC includes one DWR extensometer on the Natomas Cross Canal. Monitoring could be necessary, depending on the hydrology, expected groundwater use for an irrigation season, and the volume of groundwater extracted under the Flexible Purchase Alternative.

EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program to address potential land subsidence effects. The level of monitoring needed to monitor land subsidence may be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality: The migration of reduced quality groundwater and on-farm use of reduced quality water are two types of potential water quality effects associated with increased groundwater withdrawals.

The migration of reduced quality groundwater. Groundwater underlying McClellan Air Force Base east of the Natomas Central MWC is contaminated by organic solvents and is migrating southward, towards the City of Sacramento wells. Remedial measures currently in use include supplying some domestic well users with municipal sources, monitoring, installing physical surface barriers, and groundwater pump and treat systems. There is potential for contamination to migrate into Natomas Central MWC; however, groundwater levels would have to be substantially lowered for several years for this to occur (Luhdorff & Scalmanini 2002).

EWA groundwater substitution transfers could cause potentially significant effects on groundwater quality; however, transfers would be limited to short-term withdrawals during the irrigation season and would most likely not result in substantial groundwater declines. The Well Review stipulated in the groundwater mitigation measures provides further assurances that the potential for reduced groundwater quality migration would be evaluated prior to the transfer, further reducing the likelihood of adverse effects. The mitigation measures would therefore reduce effects to less than significant levels.

On-farm Use of Reduced Quality Water. Potential Natomas Central MWC farmers that may participate in the groundwater substitution transfers could experience changes in water quality as they switch from surface water to groundwater. Elevated levels of TDS, chloride, sodium, bicarbonate, boron, iron, manganese, and arsenic have been detected in the western portions of the agency, west of Highway 99, that could be harmful to some crops. Elevated levels of boron and iron have also been detected near the Sacramento International Airport (Luhdorff & Scalmanini 2002).

The groundwater mitigation measures specify that Natomas Central MWC be responsible for monitoring groundwater quality within the local pumping area and mitigating any adverse effects should they occur; therefore, the mitigation measures would reduce any impacts to less than significant levels.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, in many areas that may participate in the EWA Program, groundwater data indicate that during normal and wet years groundwater levels tend to recover to pre-irrigation levels. During dry years, however, groundwater use is typically increased, and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than during normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels would likely to decline throughout the dry period and then only recover after several normal or wet years. Historical water level data illustrate this trend: groundwater levels tend to recover during normal and wet years, but the likelihood of full recovery decreases during dry years. Therefore, if EWA groundwater transfers were to occur for several consecutive years during a dry period, the transfer could contribute to the groundwater levels declining over a period of several years. Without sufficient wet season recovery, this decline could result in significant impacts.

The EWA's effect on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects would be probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal, then the transfer could commence. All sellers to the EWA Project Agencies should have a monitoring and mitigation program in place that would address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management: Because Natomas Central MWC is a private entity, the agency cannot adopt a formal AB3030 Plan; however, Natomas Central MWC has developed a groundwater management plan (that contains many of the components specified in AB3030) to serve as an "effective equivalent." The overall goal of the plan is to expand the Agency's local groundwater use for agriculture and other users while continuing to use local surface water supplies. Additional goals of the plan are to:
1) continue groundwater development in accordance with the perennial yield,
2) implement conjunctive use that preserves surface water rights and supplies,
3) cooperate with local agencies to find a solution to alleviate the groundwater depression east of the service area, and 4) cooperate in implementing CALFED Regional Partnerships that address the beneficial use of surplus surface water supplies incorporating regional and local transfers. The plan prioritizes the AB3030 elements according to first and second priority (Luhdorff & Scalmanini Consulting Engineers 2002).

Natomas Central MWC is also a signatory of the Water Forum Agreement (WFA), accepting to "endorse and, where appropriate, participate in implementation of the Sacramento North Area Groundwater Management Authority to maintain a North

Area estimated average sustainable yield of 131,000 acre-feet (Water Forum 1999)." (See Local Groundwater Management in the North American Groundwater Purchase in this section for more details.) Natomas Central MWC and the Sacramento Groundwater Authority (SGA) are preparing a Memorandum of Understanding (MOU) regarding the cooperative management of water resources. Components of the management program include 1) development of a groundwater monitoring and data collection system; 2) development of economic incentives and disincentives to encourage, if necessary, the implementation of regional conjunctive use; 3) development of a regional, pilot groundwater banking and exchange/surface water transfer program; 4) coordination of groundwater quality protection; and 5) development of a comprehensive outreach and education program (Luhdorff & Scalmanini 2002).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, Natomas Central MWC would have to implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the North American (River) groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.8) that will reduce these impacts to less than significant.*

North American (River) Groundwater Subbasin Groundwater Purchase

EWA acquisition of American River water in the North American groundwater subbasin via groundwater purchase would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater transfers would most likely be managed by the Sacramento Groundwater Authority (SGA) and concentrated in the City of Sacramento, Fair Oaks Water District, and Citrus Heights Water District.

Groundwater Levels: EWA Project Agency groundwater purchase transfers could result in temporary declines of groundwater levels. Groundwater levels in Sacramento County were relatively stable at an elevation of 30 feet above msl in the 1930s. In the northern third of the subbasin, groundwater pumping resulted in groundwater level declines until the mid-1960s when the Camp Far Reservoir was completed in 1963, supplying surface water (Fielden 2003). In contrast, pumping in the southern portion of the subbasin has increased steadily since the 1970s, causing groundwater levels to generally decrease by about one and one-half feet per year. (This does not pertain to the portion of the subbasin underlying Natomas Central MWC. (See previous section on groundwater levels in Natomas Central MWC for further details.) The greatest declines have been observed in the vicinity of McClellan

Air Force Base (DWR 2002). Groundwater acquired under the Flexible Purchase Alternative would most likely be extracted from wells owned by the City of Sacramento, Fair Oaks WD, and Citrus Heights WD. Figure 6-27 shows representative hydrographs for wells in these areas.

The 131,000 acre-foot sustainable yield noted in the WFA applies to the Sacramento County portion of the North American Subbasin, which is managed by the SGA. As a result of the WFA, groundwater extraction in the SGA's management area are not to exceed the defined sustainable yield, which should maintain groundwater levels above –70 to –80 feet msl (EDAW and SWRI 1999). Any EWA-related groundwater extraction would also be subject to this limit and consequently, EWA transfers could not contribute to the exceedance of the sustainable yield.

Estimates of the potential regional drawdown that could be caused by an EWA groundwater transfer for areas in which groundwater purchases are expected to occur have been made. Figure 6-27 shows the areas for which the regional declines were calculated. These areas were selected based on wells used previously for the 2002 EWA Program transfer. (See discussion below.) This analysis assumes a proportional distribution of pumping according to the amounts transferred to the EWA Program in 2001. Sixty five percent of the potential EWA acquisition of 10,000 acre-feet was allocated to the Citrus Heights and Fair Oaks wells, and the remaining thirty five percent was allocated to the City of Sacramento wells. Declines of 2 and 4 ½ feet were estimated for the City of Sacramento wells and the Citrus Height/Fair Oaks wells, respectively. Adverse effects associated with these regional declines are minimal.

Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, surrounding the pumping wells. These declines could be larger than the regional declines discussed above, possibly causing local effects to wells within the cone of depression.

DWR currently monitors groundwater levels in 53 wells semi-annually and in 7 wells monthly throughout the North American subbasin. Sacramento County also monitors groundwater levels in 17 wells throughout the county (DWR 2002). EWA groundwater purchase transfers could result in groundwater declines in excess of seasonal variation and these effects on groundwater levels could be potentially significant. To reduce these effects, in addition to these monitoring activities, the groundwater mitigation measures specify that the SGA be responsible for establishing a monitoring program that would monitor groundwater level fluctuations within the local pumping area for an EWA transfer and if effects were shown or reported to be occurring, the SGA would implement appropriate mitigation measures. These mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: During the 2002 irrigation season, the SGA provided 7,143 acre-feet of groundwater to the EWA Program via groundwater purchase. This sale was a pilot operation with the option that it could be expanded in the future. The

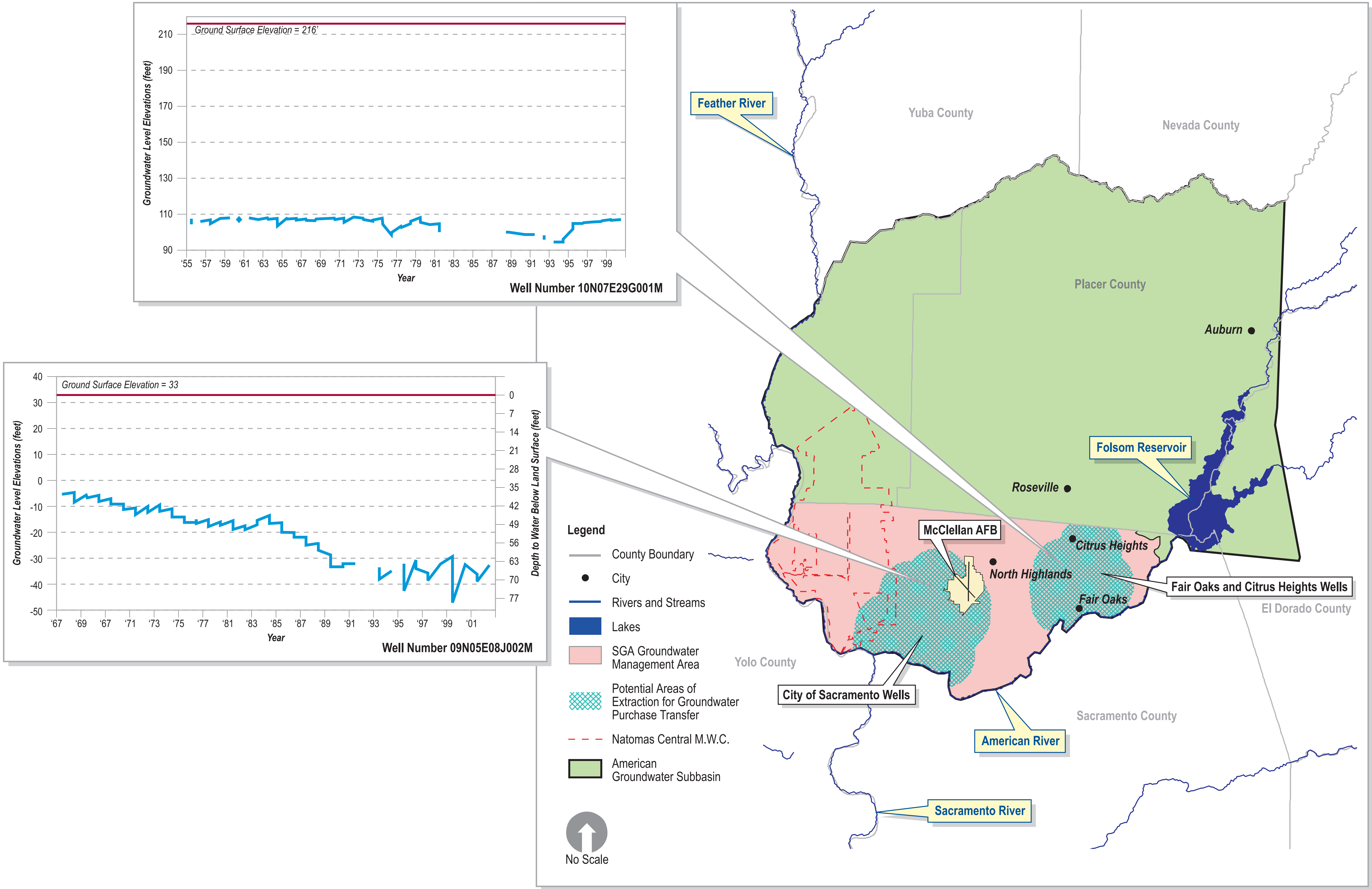

Figure 6-27
Groundwater Levels and Potential Sellers in the SGA Management Area

agencies involved with this transfer included SGA, Citrus Heights WD, Fair Oaks WD, Northridge WD, City of Sacramento, and San Juan WD. Citrus Heights and Fair Oaks agreed to use 4,646 acre-feet of groundwater in their service areas in-lieu of treated surface water from San Juan WD. This permitted San Juan WD to reduce its surface water diversion from Folsom Lake, allowing surplus water to be transferred to the EWA. Northridge WD accounted for the delivery of surface water in lieu of the extraction of groundwater by Citrus Heights WD and Fair Oaks WD, negating any effects to the groundwater basin underlying Sacramento County north of the American River. The City of Sacramento also agreed to use 2,497 acre-feet of groundwater in lieu of receiving surface water diversion from the American River. The 2,497 acre-foot of surface water remaining in the American River was transferred to the EWA Project Agencies. The City of Sacramento accounted for the delivery of 2,497 acre-feet of surface water from an alternative water source in lieu of extracting groundwater, thus negating any potential groundwater impacts.

Interaction with Surface Water: Pumping near the American River along the southern border of the North American subbasin and close to its tributaries could reduce channel flows and thus adversely affect riparian and aquatic habitats and downstream water users. Furthermore, pumping activities could drain or interrupt wetland habitats in the close vicinity of pumping.

Groundwater pumping for EWA groundwater purchase transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures require assessment of measures to avoid and minimize all potential effects prior to an EWA transfer. Through the Well Review process of the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. Production wells within 2 miles of a surface water body would need to meet well depth criteria if data were insufficient to show that pumping would not result in adverse effects. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, to avoid hydraulic interaction between pumping and overlying surface water systems.

In addition to the well review, the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land Subsidence: Groundwater extraction for the EWA asset acquisition could decrease groundwater levels, increasing the potential for local subsidence. Minor subsidence of up to 0.4 foot occurred in SGA's management area between 1912 and the 1960s (EDAW and SWRI 1999). These historical data, in addition to projected groundwater extraction, do not indicate the likelihood of any substantial subsidence from groundwater pumping in the future. As discussed under Local Groundwater Management below, the WFA's sustainable yield results in a stabilized groundwater level of approximately –83 feet msl with a range of –70 to –87 feet msl. As part of the WFA EIS/EIR, potential subsidence was evaluated assuming that groundwater level declines would not exceed levels stipulated by the WFA. The WFA used the Integrated Groundwater-Surface Water Model (IGSM) to model subsidence. The model indicated that an additional 0.35 foot of subsidence over several decades was possible, assuming the ratio of about 0.02 foot of subsidence per foot of groundwater level decline (EDAW and SWRI 1999). As long as transfers under the Flexible Purchase Alternative do not cause the groundwater to decline below the target groundwater level proposed by the WFA, substantial subsidence would not be expected.

Land subsidence monitoring within the vicinity of the SGA service area includes one DWR extensometer on the Natomas Cross Canal at the border of Natomas Central MWC. Additional monitoring may be necessary, depending on the hydrology, expected groundwater use, and the extraction SGA plans to pump.

EWA groundwater purchase transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place that would address potential land subsidence effects. The level of monitoring needed to monitor land subsidence may be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce these effects to less than significant levels.

Groundwater Quality: Groundwater withdrawals under the Flexible Purchase Alternative could induce the migration of reduced quality groundwater into previously unaffected areas. Groundwater is generally of good quality; however, there are areas of concern. Reduced quality water at several well sites has caused the wells to be shut down. Elevated levels of TDS, chloride, sodium, bicarbonate, boron, fluoride, nitrate, iron manganese, and arsenic have been detected in localized areas. Contaminated sites in the area include an abandoned Pacific Gas and Electric (PG&E) site adjacent to the Sacramento River near Old Sacramento, the Union Pacific Railroad yards in downtown Sacramento and in the City of Roseville (EDAW and SWRI 1999), and a TCE plume in Fair Oaks WD. Contaminants underlying McClellan Air Force Base have migrated south, toward the City of Sacramento wells. Remedial measures implemented include supplying some domestic well users with municipal water sources, groundwater monitoring, installing physical surface barriers in one location, and extracting and treating groundwater (Luhdorff & Scalmanini 2002).

EWA groundwater substitution transfers could cause potentially significant effects on groundwater quality; however, inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction is anticipated to be limited to short-term withdrawals, and EWA extraction that could potentially induce the migration of reduced quality groundwater would be avoided through the groundwater mitigation measures Well Review (See Section 6.2.7.2 for more details.) These mitigation measures would reduce effects to less than significant levels.

The Department of Health Service monitors water quality in 339 wells throughout the North American subbasin, and the DWR monitors groundwater quality in 32 wells (DWR 2002). No significant impact related to the use of reduced quality water would be likely; however, the mitigation measures would reduce any such impacts to less than significant levels. To reduce these impacts, in addition to this monitoring, the groundwater mitigation measures specify that SGA's monitoring program for an EWA groundwater purchase transfer would monitor groundwater quality within the local pumping area. If there were to be unanticipated adverse groundwater quality effects as a result of the transfer, the groundwater mitigation measures specify that SGA would be responsible for mitigation of any adverse effects.

Multi-Year Acquisition and Purchase During Dry Years: As discussed above, during dry years, groundwater use increases and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than in normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels are likely to continue to decline until a wet period enables groundwater levels to recover. In addition, groundwater levels may not fully recover from a preceding year's transfer. (As previously mentioned, this occurred in portions of the North Yuba subbasin in the 1991 State Drought Water Bank Transfer). Groundwater transfers over several consecutive years may increase the potential for adverse effects by causing net groundwater levels to decline.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects , local management and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal, then the transfer could commence. All sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects should they occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management: In 1991, the Sacramento City-County Office of Metropolitan Water Planning was formed to develop a regional water plan for the

Sacramento area. Six years of negotiations among many participant stakeholders led to the WFA adopted in 1998. The agreement consists of seven major elements designed to meet the following overall objective: "Provide a reliable and safe water supply for the region's economic health and planned development to the year 2030; and preserve the fishery, wildlife, recreational, and aesthetic values of the Lower American River." The WFA's Groundwater Element encourages the management of the limited groundwater resources in three hydrogeologic areas within Sacramento County (Water Forum 1999). The WFA area that could be affected by EWA actions includes only the "North Area," bounded on the north and east by the Sacramento County line, by the Sacramento River on the west, and by the American River on the south (Figure 6-27). Two of the major outcomes of this agreement are a recommended sustainable yield of 131,000 acre-feet for the North Area and the formation of the SGA and the American River Basin Cooperating Agencies (ARBCA) (Water Forum 1999). The paragraphs below provide additional information on the SGA and ARBCA and on the American River Basin Regional Conjunctive Use Program and Natomas Central MWC.

Sacramento Groundwater Authority: SGA is a joint powers authority that was established in 1998 to manage and protect the North Area in Sacramento County (See Figure 6-27 for the location of the North Area.) SGA's 16 member board of directors is comprised of representatives from the overlying water purveyors in the basin along with an individual representative from agriculture and an individual representative from self-supplied groundwater users (mostly parks and recreational districts).

SGA member agencies serve the needs of over 500,000 people in the Sacramento area. Current water deliveries total about 300,000 acre-feet per year, with about one-third of this from groundwater pumping and the remaining amount from surface water deliveries from the American and Sacramento Rivers. Over 70 percent of the deliveries are for municipal and industrial supplies, and about 30 percent to agriculture in the western portion of the service area.

SGA's primary mission is to protect the basin's safe yield, defined in the WFA, and water quality. Additional goals and objectives include: 1) Develop/facilitate a regional conjunctive use program consistent with the WFA. The basin has approximately 600,000 acre-feet of evacuated storage that could be exercised in such a program. The ultimate potential wet year in-lieu banking potential is about 100,000 acre-feet per year, with a potential dry year surface water exchange potential of over 50,000 per year. In the near-term (2005), facility improvements are under construction (with assistance from a $22 million Proposition 13 grant) to produce 25,000 acre-feet of dry-year surface water yield available for exchange with American River (or downstream) users; 2) mitigate conditions of regional groundwater overdraft; 3) replenish groundwater extraction; 4) mitigate groundwater contaminant migration; 5) monitor groundwater elevations and quality; and 6) develop relationships with State and Federal Agencies.

American River Basin Cooperating Agency: ARBCA was formed in 1997 to develop a regional partnership for water resources planning and conjunctive use and to develop a Regional Water Master Plan on a cooperative basis. ARBCA membership includes the SGA, water purveyors from Sacramento County, the City of Roseville, and Placer County. An SGA/ARBCA partnership is developing a regional groundwater management plan that incorporates both the Water Forum Plan and the Regional Water Master Plan (Thomas 2001).

American River Basin Regional Conjunctive Use Program: A partnership between SGA and ARBCA resulted in the American River Basin Regional Conjunctive Use Program. An outcome of the WFA, this Program intends to assist in meeting the WFA objectives, discussed above, by using the overdrafted basin in the North Area for groundwater banking. Groundwater recharge consists of either direct recharge using surface water from the American River and/or Sacramento River, or, in lieu of recharge, application of surface water substituted for groundwater. During the "exchange cycle," (groundwater substitution) the banked groundwater is substituted for surface water, allowing the surface water to remain in reservoirs. This additional reservoir water helps maintain the WFA American River flow standards for environmental purposes. The project could bank up to 40,200 acre-feet of groundwater in wet years and recover up to 25,000 acre-feet of banked water for the surface water exchange in dry years. The average annual yield is expected to be about 21,400 acre-feet per year (SGA 2001).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the transfers discussed above to occur, SGA would have to implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater purchase transfers in the North American (River) groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers would be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that would reduce these impacts to less than significant.*

6.2.4.1.3 North San Joaquin Groundwater Basin

<u>North San Joaquin Groundwater Basin Crop Idling</u>

EWA acquisition of water via the idling of cotton crops would decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

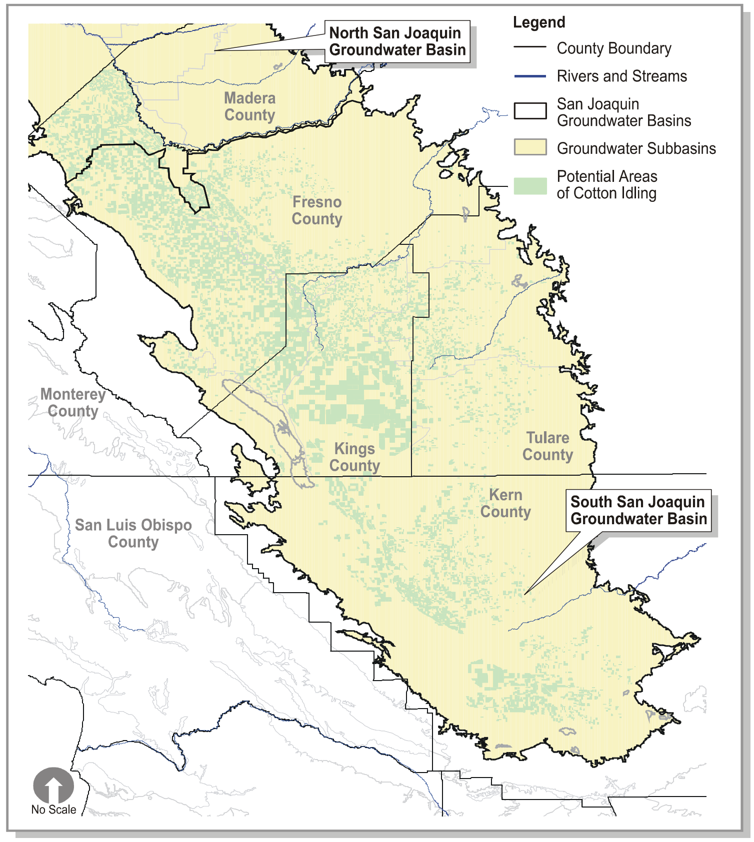

Figure 6-28
Potential Areas of Cotton Idling in the San Joaquin Valley

Figure 6-28 shows the areas that could be idled in both the North San Joaquin and South San Joaquin Groundwater Basins. Possible adverse effects resulting from decline of groundwater levels are not expected to be potentially significant given that:

- Groundwater level declines would be negligible relative to the substantial historical groundwater level fluctuations that have occurred in the North and South San Joaquin Groundwater Basins over the past century. A five-year CVPIA Land Retirement Program Demonstration Project, on 7,000 acres in Westlands WD, is investigating the how land idling would affect local drainage. Water level data from the first 15 months of the study indicated that local groundwater level declines (mainly attributed to the reduction in applied recharge) ranged from only 2.4 to 3.8 feet in the shallow aquifer (Westlands WD 2000).

- Many water users in the study area rely on surface water rather than groundwater and would not be affected by groundwater level declines. The study area overlies the Corcoran Clay, in which groundwater development in the shallow aquifer is not as extensive as in the deep aquifer, because of reduced water quality and lower well yields. Two thirds of the groundwater in the Tulare Basin WSD cannot be produced economically due to reduced water quality and poor well yields (Tulare Lake WSD 1981).

- According to State Water Code Section 1745.05, crop idling transfers are limited to 20 percent of the amount of water that would have been applied in an agency for a given hydrologic year. This State Code further minimizes the potential for adverse regional effects by placing a limit on the applied water reduction. A reduction in applied recharge as a result of idling cotton fields could have an effect on groundwater recharge and levels. However, the action of crop idling of cotton fields would not substantially reduce the percentage of applied water that recharges the underlying basin.

The potential for reduction in groundwater recharge associated with the idling of cotton in the North and South San Joaquin Groundwater Basins would be less than significant.

<u>Merced River Contractor Groundwater Substitution</u>

EWA acquisition of Merced River Contractor water via groundwater substitution would affect groundwater hydrology. Specific potential effects would be decline in groundwater levels, decrease of water levels in neighboring surface water channels including the Merced River, increased potential for land subsidence, and degradation of groundwater quality.

Groundwater Levels: Acquisition of EWA Assets through groundwater substitution could result in temporary local declines in groundwater levels. In the Merced subbasin, groundwater levels declined by almost 30 feet from 1970 to 2000, yet increased after wet years in the late 1990s and early 2000s (DWR 2002). The greatest declines were in the southeastern, central, and northern portions of the subbasin, with the two largest cones of depression 13 miles southeast of Merced in the Le Grand-Athlone area and 17 miles northwest of Merced (MCDEH 1997). Figure 6-29 shows hydrographs of the groundwater fluctuations in these areas.

It has been estimated that the Merced groundwater subbasin is overdrafted by an average of 20,000 acre-feet per year (MCDEH 1997). This value does not readily reflect the recent change in conditions (that occurred for several years prior to 2001) that resulted in lower volumes of pumping Recently, groundwater levels have increased after several consecutive wet years (CH2M Hill 2001[b]). Since 1993, projects encouraging water conservation and in-lieu recharge have reduced the amount of groundwater Merced ID pumps and delivers to the highland areas (higher elevation areas that have historically relied solely on groundwater) from the average 27,000 acre-feet to 9,000 acre-feet, creating over 140,000 acre-feet of in-lieu recharge. These projects, in addition to Merced ID's own operational changes and conservation practices, have resulted in a total in-lieu recharge exceeding 200,000 acre-feet as of September 2001. Merced ID plans to continue these water conservation and in-lieu recharge efforts as reflected in the Merced Water Supply Update Status Report (Merced ID 2002). Because of these efforts, an EWA transfer would likely have a minimal effect on long-term groundwater level trends.

Estimates of the potential drawdown for the Merced ID resulting from an EWA agency-directed groundwater transfer have been made. Since pumping would occur throughout the agency, the entire agency service area was used to estimate a regional decline of 2 feet, assuming a maximum purchase of 25,000 acre-feet (given in Table 2-5).

Increased groundwater pumping could cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines could be larger than that indicated by the regional estimate, possibly causing effects to wells within the cone of depression. In general, groundwater supplements surface water for irrigation in this area, and represents about 51 percent of total applied water in the Merced subbasin (MCDEH 1997). Municipalities within the agency borders, of which the City of Merced is the largest, rely solely on groundwater (Merced ID 1996).

Neighboring agencies and extensive agricultural areas outside Merced ID borders also rely on groundwater. Potential adverse effects to areas relying solely on groundwater could be avoided through the Well Review process stipulated by the groundwater mitigation measures.

DWR and cooperators monitor groundwater levels in Merced subbasin semi-annually in 378 wells (DWR 2002). EWA groundwater substitution transfers could results in groundwater declines in excess of seasonal variation and these effect on groundwater levels could be potentially significant. In addition to this monitoring, the groundwater mitigation measures specify that Merced ID establish a program to monitor groundwater levels for any EWA groundwater purchase transfer. The program would monitor groundwater level fluctuations within the local pumping area and if impacts were shown or reported to be occurring, Merced ID would implement appropriate mitigation measures. These mitigation measures would reduce effects to less than significant levels.

Past Groundwater Transfers: In 2001, Merced ID conducted an investigation to assess the potential effect of transferring 25,000 acre-feet of groundwater to the EWA Program. This included a review of the historical groundwater levels and groundwater development, review of the current groundwater management plan and recent management activities, a well review, and an evaluation of groundwater modeling data. The investigation concluded that a transfer in 2001 would not result in significant impacts, and made the following observations:

- Although groundwater levels decreased during the drought in the late 1980s, the levels have increased or stabilized since the mid-1990s. The overdraft of 20,000 acre-feet is based on average conditions that do not reflect the lower volumes of pumping that had occurred for several years prior to the 2001 EWA Program transfer (CH2M HILL 2001[b]).

- Calculations prior to the transfer indicated that an additional pumping of 25,000 acre-feet for the 2001 EWA Program would only increase Merced ID's total 2001 annual pumping amount to 33,000 acre-feet, which is below its annual average extraction of 56,000 acre-feet (CH2M HILL 2001[b]).

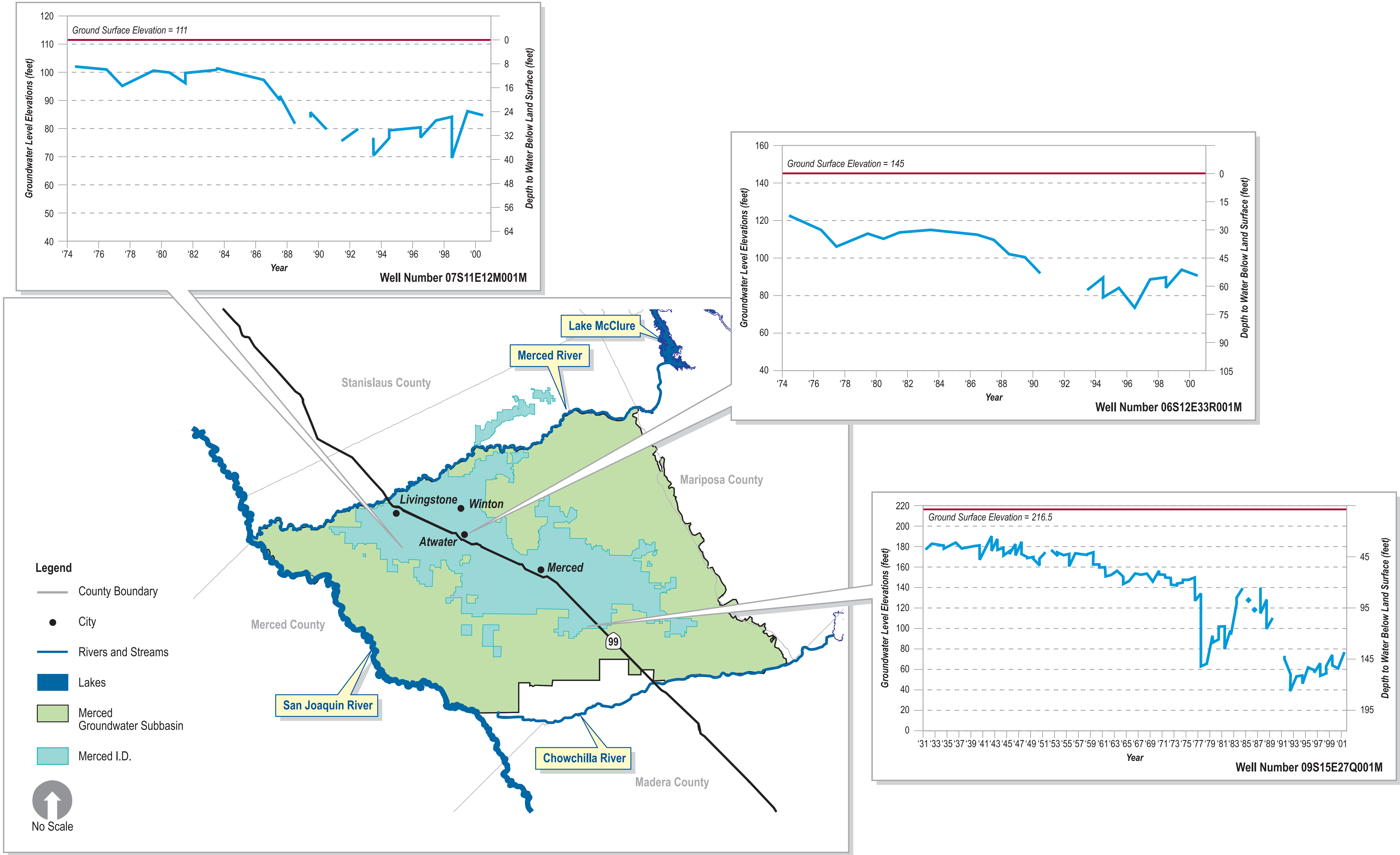

Figure 6-29
Groundwater Levels and Merced I.D. in the Merced Subbasin

- As discussed above, Merced ID implemented a series of ongoing projects intended to protect the underlying groundwater basin. An important component of Merced ID's Management Plan is the construction of additional recharge facilities. The groundwater transfer to the EWA would facilitate a phased test of Merced ID's pumping capacity and local effects on groundwater. This information would not only provide well drawdown data, but would also be useful in determining the locations of future groundwater recharge facilities (Merced ID 2001).

- All wells proposed for the transfer were reviewed. The proposed wells included about one half of the wells normally used to pump groundwater into Merced ID's surface water distribution system. The transfer was for a 60 to 75 day period, in which the active wells were spread throughout the service area, minimizing the potential for concentrated effects. Some of the wells operated full time, while the others operated 50 to 75 percent of the time (Merced ID 2001).

Although these observations are useful when considering the likelihood of effects for future transfers, hydrology, groundwater extraction, and many other variables would vary from year to year. The groundwater mitigation measures provide assurances that a well review and a monitoring and mitigation program would be established prior to every EWA transfer to address adverse effects.

Interaction with Surface Water: Pumping near the Merced River, along the northern border of the subbasin, could reduce channel flows. This could adversely affect riparian and aquatic habitats and downstream water users. Furthermore, wetlands occur throughout the Merced subbasin and pumping activities could drain or interrupt the wetlands' water supply, thus adversely affecting these habitats.

The Merced River appears to be gaining groundwater west of Highway 99, but east of the highway the river appears to be losing water to a cone of depression 17 miles northwest of Merced (MCDEH 1997). Prior to the 2001 EWA transfer, a groundwater-surface water model developed for the Water Supply Plan Update assessed the potential groundwater effects. The model results showed that the maximum rate of net groundwater discharge to the Merced River was about 65 cfs, occurring in 1970, and the maximum rate of seepage from the river was about 18 cfs in 1992 (Merced 2001). These rates are relatively small compared to the average 1992 flow in the channel of 642 cfs, measured just below Merced Falls Dam (USGS 2002). Furthermore, the wells proposed for the EWA transfer in 2001 were chosen a sufficient distance away from the river to avoid groundwater/surface water interaction effects (Merced ID 2001). Consequently, the study concluded that adverse effects to the Merced River, in response to groundwater pumping, would be minimal.

Groundwater pumping for EWA groundwater substitution transfers could reduce flows in nearby surface water bodies and these effects could be potentially significant. To reduce these effects, the groundwater mitigation measures would involve assessment of measures to avoid and minimize all potential effects prior to an EWA transfer. Through the Well Review process identified in the groundwater mitigation measures, the purchasing agency would review the location and screened interval of the proposed production wells. Production wells within 2 miles of a surface water body could need to meet well depth criteria if data were insufficient to show that pumping would not result in adverse effects. Furthermore, the Well Review may determine that pumping activities should be limited to a specified depth in some areas, in order to avoid hydraulic interaction between pumping and overlying surface water systems. In addition to the well review, , the groundwater mitigation measures provide guidance for the establishment of a local monitoring and mitigation program, designed to identify and mitigate local impacts. These mitigation measures would reduce effects to less than significant levels.

Land subsidence*:* An EWA groundwater substitution transfer could contribute to land subsidence if groundwater level declines were to exceed historical levels; however, declines are expected to be minimal. Currently, Merced ID relies on field inspection at the wellheads by local maintenance crews and on information from adjacent water users for information concerning land subsidence (Selb 2002). No subsidence has been observed and as previously discussed, Merced ID is implementing a variety of measures intended to minimize groundwater declines, thus reducing the potential for future land subsidence.

Additional monitoring may be necessary, depending on the hydrology, expected groundwater use, and the extraction Merced ID plans to pump under the Flexible Purchase Alternative. EWA groundwater substitution transfers could decrease groundwater levels that could cause potentially significant effects on land subsidence. To reduce these effects, the groundwater mitigation measures stipulate that all sellers to the EWA Project Agencies have a monitoring and mitigation program in place to address potential land subsidence effects. The level of monitoring for land subsidence may be negotiated between the Review Team and the selling agency prior to the transfer. These mitigation measures would reduce effects to less than significant levels.

Groundwater Quality*:* The migration of reduced quality groundwater and the distribution of reduced quality groundwater are the two types of potential water quality effects associated with increased groundwater withdrawals related to EWA asset acquisition from the Merced ID.

The Migration of Reduced Groundwater Quality: Groundwater quality in Merced ID is generally good, with TDS concentrations ranging from 200-400 mg/L Elevated levels of hardness, iron, nitrate, and chloride occur in localized areas through the subbasin (DWR 2002). Inducing the movement or migration of reduced quality water into previously unaffected areas through groundwater pumping is not likely to be a concern unless groundwater levels and/or flow patterns are substantially altered for a long period of time. EWA groundwater extraction is anticipated to be limited to short-term withdrawals during the irrigation season and EWA extraction near areas of reduced groundwater quality concern would be avoided through the groundwater mitigation measures Well Review (See Section 6.2.7.2 for more details.) Consequently, adverse effects from the migration of reduced groundwater quality would be minimal.

Distribution of Reduced Quality Water: Groundwater extracted for an EWA transfer may be of reduced quality relative to the surface supply allotment the agency normally receives. However, because groundwater is generally of good quality, potential regional impacts would be minimal. Therefore, no significant impacts related to the distribution of reduced quality water would be likely.

Merced ID has monitored groundwater pumping monthly since 1943 in a network of monitoring wells and began monitoring water levels at the beginning and end of the irrigation season in its production wells in 1959 (MID 1996). Currently, the district measures 196 active wells and other shallow monitoring wells in areas of high or perched groundwater on a monthly basis. In addition, the City of Merced monitors groundwater quality from the water supply wells. The Merced County Division of Environmental Health also monitors individual domestic wells (MCDEH 1997).

Additional assurances are provided by the groundwater mitigation measures that specify that Merced ID have a monitoring and mitigation program in place that addresses potential adverse groundwater effects. If adverse effects to groundwater quality as a result of a transfer were to occur, the groundwater mitigation measures further specify that Merced ID mitigate any impacts.

Multi-Year Acquisition and Purchase During Dry Years: During dry years, groundwater use increases and percolation from natural runoff is often lower than normal, causing groundwater levels to decline more than during normal and wet years. Furthermore, when dry years occur consecutively, groundwater levels are likely to continue to decline until a wet period occurs when groundwater levels may recover. In addition, groundwater levels may not fully recover from a preceding year's transfer. Groundwater transfers over several consecutive years may increase the potential for adverse effects by causing net groundwater levels declines.

The EWA's effects on groundwater levels during multi-year transfers or during dry years could be potentially significant. To reduce these effects, local groundwater management and the groundwater mitigation measures provide guidelines to evaluate groundwater levels prior to each EWA transfer. If groundwater levels prior to a proposed purchase were low relative to previous years, a pre-purchase evaluation would be performed to evaluate regional groundwater levels and potential drawdown. (See Section 6.2.7.2 for further details.) If the Review Team concluded that significant regional effects were probable, the EWA Project Agencies would not purchase water via groundwater substitution for the given hydrologic year, or they would request changes in the transfer mechanisms from the willing sellers. In contrast, if the Review Team concluded that the likelihood of regional effects would be minimal, then the transfer could commence. The groundwater mitigation measures further stipulate that all sellers to the EWA Project Agencies should have a monitoring and mitigation program in place to address adverse effects if they should occur. These mitigation measures would reduce effects to less than significant levels.

Local Groundwater Management: The City of Merced and the Merced ID developed a water supply plan during 1995 that was subsequently updated in 2001. This plan incorporated a variety of strategies, planning scenarios, and groundwater and strategic modeling tools to recommend a set of immediate actions to meet the water demands through the year 2030. These actions include additional groundwater recharge facilities, groundwater to surface water irrigation conversion, the repair and maintenance of existing facilities, technology enhancements, and various irrigation efficiency programs (CH2M Hill 2001, MID 2001).

Merced ID and the surrounding water agencies in the Merced subbasin have also developed AB3030 Groundwater Management Plans (Table 6-2 shows the components included in the plans). The goal of Merced ID's 1996 Groundwater Management Plan is to maintain the long-term average groundwater level at 1990 levels while meeting the region's water demand. To achieve this goal, Merced ID would vary operations depending on conjunctive use capabilities in local areas, local water needs, and the desired groundwater level. The District's General Manager implements and manages the Plan in accordance with the Board of Directors. The Plan covers Merced ID's service area south of the Merced River. The Turlock ID Groundwater Management Plan, adopted in 1993, covers the service area north of the Merced River. In 1997, the Merced Area Groundwater Pool Interests developed the Merced Groundwater Basin Groundwater Management Plan, which covers the entire Merced ID service area and neighboring water users within the subbasin. Pursuant to the AB3030 Water Code, both groundwater management plans include provisions for coordination between the two plans (MID 1996).

In addition to the local management efforts described above, the EWA Project Agencies would not purchase water from a district unless the district had successfully complied with the groundwater mitigation measures. Therefore, for the transfers discussed above to occur, Merced ID should determine whether a pre-purchase evaluation is necessary and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers of Merced River Contractor groundwater in the North San Joaquin groundwater basin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

6.2.4.2 Export Service Area

EWA acquisitions that could affect groundwater resources in the Export Service Area include crop idling, groundwater purchase, and groundwater storage. The effects associated with these acquisitions include groundwater level declines, alteration of surface and groundwater hydrology, land subsidence, and changes in groundwater quality. This discussion covers potential effects as a result of crop idling at a regional scale and groundwater substitution and groundwater purchase at a local scale.

6.2.4.2.1 South San Joaquin Groundwater Basin Crop Idling

EWA acquisition of water via cotton crop idling would decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

Figure 6-28 shows the areas that could be idled in both the North San Joaquin and South San Joaquin Groundwater Basins. Adverse effects resulting from decrease of groundwater recharge are expected to be less than significant. Section 6.2.4.1.3, North San Joaquin Groundwater Basin Crop Idling, discusses this conclusion in more detail.

6.2.4.2.2 South San Joaquin Groundwater Basin Banked Groundwater

EWA acquisition of banked groundwater from potential water bank participating agencies in Kern County, via groundwater purchase and recovery through direct extraction from the banking facilities, could decrease groundwater levels. Specific potential effects would be declines in groundwater levels, increased potential for land subsidence, degradation of groundwater quality, and the reduction of groundwater available for future transfers.

There are two recovery methods for the acquisition of banked groundwater in Kern County: exchange and direct pumpback recovery. During an exchange recovery, Kern County WA exchanges water from the SWP stored in San Luis Reservoir for banked groundwater. Water is released from the San Luis reservoir, while the banked groundwater physically remains in storage and is reaccredited as water from the SWP. During a direct pumpback recovery, groundwater is directly extracted from the banking facility and conveyed into the California Aqueduct for the EWA asset management (Bucher 2002).

Groundwater Levels*:* Groundwater in the South San Joaquin Groundwater Basin has historically been used heavily, and excessive groundwater withdrawals have caused substantial declines in groundwater levels. Figure 6-30 shows the groundwater levels of wells in Semitropic WSD, Arvin-Edison WSD, and Kern Fan Element Banking facilities. As shown, groundwater levels have substantially increased relative to pre-project groundwater levels in these banks.

EWA groundwater purchase and direct extraction from these banking facilities could result in declines of groundwater levels; however, the levels would generally remain higher than they would have been absent the banks. In contrast to the affected subbasins discussed previously, no estimated groundwater declines exist for this region. Groundwater banking agencies have policies that do not allow greater extraction of groundwater than the project has banked. Banking participants have signed MOUs and Agreements to monitor and regulate these declines. Table 6-17 lists the MOUs, Agreements, and environmental documents that have been developed for each bank that may provide water to the EWA Project Agencies.

Table 6-17
Documents Pertaining to Banking Operations, Monitoring, and Mitigation

Groundwater Bank	Agreements/MOUs/Plans	Environmental Documents
Kern Water Bank	• MOU Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program, Oct 1995 • Joint Powers Agreement for the KWB Authority, Oct 1995. • • Proposed Monitoring Plan for the Kern Fan Element of the KWB, 1995 • Standard Scheduling and Payment Provisions for Banking and Recharge Projects, Feb 1997	• Final EIR, Artificial Recharge, Storage and Overdraft Correction Program, Dec 1986. • Monterey Addendum which includes Volume IV (NEPA/CEQA) of the KWB Habitat Conservation Plan (HCP) Oct 1997
Pioneer Groundwater Recharge and Recovery Project	• MOU Regarding Principles Governing Implementation of the Pioneer Project, Dec 1995 • Pioneer Project Joint Operating Agreement, Oct 1996 • Agreement with COB on the Coordinated Operation of Recharge and Recovery Project located on the Kern River Fan, Dec 1996 • The Pioneer Project Participation Agreement, May 1998 • Proposed Monitoring Plan for the Kern Fan Element of the KWB, 1995 • Standard Scheduling and Payment Provisions for Banking and Recharge Projects, Feb 1997	• Negative Declaration for the Pioneer Groundwater Recharge and Recovery Project, November 1996
Berrenda Mesa Project	• Agreement Regarding Joint Water Banking Project on the Berrenda Mesa Property, Oct 1999 • MOU Between Berrenda Mesa WD and Kern County WA for Developing and Operating a Joint Water, Aug 1992Recharge/Recovery Project, Aug 1992 • Proposed Monitoring Plan for the Kern Fan Element of the KWB, 1995 • Standard Scheduling and Payment Provisions for Banking and Recharge Projects, Feb 1997	
Semitropic Groundwater Banking Project	• MOU between Semitropic WSD and the Adjoining Entities, Sep 1994	• Stored Recovery Unit Final Supplemental EIR – Findings and Mitigation Monitoring Plant, Jan 2000 • Stored Recovery Unit Final Supplemental EIR, Jan 2000 • Semitropic WSD. Semitropic Groundwater Banking Project Draft EIR, Mar 1994
Arvin-Edison	• Agreement Between Arvin-Edison WSD and MWD of Southern California for a Water Management Program, Dec 1997	• EIS for MWD and Arvin Agreement

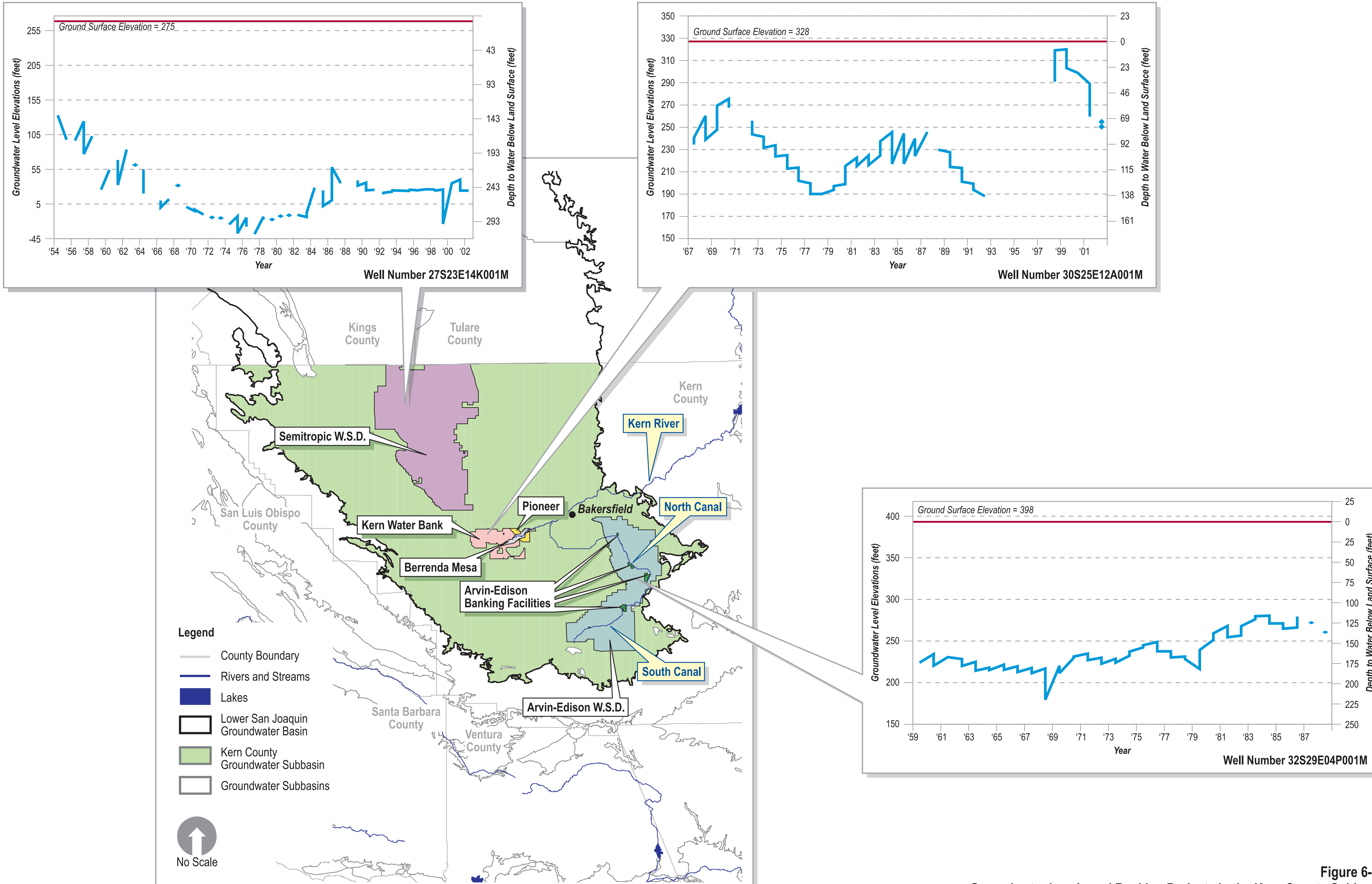

Figure 6-30
Groundwater Levels and Banking Projects in the Kern County Subbasin

The following paragraphs describe groundwater level monitoring activities within the banks.

Kern Fan Element: The "MOU Regarding Operation and Monitoring of the Kern Water Bank Groundwater Banking Program" (Monitoring MOU), applies to the Pioneer, Berrenda Mesa, and KWB projects within the KWB Fan Element. According to this memorandum, all disputes must be submitted initially to the Monitoring Committee for review. Following a technical evaluation, the Monitoring Committee is to offer a fair resolution. This resolution may entail operational changes and/or mitigation measures. The Monitoring MOU also provides a list of suggested mitigation measures that may be implemented to address adverse effects (KCWA 1995a).

In 2001, a relatively high amount of groundwater was recovered from the Kern Fan groundwater banking projects. An operator of a well field near the Kern Fan Element expressed concern to the Monitoring Committee about the relatively large drawdown that was occurring within proximity to the subject's well field. The Monitoring Committee consulted with a professional hydrogeologist who, following a technical review, concluded that the subject's well field would not be adversely affected if pumping from the groundwater banks continued. Following this review, additional monitoring was conducted in the area as a precautionary measure. The monitoring results verified that the well field was not at risk from the Kern Fan groundwater banking extraction (Iger 2002).

Semitropic WSD: In addition to the agreements in Table 6-17, Semitropic WSD has established a "15-foot, three year rule" that applies to the existing banking facilities and the proposed new well field. This rule states: "withdrawals would be stopped or modified at specific locations if such withdrawals would cause the average groundwater level over a 3-year period to be 15 feet less than what the average would have been without the Project over the same 3-year period" (Semitropic WSD 1994a). Semitropic WSD has installed additional wells to monitor groundwater levels and quality and to identify effects if they occur (Semitropic WSD 1994a).

Arvin-Edison WSD: Direct extraction of the purchased banked water from the Arvin-Edison Banking facilities must adhere to the "Agreement Between Arvin-Edison WSD and MWD for a Water Management Program." This agreement specifies a set of operational parameters agreed upon by local landowners and the neighboring district, Kern-Delta WD. These parameters are designed to avoid effects to purveyors within the Arvin-Edison District and to Kern-Delta WD. Arvin-Edison WSD monitoring includes monthly measurement of water levels from 72 monitoring wells during recovery operations, semi-annual groundwater level surveys district wide, and a district wide annual hydrologic inventory that includes a water level survey (Lewis 2002).

The MOUs, Agreements, and monitoring programs developed by these banks provide assurances that Kern County WA and/or the participating banking agencies have a sufficient level of monitoring and management to address effects if they occur. Kern County WA and/or the participating Kern County WA banking agencies are responsible for implementing mitigation measures. Such mitigation measures would reduce any effects to less than significant.

Water Transfer History with the EWA Program: Kern County WA has participated in a number of transfers. Because of the large number and complexity of these past transfers, this document focuses on the transfers conducted within the EWA Program in 2000 and 2001.

The Monterey Amendment[16] to the SWP contracts has increased water management flexibility for SWP contractors, improving their ability to manage their groundwater resources. However, all EWA acquisitions from member districts of Kern County WA must be approved by Kern County WA. For transactions involving banked SWP water, SWP contracts prohibit the sale of banked SWP water. CVP contracts also place limitations on potential sales of Friant-Kern CVP water. A place-of-use restriction requires the use of banked Friant-Kern groundwater to be within county limits. Consequently, these agreements legally limit the classification of water that may be sold to the EWA Project Agencies. Current Kern County WA policy and SWP contracts place limitations on the sale of banked SWP water, and CVP contracts place further limitations on potential sales of Friant-Kern CVP water.

To establish the EWA Program, the DWR and Kern County WA made an exception to this policy during the initial operating years of the EWA in 2000 and 2001. Water from the SWP, banked in the hydrologic years of 1995-1999, was sold to the EWA Project Agencies. The rationale for using the 1995-1999 years was that these were wet years, and a surplus of water was available. All of the Kern Water Bank member agencies either used and/or stored their entire SWP allocations, continually recharging the underlying groundwater basin. The sale of 1995-1999 water from the SWP may continue until all supplies have either been used or sold to the EWA Project Agencies (Bucher 2002).

Table 6-18 summarizes the water agencies and water banks involved in the sales that Kern County WA made to the EWA Project Agencies in 2000 and 2001. No effects resulting directly from EWA-related transfers have been reported to DWR.

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16 The Monterey Amendments to the SWP contracts enhance management of SWP supplies and operations. This amendment established a number of water management tools including: 1) Turn-back pool - SWP contractors may sell unwanted SWP Table A amounts through a "turn back pool" to other contractors; 2) Water Transfers - Subject to DWR approval, SWP Contractors may permanently transfer Table A amounts to other SWP Contractors, 3) Storage Outside the Service Area - SWP Contractors may store water outside of their service areas for use in their SWP service area at a later date; and 4) Flexible management of SWP terminal reservoirs - Contractors may store water in certain SWP facilities in Southern California and withdraw excess deliveries from these facilities for a limited time.

Table 6-18 ***Sales by Kern County WA to the Environmental Water Account in 2000 and 2001***				
Seller	***Amount (AF)***	***Banked Groundwater Type***	***Groundwater Banking Facility or Agency***	***Date Water Released to EWA***
2000 SWP Table A Allocation Exchange Water Purchased and Delivered in 2000				
Kern Water Bank Participants	31,555	Friant-Kern Flood	KWB	7/00
	40,725	Kern River Flood	KWB	8/00
2000 SWP Carryover Table A Allocation Exchange Water Purchased and Delivered in 2001				
Arvin-Edison	10,000	Friant-Kern Flood	Arvin-Edison WSD	3/01
Rosedale Rio Bravo	19,036	Friant-Kern Flood	Rosedale Rio Bravo WSD	3/01
Westside Mutual Water Co.	15,000	SWP Table A Allocation	KWB	3/01
2000 SWP Exchange Subtotal	116,316			
2000 SWP Table A Allocation Exchange Water Purchased and Delivered in 2001				
Kern County WA for Nickel Family LLC[1]	10,000	Kern River Flood	Pioneer Project	5/01
Kern County WA/ID	10,000	Kern River Flood	KWB	6/01
Buena Vista/ Rosedale/ West Kern	20,218	SWP Table A Allocation	Buena Vista WSD	5/01
Buena Vista/ Rosedale/ West Kern	1,000	SWP Table A Allocation	Buena Vista WSD	5/01
Buena Vista/ Rosedale/ West Kern	2,500	SWP Table A Allocation	Buena Vista WSD	7/01
Semitropic WSD	10,767	SWP Table A Allocation	KWB	10/01
Semitropic/ Tulare ID	4,233	Friant-Kern [2]	Semitropic WSD	11/01
Westside Mutual/Tejon Castaic	21,000	SWP Table A Allocation	KWB	10/01
Cawelo WD	5,000	SWP Table A Allocation	KWB[3]	11/01
2001 SWP Exchange Subtotal	84,718			
2000 & 2001 Total	201,034			

Source: KCWA 2002

[1] The Nickel Family LLC is a private company primarily invested in farming. Nickel was the owner of a pre-1914 Kern River Water Right, referred to as the Lower River Water Rights. KCWA recently purchased the Lower River Rights from Nickel, and as part of the deal, Nickel is supplied with 10,000 AF of water per year by KCWA. Nickel banks this water in KCWA's portion of the Pioneer Project.

[2] Tulare ID delivered non-CVP water to Semitropic WSD via a Friant-Kern exchange.

[3] Westside Mutual pumped its KWB account in exchange for a like amount of Cawelo's 2800-acre account that was assigned to Belridge on behalf of Westside Mutual.

Interaction with Surface Water: The interaction of groundwater and wetlands in the Kern Fan Element are addressed in the Final EIR, Artificial Recharge, Storage and Overdraft Correction Program, December 1986, and the Monterey Addendum, which includes Volume IV (NEPA/CEQA) of the KWB Habitat Conservation Plan (HCP) Oct 1997. Groundwater underlying the Semitropic WSD and Arvin-Edison WSD is deep enough to be hydraulically disconnected from the surface water. Transfers to the EWA would not result in significant adverse impacts to the minor surface water features.

Land Subsidence*:* Both Arvin-Edison WSD and the Kern Fan Element have experienced substantial drawdown in the past, with a maximum subsidence rate (as of 1970) in excess of 0.5 feet per year observed in the Arvin-Maricopa area, and a total maximum approaching 9 feet (centered west of the Arvin-Edison WSD within the eastern portion of the Kern-Delta WD). The majority of this subsidence was attributed to overdraft of groundwater. An evaluation of subsidence in the Arvin-Edison WSD has not been performed since 1975; however, groundwater levels have stabilized and recovered significantly. Since 1980, subsidence related effects have not been observed in the Arvin-Edison WSD as a result of improvement in the water balance and stabilization of groundwater levels as a result of their Groundwater Management Plan (Arvin-Edison WSD 2003). Historical land subsidence has also been observed in Semitropic WSD, as shown in Figure 6-16, with subsidence of up to 8 feet since 1948 (Semitropic 1994a). The CEQA environmental review addressed the potential for further subsidence from the Semitropic Banking Project, and concluded that banking activities would not decrease groundwater elevations below that which would have occurred if Semitropic WSD had not established a bank. Consequently, this review concluded that the banking project would not induce subsidence.

Similarly, transfers under the Flexible Purchase Alternative would not result in drawdown that exceeds historical groundwater level declines. The operational parameters within the Kern Fan specify that groundwater levels are not to decrease beyond the pre-project groundwater level conditions.(KCWA 1995a). Therefore, the potential for land subsidence would not be increased (Iger 2002). Operational parameters are similar for the Semitropic WSD and Arvin-Edison WSD banking projects. Consequently, although groundwater transfers to EWA Project Agencies would lower groundwater levels, there would be minimal chance for adverse land subsidence effects, and any effects would be less than significant.

Groundwater Quality: The migration of reduced quality groundwater and distribution of reduced quality water into the aqueduct system are two types of potential water quality effects associated with increased groundwater withdrawals for EWA asset acquisition. The banking projects' MOUs, agreements, and monitoring activities address many of these groundwater quality concerns.

Groundwater in the Kern Fan Element banking projects is monitored routinely for TDS and constituents that may be of concern, including DBCP, EDB, and nitrates. These constituents have been detected at elevated concentrations in shallow groundwater north of the Kern River and west of Enos Lane. Uranium is also monitored in several areas of concern, and arsenic was recently added as an element to monitor. Additionally, California Code of Regulations Title 22 drinking water analyses of public supply wells in the local area and neighboring agencies actively monitor groundwater quality (KCWA 1995c).

The 1995 Proposed Monitoring Plan for the Kern Fan Element of the Kern Water Bank specifies a list of mitigation measures that are intended to protect groundwater quality. These mitigation measures include 1) the banking projects should be operated such that the TDS concentrations of recharged water does not exceed the TDS of recovered water; 2) purveyors should attempt to control the migration of reduced quality water; and 3) problem areas may be addressed either by limiting those pumping/recharge activities that enhance the migration of reduced quality water or by increasing extraction that may result in beneficial groundwater gradients (KCWA 1995c).

Groundwater quality concerns within Semitropic WSD include localized high concentrations of salinity and two landfills that could be point sources of contamination. The EIS Reports for the original Semitropic Banking Project concluded that in-lieu recharge and extraction would take place primarily in the lower confined aquifer, and would not significantly affect the shallow aquifer in which the potential contamination is located. Furthermore, the banking project would result in higher groundwater levels than without project conditions, thus inhibiting the migration of reduced quality water . The installation of additional monitoring wells, solely for the purpose of monitoring groundwater quality , mitigated potential effects to a less than significant level. The placement and operation of these wells are consistent with the criteria set forth in a February 1992 draft KWB Groundwater Monitoring Program that was designed originally for the banking projects in the Kern Fan Element (Semitropic WSD 1994). For any new groundwater storage unit, additional monitoring wells are to be installed in the northwestern section of the district to monitor for groundwater levels and groundwater quality (Semitropic WSD 2000b).

Arvin-Edison WSD monitors groundwater quality annually in 50 to 70 wells and canals throughout the district. Constituents of concern are arsenic and nitrates. The historic decline of the water table has induced migration of high boron concentrations from the east. There are some indications that this migration has been reduced through conjunctive use efforts. Generally, the groundwater is considered to be of good quality, with constituents below MCL standards, yet constituents have exceeded background concentrations present in the California aqueduct (Lewis 2002). If water quality declines below the threshold concentration specified in the MWD/Arvin-Edison agreement, Arvin-Edison WSD has agreed to purchase the water from MWD for the price at which it would purchase Class 2 (lower quality) Friant-Kern supplies (Arvin-Edison 1997).

In addition to the monitoring activities in the Kern Fan Element and the water quality control measures incorporated into Semitropic and Arvin-Edison's operations, the *Interim DWR Water Quality Criteria for Acceptance of Non-Project Water into the SWP* protects the quality of the water transported within SWP aqueducts. All groundwater that is directly pumped from the banking projects and conveyed into the California aqueduct must comply with criteria requiring that all non-Project water entering the SWP aqueducts remain within or exceed historical water quality levels. Prior to the transfer, an established facilitation group must review the request for input and the DWR must give final approval (DWR 2001).

A series of MOUs, agreements, and monitoring activities have been established to monitor and regulate groundwater quality in Kern County. (See Local Groundwater Management below for more information.) If impacts were shown or reported to be occurring, Kern County WA and the participating Kern County WA member agencies would be responsible for implementing mitigation measures.

Multi-Year Acquisitions: The acquisition of banked groundwater for consecutive years could reduce the amount of banked groundwater available in subsequent years. As discussed previously, a series of MOUs, agreements, and monitoring activities monitor and regulate groundwater levels, minimizing the potential for adverse effects. If these activities determine that existing groundwater levels are at a level that could result in adverse effects if a transfer occurs, the transfer would not be allowed to proceed, which would limit the amount of water available to the EWA Program.

Local Groundwater Management: Groundwater transfers to the EWA Project Agencies must meet Kern County WA approval. Kern County WA serves as an "umbrella organization" that acquires water from the SWP and sells the water to its member agencies within the county. Kern County WA must approve of all water that enters or leaves the county and also reserves the right to control flood and storm water, drain and reclaim land, store and reclaim water, protect groundwater quality, and conduct investigations involving water resources. Kern County WA serves as an important intermediate link and resource organization representing local interests at the State level.

Operations of the Kern County groundwater banks (by the owners/sponsors listed in Table 6-3) must adhere to the MOUs and Agreements (Table 6-17) signed by these participating agencies. Groundwater transfers to the EWA Project Agencies must not only meet the approval of Kern County WA, but also must gain the approval of the banking participants and meet the operation criteria set forth by the MOUs and agreements. These MOUs and agreements specify operational parameters and priorities for participating entities, monitoring requirements, and mitigation strategies. *Consequently, all potential impacts associated with the groundwater purchase and direct recovery operations conducted in accordance with local groundwater management requirements for the EWA Program would be less than significant.*

<u>South San Joaquin Groundwater Basin Groundwater Storage</u>

Acquisition of groundwater storage capacity for EWA acquisition water in Semitropic WSD or Arvin-Edison WSD's groundwater banking facilities would change groundwater levels. This could result in potential adverse impacts generally associated with groundwater banking facilities, including groundwater level declines when groundwater is extracted, land subsidence, and groundwater quality degradation.

The assessment of Kern County WA groundwater purchase effects above discusses potential effects in both Semitropic WSD and Arvin-Edison WSD. The acquisition of storage capacity for EWA water would result in the same potential effects as those listed above. As shown in Table 6-17, Semitropic WSD and Arvin-Edison WSD currently have established MOUs/agreements with participating banking and adjoining agencies. It is anticipated that if the EWA became an active banking participant by storing EWA water in either Arvin-Edison WSD or Semitropic WSD, the EWA Program would also have an operating agreement or MOU that would address potential adverse effects. These agreements would address the mitigation of potential adverse effects associated with groundwater banking activities, including periodic groundwater level declines caused by groundwater extraction, land subsidence, and groundwater quality degradation. *Consequently, for groundwater transfers conducted in accordance with local management, the potential groundwater impacts would be less than significant.*

Groundwater storage of EWA acquisition water in Semitropic WSD or Arvin-Edison WSD's groundwater banking facilities could change groundwater levels and would provide benefits.

As previously discussed, groundwater resources in Semitropic WSD and Arvin-Edison WSD have experienced overdraft conditions in past years. Although groundwater levels have increased since the beginning of banking operations (Figure 6-30), a large amount of storage capacity is available in the underlying aquifer. The purchase of storage space for EWA water (used to recharge the underlying aquifer) would increase the EWA agencies' operational flexibility because EWA assets could be stored if they were available at times that they could not be used immediately. The banked EWA water would also benefit Semitropic WSD and Arvin-Edison WSD by increasing groundwater levels in their underlying basins.

6.2.5 Environmental Consequences/Environmental Impacts of the Fixed Purchase Alternative

The Fixed Purchase Alternative specifies purchases of 35,000 acre-feet from areas Upstream from the Delta Region and 150,000 acre-feet from the Export Service Area. While the amounts in each region are fixed, the acquisition types and sources could vary. In this section, the effects of each potential transfer are analyzed to allow the EWA Project Agencies maximum flexibility when negotiating purchases with willing sellers. The possible transfers for the Fixed Purchase Alternative are the same as the Flexible Purchase Alternative, but the total quantity of water acquired would be limited by the total acquisition amount in each region (35,000 acre-feet from the areas Upstream from the Delta Region and 150,000 acre-feet from the Export Service Area).

Despite the differences in transfer quantities between the two Purchase Alternatives, the acquisition areas are the same; consequently, the type of potential adverse effects for the Fixed and Flexible Purchase Alternative in each Region are the same. The following text lists the potential effects for each of the groundwater subbasins and provides regional drawdown estimates, if they differ from the Flexible Purchase Alternative estimates. The regional drawdown estimates differ in acquisition areas where the maximum amount of water that may be transferred, given in Table 2-9, exceeds the total Fixed Purchase acquisition cap. Because the kinds of adverse effects would be the same with both Purchase Alternatives, the majority of discussion on the potential effects is referred to Section 6.2.4, Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative.

6.2.5.1 Upstream from the Delta Region

EWA Project Agency acquisitions that could affect groundwater resources in the areas Upstream from the Delta Region include groundwater substitution, groundwater purchase, and crop idling. The effects associated with each of these acquisitions would be groundwater level declines, alteration of surface and groundwater hydrology, land subsidence, and changes in groundwater quality.

This discussion covers the effects of crop idling at a regional scale and the potential effects of groundwater substitution and groundwater purchase at the local scale. Section 6.2.5.1.1 below covers the Redding Groundwater Basin. Section 6.2.5.1.2 covers the Sacramento Groundwater Basin, which includes the Colusa, East Butte, West Butte, East Sutter, North Yuba, South Yuba, and North American subbasins.

6.2.5.1.1 Redding Groundwater Basin

EWA acquisition of Sacramento River Contract water in the Redding groundwater subbasin via groundwater substitution could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Anderson-Cottonwood ID.

The maximum Fixed Purchase acquisition amount of 35,000 acre-feet is less than the maximum acquisition of 40,000 acre-feet for the Flexible Purchase Alternative. Consequently, the regional groundwater drawdown estimates differ. Table 6-19 shows the estimated regional drawdown relative to typical seasonal groundwater level fluctuations in normal and drought years for the Fixed Purchase Alternative.

Table 6-19
Fixed Alternative Estimate of the Groundwater Drawdown for the Redding Basin

EWA Acquisition Range	10,000 to 35,000
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition	5 to 17 feet
Normal Year Seasonal Fluctuations	2-3 feet (unconfined) 2 – 5 feet (semi-confined – confined)
Drought Year Seasonal Fluctuations	4-10 feet (unconfined) 4-16 feet (semi-confined and confined)

Source for groundwater level fluctuations: DWR Northern District 2002

As shown in Table 6-19, the potential groundwater level declines resulting from EWA Project Agency acquisitions would range from 5 to 17 feet in addition to seasonal fluctuation. Potential declines associated with the higher end of the EWA Project Agency acquisition range would be relatively large when compared to normal seasonal fluctuations, yet would be relatively close to the higher range of drought year seasonal fluctuations. The potential for adverse drawdown effects would be highest during the dry years when baseline fluctuations are already large and groundwater levels may be lower than normal. Groundwater levels would increase as the amount of extracted water increased. The potential may also increase if Anderson-Cottonwood ID is conducting groundwater substitution transfers in consecutive years and has experienced an annual net groundwater level decline.

Although groundwater drawdown may be less for the Fixed Purchase Alternative than for the Flexible Purchase Alternative, the types of potential adverse effects would be the same. Further discussions of these effects are provided in the Flexible Alternative discussion in Section 6.2.4.1.1 for the Redding Groundwater Basin.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not make purchases that interfere or conflict with the local management efforts described in Section 6.2.4.1.1 and would not purchase water from an agency unless that agency had successfully complied with the groundwater mitigation measures. Therefore, for Anderson-Cottonwood ID to conduct an EWA transfer via groundwater substitution, the agency would have to implement the well review, access the need for a pre-purchase evaluation, and establish monitoring and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the Redding groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

6.2.5.1.2 Sacramento Groundwater Basin Crop Idling (Fallowing)

EWA acquisition of Sacramento River contractor water via crop idling of rice could decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

Figure 6-21 shows areas of rice production that could be idled in counties in the areas Upstream from the Delta Region. The assessment in this EIS/EIR limits EWA crop idling transfers to 20 percent of the amount of water that would have been applied in an agency for a given hydrologic year, based on economic considerations (Chapter 11). This would result in a loss of applied recharge to the Sacramento Groundwater Basin. However, this loss would be relatively small when compared to the total amount of water that recharges the Sacramento Groundwater Basin. A large portion of the total recharge to the basin is through precipitation and runoff over the spring and winter. As illustrated by the hydrographs on Figures 6-22 through 6-27, groundwater levels tend to generally recover during the rainy winter season. A 20 percent reduction in applied water recharge would be within the variability of annual recharge.

Furthermore, the land used for rice production consists of low permeable soils. A substantial portion of the applied water does not percolate to the underlying aquifer, but rather discharges to the farmer's surface drainage system. A reduction in applied recharge because of idled rice fields could have an effect on groundwater recharge and levels; however, the idling of rice fields would probably not substantially reduce the percentage of applied water that recharges the underlying Basin. *Consequently, the reduction in groundwater recharge as a result of rice idling would be less than significant.*

<u>Colusa Groundwater Subbasin Groundwater Substitution</u>

EWA Project Agency acquisition of Sacramento Contractor water in the Colusa groundwater subbasin via groundwater substitution could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. Groundwater substitution would most likely be concentrated in Glenn-Colusa ID and Reclamation District 108 (RD 108).

Groundwater substitution for EWA asset acquisition could result in temporary drawdown that exceeds historical seasonal fluctuations. (See the Colusa Subbasin discussion in Section 6.2.4.1.2 for more details on historical groundwater level fluctuations.) Table 6-20 compares the estimated potential drawdown resulting from a one-year EWA transfer with historical fluctuations for the Glenn-Colusa ID and RD 108. (The acquisition range and consequently the drawdown for RD 108 are the same as the Flexible Purchase Alternative shown in Table 6-8). Figure 6-22 shows the areas for which the regional declines are estimated**.** These areas were selected based on the wells used for the 2001 Forbearance Agreement transfer. Groundwater substitution pumping within Glenn Colusa ID was allocated proportionally according to the number of wells in each area – north, central, and south. The majority of the wells are concentrated in the northern part of the district.

Table 6-20
Fixed Alternative Estimate of the Groundwater Drawdown for Glenn-Colusa and Reclamation District 108

	Reclamation District 108	Glenn Colusa ID		
EWA Acquisition Range	5 TAF	20-35 TAF		
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition (feet)	3	North area	Central area	South area
		3 to 6	1 to 2	Up to 1
Normal Year Fluctuations	2 to 5 feet (unconfined) 6-12 feet (semi-confined)	1 to 6 feet (unconfined) 2-20 feet (confined)		
Drought Year Fluctuations:	8-12 feet (unconfined)	2 to 12 feet (unconfined) 3-30 feet (confined)		

Source for annual fluctuations: DWR 2001

As shown in Table 6-20, the potential groundwater level declines resulting from the EWA acquisitions would range from one to six feet in addition to seasonal fluctuation. The magnitude of this potential drawdown is within the range of seasonal fluctuations. According to well data for Glenn Colusa ID (Table 6-9), 60 percent of the district's domestic wells and 10 percent of their agricultural wells are 110 feet deep, or shallower. It is unlikely that the transfers would result in a substantial regional effect to existing wells. Increased groundwater pumping could also cause localized declines in groundwater levels, or cones of depression, near pumping wells. These declines could be larger than those indicated in Table 6-20, possibly causing effects to wells within the cone of depression.

Although the potential maximum acquisition amount for Glenn Colusa ID differs between the Fixed and Flexible Purchase Alternatives by 60,000 to 35,000 acre-feet, the kinds of potential adverse effects would be the same. Past groundwater transfers, groundwater/surface water interaction, land subsidence, groundwater quality, and local groundwater management are discussed further in the Flexible Purchase Alternative, Section 6.2.4.1.1.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not make purchases that interfere or conflict with the local management efforts described in Section 6.2.4.1.2 and would not purchase water from an agency unless that agency had successfully complied with the groundwater mitigation measures. Therefore, Glenn Colusa ID and RD 108 shall implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures before they conduct an EWA transfer via groundwater substitution. *Consequently, EWA groundwater substitution transfers conducted in the Colusa groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

<u>East Butte and West Butte Groundwater Subbasins Groundwater Substitution</u>

EWA acquisition of Feather River Contractor water in the East Butte and West Butte groundwater subbasins via groundwater substitution could affect groundwater hydrology. The potential effects could be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater substitution would be concentrated in the Joint Water Districts and Western Canal WD.

Groundwater substitution for EWA asset acquisition could result in temporary drawdown that exceeds historical seasonal fluctuations. (See the Colusa Subbasin discussion in Section 6.2.4.1.2 for more details on historical groundwater level fluctuations.) Table 6-21 compares the estimated potential drawdown as a result of a single year EWA-related groundwater transfer with historical fluctuations. Figure 6-23 shows the areas for which the regional declines are calculated. In the East Butte subbasin, groundwater has been extracted from throughout the districts; consequently, this analysis used areas within the districts' boundaries to estimate drawdown.

Table 6-21
Fixed Alternative Estimate of Groundwater Drawdown for the Butte Subbasins

	West Butte Subbasin	East Butte Subbasin	
EWA Acquisition Range	Western Canal – 10-35 TAF[1]	Joint Water Districts – 20-60 TAF[2] Western Canal WD – 10-35 TAF[1]	
Estimated Regional Drawdown based on Range of Possible One-Year EWA Asset Acquisition	Western Canal WD – 3 to 10 feet	Joint Water Districts – 3 to 8 feet Western Canal WD – 3 to 10 feet	
Normal Year Fluctuations	15 - 25 feet (semi-confined, confined)	North 15 feet (composite wells[3])	South 4 feet (composite wells) 4 feet (confined and semi-confined)
Drought Year Fluctuations	Up to 30 feet (semi-confined, confined)	North 30 -40 feet (composite wells[1])	South 10 feet (composite wells) 5 feet (confined and semi-confined)

Source of the normal and drought year fluctuations: DWR 2002

1 This acquisition range applies to the entire Western Canal WD, both in the West and East Butte subbasin.

2 This estimate assumes that 75 percent of the acquisition range of 20-60 TAF is allotted to the three of the Joint Water Districts, Biggs-West Gridley, Richvale, and Butte WD in the East Butte subbasin. The remaining 25 percent is allotted to Sutter Extension WD in the Sutter subbasin. This partitioning was based on the density of potential pumping wells in each subbasin.

3 Composite wells represent groundwater fluctuations that combine confined and unconfined portions of an aquifer

As shown in Table 6-21, the potential regional groundwater level declines resulting from an EWA-related transfer may cause an additional 3 to 10-foot decline in the Butte subbasins. This would not be a substantial decline when compared with the normal and drought year fluctuations for the northern portions of the subbasins. The selling agencies could experience regional declines of up to 10 feet, which could exceed normal year fluctuations in the southern portion of the subbasins. The potential for adverse drawdown effects would increase as the amount of extracted water increased. The potential for adverse effects would be higher still during dry years, when baseline fluctuations are already large and groundwater levels may be low.

Although there are exceptions,[17] the Joint Water Districts' members and Western Canal WD rely primarily on surface water diverted from the Feather River. During normal years, groundwater transfers would be less likely to affect wells throughout the majority of the districts because local users rely extensively on surface water. During dry years, however, DWR has the option to reduce supplies to the Joint Water

17 Such an exception is a portion of the Richvale ID service area, just west of Biggs and adjacent to the Butte Creek and Cherokee Canal. This area does not receive SWP allocation, but relies on groundwater and drainage water.

Districts.[18] Table 6-12 shows the number of wells within each district and the average depth of wells. Wells within the potential sellers' districts are relatively shallow. During dry years, groundwater may be an important supplement to surface water in some areas, and additional declines caused by groundwater substitution transfers would be more likely to result in adverse effects. Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression near pumping wells. These declines are likely to be larger than those indicated in Table 6-11, possibly causing effects to wells within the cone of depression.

Although the potential maximum acquisition amount for the Joint Water Districts differs between the Fixed and Flexible Purchase Alternatives by 35,000 to 60,000 acre-feet the kinds of potential adverse effects are the same. Additional information on past groundwater transfers, groundwater/surface water interaction, groundwater quality, land subsidence, and local management are provided in the East Butte and West Butte Groundwater Subbasins discussion in Section 6.2.4.1.2.

Similar to the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for Biggs-West Gridley WD, Richvale ID, Butte WD, and Western Canal WD to conduct an EWA transfer via groundwater substitution, the selling agencies would have to evaluate the need for a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the East Butte and West Butte groundwater subbasins could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

<u>East Sutter Groundwater Subbasin Groundwater Substitution</u>

EWA acquisition of Feather River Contractor water in the East Sutter groundwater subbasin via groundwater substitution would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts. EWA groundwater substitution would be concentrated in Sutter Extension ID and Garden Highway MWC.

Groundwater substitution under the Fixed Purchase Alternative could result in temporary drawdown that exceeds historical seasonal fluctuations. The potential drawdown as a result of an EWA-related groundwater transfer for Sutter Extension WD and Garden Highway is estimated to be between 3 to 6 feet and 22 feet,

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[18] The Joint Water District administers 630,000 acre-feet of Feather River water to its member agencies, including Biggs-West Gridley WD, Butte WD, Richvale ID, and Sutter Extension ID. The Board controls, maintains, and operates the joint water distribution facilities for each district but does not own any production wells.

respectively. (See Figure 6-24 for the acquisition areas.) These estimates are based on the assumption for the Fixed Purchase Alternative acquisitions of 8,750 TAF[19] and 3 TAF for Sutter Extension WD and Garden Highway MWC, respectively. (The acquisition range and consequently the estimated regional drawdown for Garden Highway MWC is the same for both the Fixed and Flexible Purchase Alternative.) This drawdown could adversely affect local wells; however, there are insufficient data to determine typical regional groundwater level fluctuations. Increased groundwater pumping could also cause localized declines of groundwater levels, or cones of depression, near pumping wells. These declines would likely be larger than the regional declines, possibly causing effects to wells within the cones of depression.

Although the potential maximum acquisition amount for Sutter Extension differs between the Fixed and Flexible Purchase Alternatives, the kinds of potential adverse effects are the same. Additional information on past groundwater transfers, groundwater/surface water interaction, groundwater quality, land subsidence, and local management are provided in the East Sutter Groundwater Subbasin discussion in Section 6.2.4.1.2.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for Sutter Extension WD and Garden Highway MWC to conduct a transfer to the EWA Program via groundwater substitution, these selling agencies would evaluate the need to conduct a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the East Sutter groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

19 Sutter Extension is a member of the Joint Water Districts, which also includes Richvale ID, Butte WD, and Biggs-West Gridley WD. The 8,750 acre-feet acquired by Sutter Extension is one-fourth of the total 35,000 acre-foot acquisition amount that may be acquired by the Joint Board for the Fixed Purchase Alternative.

North and South Yuba Groundwater Subbasins

EWA acquisition of water from Yuba County Water Agency by groundwater substitution in the North Yuba and South Yuba groundwater subbasins could affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality impacts . Groundwater substitution would be concentrated in the Yuba County Water Agency (WA) member agencies of Browns Valley ID, Brophy WD, Ramirez WD, Hallwood Irrigation Company, South Yuba WD, Dry Creek MWC, and Cordua ID.

EWA groundwater substitution transfers could result in groundwater level declines in excess of seasonal variation and these effects could be potentially significant. a. However, both subbasins demonstrate relatively quick recovery rates, indicating that they are not in overdraft and an EWA single year asset transfer would likely have a minimal effect on long-term groundwater level trends. However, multi-year groundwater transfers would increase the potential for adverse groundwater effects. Groundwater levels in portions of the North Yuba subbasin did not fully recover by the following spring after the 1991 State Drought Water Bank transfer. See North Yuba and South Yuba Groundwater Subbasins in Section 6.2.4.1.2 for further details on historical long-term groundwater level fluctuations.

Groundwater substitution under the Fixed Purchase Alternative could result in temporary groundwater drawdown that exceeds seasonal fluctuations. Estimates of potential regional drawdown caused by an EWA groundwater transfer could be 8 feet for both the North Yuba and South Yuba subbasins. Figure 6-25 shows the areas for which these regional declines were calculated. These areas were selected based on the use of wells for previous transfers to the EWA Project Agencies in 2001 and 2002. The estimate assumes that the North Yuba and South Yuba subbasins would each pump half the total 35 TAF acquisition amount.

Extraction from the South Yuba subbasin would be less likely to cause adverse effects than extraction from other areas, because the potential declines would be within the range of historical fluctuations. Because drawdown would affect shallow wells before deeper wells, the potential for adverse drawdown effects is greater in areas with more shallow wells.

Increased groundwater pumping could also cause localized declines of groundwater levels, or the development of cones of depression near pumping wells. To address these potential local declines, DWR and Yuba County WA implemented a cooperative monitoring program during Yuba County WA's groundwater substitution transfers to the EWA Project Agencies in 2001 and 2002.

Although the potential maximum acquisition amount of 35,000 acre-feet for the Fixed Purchase Alternative is less than the maximum amount of 85,000 acre-feet for the Flexible Purchase Alternative, the kinds of potential adverse effects would be the same. Additional information on past groundwater transfers, groundwater/surface water interaction, groundwater quality, land subsidence, and local management are provided in the Yuba Groundwater Subbasins discussion in Section 6.2.4.1.2.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, before the Yuba County WA or its member agencies conduct a transfer to the EWA Program via groundwater substitution, the Yuba County WA and/or its member agencies should evaluate whether it is necessary to conduct a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the North Yuba and South Yuba groundwater subbasins could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant*.

<u>North American (River) Groundwater Subbasin Groundwater Substitution</u>

EWA acquisition of American and Sacramento River water in the North American groundwater subbasin via groundwater substitution would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality effects. Groundwater substitution would most likely be concentrated in Natomas Central Mutual Water Company.

Groundwater substitution could result in temporary declines of groundwater levels. Historical groundwater level fluctuations in the North American subbasin vary. The underlying aquifer has a relatively short recovery period, and an EWA-related transfer would likely have a minimal effect on long-term groundwater level trends. See the North American (River) Groundwater Subbasin Groundwater Substitution in Section 6.2.4.1.2 for further details on historical long-term groundwater level fluctuations.

Groundwater substitution involving EWA asset acquisitions could result in temporary drawdown that exceeds historical seasonal fluctuations. The groundwater substitution acquisition ranges for both the Fixed and Flexible Purchase Alternatives would be the same. Consequently, the regional drawdown estimates and kinds of potential adverse effects for the Fixed Purchase Alternative would be the same as for the Flexible Purchase Alternative. Information on groundwater level effects, past transfers, groundwater/surface water interaction, land subsidence, groundwater quality, and local management are provided in North American (River) Groundwater Subbasin Groundwater Substitution discussion in Section 6.2.4.1.2.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for Natomas Central MWC to conduct a groundwater substitution transfer with the EWA Program, Natomas Central MWC should evaluate whether it needs to conduct a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers in the North American (River) groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

<u>North American (River) Groundwater Subbasin Groundwater Purchase</u>

EWA acquisition of American River water in the North American groundwater subbasin via groundwater purchase would affect groundwater hydrology. The potential effects would be decline in groundwater levels, interaction with surface water, land subsidence, and water quality effects. EWA groundwater transfers would most likely be managed by the Sacramento Groundwater Authority (SGA) and concentrated in the City of Sacramento, Fair Oaks Water District, and Citrus Heights Water District.

As described in the North American (River) Groundwater Subbasin Groundwater Purchase in Section 6.2.4.1.2, SGA manages the groundwater underlying the North Area, where the EWA Program may purchase groundwater. This area has historically been overdrafted. (See Section 6.2.4.1.2 for more details.) As a result of the WFA, groundwater extraction in the SGA's management area are not to exceed the defined sustainable yield of 131,000 acre-feet (EDAW and SWRI 1999). Any EWA-related groundwater extraction would also be subject to this limit and consequently, EWA transfers could not contribute to the exceedance of the sustainable yield.

Groundwater purchases involving EWA asset acquisitions could result in temporary drawdown that exceeds seasonal fluctuations. The groundwater purchase acquisition ranges for both the Fixed and Flexible Purchase Alternatives would be the same. Consequently, the regional drawdown estimates and potential adverse effects for the Fixed Purchase Alternative would be the same as for the Flexible Purchase Alternative. Information on groundwater level effects, past transfers, groundwater/surface water interaction, land subsidence, groundwater quality, and local management are provided in North American (River) Groundwater Subbasin Groundwater Purchase discussion in Section 6.2.4.1.2.

As for the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, in order for the SGA to conduct a groundwater purchase transfer with the EWA Program, SGA should evaluate the need to conduct a pre-purchase evaluation and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures.

Consequently, EWA groundwater purchase transfers in the North American (River) groundwater subbasin could have potentially significant effects on groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.

6.2.5.1.3 North San Joaquin Groundwater Basin

North San Joaquin Groundwater Basin Crop Idling

EWA acquisition of water via the idling of cotton crops would decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects could be a decline in groundwater levels.

Figure 6-28 shows the areas that could be idled in both the North San Joaquin and South San Joaquin Groundwater Basins. The acquisition amounts for the Flexible Purchase and Fixed Purchase would be the same, and the potential for adverse effects for both alternatives is minimal. (See North San Joaquin Groundwater Basin Crop Idling in Section 6.2.4.1.3 for more details.) The p*otential for reduction in groundwater recharge associated with the idling of cotton in the North and South San Joaquin Groundwater Basins would be less than significant.*

Merced River Contractor Groundwater Substitution

EWA acquisition of Merced River Contractor water via groundwater purchase would affect groundwater hydrology. Specific potential effects would be decline in groundwater levels, decrease of water levels in neighboring surface water channels including the Merced River, increased potential for land subsidence, and degradation of groundwater quality.

The groundwater acquisition ranges for both the Fixed and Flexible Purchase Alternatives would be the same for the Merced subbasin. Consequently, the regional drawdown estimates and kinds of potential adverse effects for the Fixed Purchase Alternative would be the same as for the Flexible Purchase Alternative. Section 6.2.4.2.3, Merced River Contractor Groundwater Substitution , provides information on groundwater level effects, past transfers, groundwater quality effects, land subsidence effects, and local management.

Similar to the Flexible Purchase Alternative, the EWA Project Agencies would not purchase water from an agency unless the agency has successfully complied with the groundwater mitigation measures. Therefore, to conduct an EWA groundwater purchase transfer, Merced ID would have to evaluate whether a pre-purchase evaluation needs to be conducted and implement the well review, monitoring, and mitigation measures outlined in the groundwater mitigation measures. *Consequently, EWA groundwater substitution transfers of Merced River Contractor groundwater in the North San Joaquin groundwater basin could have potentially significant effects on* *groundwater levels, groundwater quality, surface water, and land subsidence. However, the groundwater transfers will be conducted in accordance with local management requirements and EWA groundwater mitigation measures (as discussed in Section 6.2.7) that will reduce these impacts to less than significant.*

6.2.5.2 Export Service Area

EWA acquisitions that could affect groundwater resources in the Export Service Area include crop idling, groundwater purchase, and groundwater storage. The effects associated with these acquisitions include groundwater level declines, alteration of surface and groundwater hydrology, land subsidence, and changes in groundwater quality.

6.2.5.2.1 South San Joaquin Groundwater Basin Crop Idling

EWA acquisition of water via cotton crop idling would decrease applied water recharge to the local groundwater system underlying the barren (idled) fields. Specific potential effects would be a decline in groundwater levels.

Figure 6-28 shows the areas that could be idled in both the North San Joaquin and South San Joaquin Groundwater Basins. The acquisition amounts for the Flexible Purchase and Fixed Purchase Alternatives would be the same, and the potential for adverse effects for both alternatives is minimal. (See North San Joaquin Groundwater Basin Crop Idling in Section 6.2.4.1.3 for more details.) *Potential groundwater impacts associated with the idling of cotton in the North and South San Joaquin Groundwater Basins would be less than significant.*

6.2.5.2.2 South San Joaquin Groundwater Basin Banked Groundwater

EWA acquisition of banked groundwater from water bank participating agencies in Kern County, via groundwater purchase and recovery through direct extraction from the banking facilities, could decrease groundwater levels. Specific potential effects would be declines in groundwater levels, increased potential for land subsidence, degradation of groundwater quality, and the reduction of banked groundwater available for future transfers.

The groundwater acquisition ranges for both the Fixed and Flexible Purchase Alternatives would be the same for the South San Joaquin Groundwater Basin (Kern subbasin). Consequently, the regional drawdown estimates and potential adverse effects for the Fixed Purchase Alternative would be the same as for the Flexible Purchase Alternative. Information on groundwater levels, past transfers, groundwater quality effects, land subsidence effects, the multi-year acquisitions and the reduction in available banked groundwater, and local management are provided in the South San Joaquin Groundwater Basin Banked Groundwater discussion in Section 6.2.42.

Operations of the Kern County groundwater banks (by the owners/sponsors in Table 6-3) must adhere to the MOUs and Agreements (Table 6-17) signed by these participating agencies. Groundwater transfers to the EWA Project Agencies must not only meet the approval of Kern County WA, but must also gain the approval of the banking participants and meet the operational criteria set forth by the MOUs and agreements. These MOUs and agreements specify operational parameters and priorities for participating entities, monitoring requirements, and mitigation strategies.

In addition to the MOUs and Agreements, current Kern County WA policy may place limitations on the sale of banked water from the SWP, and there are further limitations on potential sales of Friant-Kern (CVP) water. A place-of-use restriction requires banked Friant-Kern water to be used within county limits. Consequently, these agreements legally limit the classification of water that may be sold to the EWA Project Agencies. The acquisition of banked groundwater for consecutive years may reduce the amount of banked groundwater available to the EWA Program in following years. Ongoing discussion concerns whether the limitation on selling water from the SWP could be changed.

Consequently, potential impacts associated with the groundwater purchase and direct recovery operations conducted in accordance with local groundwater management requirements for the EWA Program would be less than significant.

6.2.5.2.3 South San Joaquin Groundwater Basin Groundwater Storage

Groundwater storage of EWA acquisition water in Semitropic WSD or Arvin-Edison WSD's groundwater banking facilities would change groundwater levels. This could result in potential adverse impacts generally associated with groundwater banking facilities, including groundwater level declines when groundwater is extracted, land subsidence, and groundwater quality degradation.

The Kern County WA groundwater purchase effects assessment above discusses potential effects in both Semitropic WSD and Arvin-Edison WSD. The storage of EWA water would result in the same potential effects. As shown in Table 6-17, Semitropic WSD and Arvin-Edison WSD currently have established MOUs/agreements with participating banking and adjoining agencies. It is anticipated that if the EWA becomes an active banking participant (storing EWA water) in either Arvin-Edison WSD or Semitropic WSD, the EWA Program would also have an operating agreement or MOU that would address potential adverse effects. These agreements would address the mitigation of potential adverse effects generally associated with groundwater banking activities, including periodic groundwater level declines caused by groundwater extraction, land subsidence, and groundwater quality degradation. *Consequently, for groundwater transfers conducted in accordance with local management, the potential groundwater impacts would be less than significant.*

Groundwater storage of EWA acquisition water in Semitropic WSD or Arvin-Edison WSD's groundwater banking facilities could change groundwater levels and would provide benefits.

As previously discussed, groundwater resources in Semitropic WSD and Arvin-Edison WSD have historically experienced overdraft conditions. Although groundwater levels have increased since the beginning of banking operations (Figure 6-30), a large amount storage of capacity is available in the underlying aquifer. The purchase of storage space for groundwater banking of EWA water (used to recharge the underlying aquifer) would increase the EWA Project Agencies' operational flexibility. The banked EWA water would also benefit Semitropic WSD and Arvin-Edison WSD by increasing groundwater levels in their underlying basins.

6.2.6 Comparative Analysis of Alternatives

The Fixed Purchase and Flexible Purchases Analyses identified the potential groundwater effects of water transfers from the proposed selling agencies listed in Tables 2-5 and 2-9. Additional information was provided on groundwater management within the local selling agencies and explanations on how the groundwater mitigation measures help to assure that effects are minimized. Including all potential transfers ensures that the analysis identifies effects for these transfers and provides the EWA agencies the flexibility to choose transfers that may be preferable in a given year. Table 6-22 provides a comparative summary of both action alternatives. EWA operations would most likely differ annually, depending on year type, and the EWA agencies would not purchase all available storage and management options in every year. This section discusses how the EWA agencies would actually operate the program in different year types, and reflects a more realistic view of what effects would occur in these years.

In the No Action/No Project Alternative, farmers would change some practices depending on the water year type. In wet years, surface water supplies would be plentiful and farmers would most likely irrigate with those supplies (in areas with water rights or contracts). In dry years, most areas with water rights or contracts would experience some reduction in surface water supplies. Farmers would then change practices to handle this reduction, often switching to groundwater supplies and occasionally idling crops. As discussed in the above sections, local water users utilize increased amounts of groundwater during dry years.

6.2.6.1 Upstream from the Delta Region

The Fixed Purchase Alternative would be limited to a maximum acquisition of 35,000 acre-feet from all sources of water. In most years, this amount could be obtained as surface water stored in non-Project reservoirs. The Fixed Purchase Alternative would not likely involve acquisition of groundwater and, thus, would have no effect on groundwater resources. In years in which surface water assets are not available (in part or in total), the EWA Project Agencies would acquire water next through groundwater substitution and/or groundwater purchase, then by crop idling. Because surface water acquisition would be the focus of the Fixed Purchase Alternative, it would be unlikely that the EWA Program would acquire water through

Table 6-22
Groundwater Effects for the Flexible and Fixed Purchase Alternatives Compared to the Baseline Condition

Region	Asset Acquisition	Result	Potential Effects	Flexible Purchase Alternative Change from Baseline	Fixed Purchase Alternative Change from Baseline	Significance of Flexible Purchase Alternative After Mitigation	Significance of Fixed Purchase Alternative After Mitigation	Comments
Upstream from the Delta Region	Crop Idling Flex: 295 TAF[1] Fixed: 35 TAF	Decrease applied water recharge to the local groundwater system.	Decline in groundwater levels.	Reduction of applied recharge of up to 295 TAF.	Reduction of applied recharge of up to 35 TAF.	PS;LTS with mitigation measures	PS; LTS with mitigation measures	Declines in groundwater levels would be minimal.
	Groundwater Substitution Flex: 315 TAF[2] Fixed: 35 TAF	Groundwater is used in place of surface water.	Groundwater level declines, decrease of water levels in neighboring surface water channels, increased potential for land subsidence and degradation of groundwater quality.	Would vary given site-specific conditions and level of pumping.	Would vary given site-specific conditions and level of pumping.	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Local management and monitoring, in addition to the groundwater mitigation measures, provide assurances that all impacts would be monitored and mitigated to less than significant on a local level.
	Stored groundwater purchase Flex: 10 TAF Fixed: 10 TAF	Extraction of water from groundwater storage.	Groundwater level declines, decrease of water levels in neighboring surface water channels, increased potential for land subsidence, and degradation of groundwater quality.	Would vary given site-specific conditions and level of pumping. Potential for adverse effects would increase during dry years.	Would vary given site-specific conditions and level of pumping. Potential for adverse effects would increase during dry years.	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Local management and monitoring, in addition to the EWA groundwater mitigation measures, provide assurances that all impacts would be monitored and mitigated to less than significant on a local level.
Export Service Area	Crop Idling Flex: 420 TAF Fixed: 150 TAF	Decrease applied water recharge to the local groundwater system underlying the barren fields.	Possible increase in soil salinity and groundwater levels under perched conditions or a decline in groundwater levels	Reduction of applied recharge of up to 420 TAF.	Reduction of applied recharge of up to 150 TAF.	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Declines in groundwater levels would be minimal.
	Groundwater Substitution Flex: 25 TAF Fixed: 25 TAF	Groundwater is used in place of surface water.	Groundwater level declines, decrease of water levels in neighboring surface water channels, increased potential for land subsidence, and degradation of groundwater quality.	Would vary given site-specific conditions and level of pumping.	Would vary given site-specific conditions and level of pumping.	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Local management and monitoring, in addition to the groundwater mitigation measures, provide assurances that all impacts would be monitored and mitigated to less than significant on a local level.

Table 6-22 ***Groundwater Effects for the Flexible and Fixed Purchase Alternatives Compared to the Baseline Condition***								
Region	***Asset Acquisition***	***Result***	***Potential Effects***	***Flexible Purchase Alternative Change from Baseline***	***Fixed Purchase Alternative Change from Baseline***	***Significance of Flexible Purchase Alternative After Mitigation***	***Significance of Fixed Purchase Alternative After Mitigation***	***Comments***
	Stored Groundwater Purchase Flex: 150 TAF Fixed: 150 TAF	Extraction of water from groundwater storage.	Groundwater level declines, decrease of water levels in neighboring surface water channels, increased potential for land subsidence, and degradation of groundwater quality.	Would vary given site-specific conditions and level of pumping	Would vary given site-specific conditions and level of pumping	PS; LTS with mitigation measures	PS; LTS with mitigation measures	Local monitoring and other operational agreements provide assurances that all impacts would be monitored and mitigated to less than significant on a local level.
	Groundwater Storage Services Amount of water stored has not been determined	Storage of EWA acquired water in groundwater storage facilities	Increase in groundwater levels.	Amount of water stored has not been determined	Amount of water stored has not been determined	PS; LTS with mitigation measures	PS; LTS with mitigation measures	It is anticipated that NEPA/CEQA documentation and other operational agreements that would be developed between the EWA Project Agencies and the banking participants would provide assurances that all impacts are LTS or monitored and mitigated to less than significant on a local level.

PS = potentially significant LTS = less than significant
The asset acquisition amounts are not simply additive and do not necessarily represent what would occur in any given year.

[1] This value represents the reduction of applied recharge and differs from the values presented for crop idling in other chapters which represent the amount of water that would be available to the EWA and conveyed through the Delta. These values differ due to release limitations for Shasta Reservoir. Releases for the EWA Program to provide fishery protection are limited until after May. Consequently, the EWA Program may lose a portion of water acquired through crop idling.

[2] This value represents the amount of groundwater extracted for a groundwater substitution transfer and differs from the values presented for crop idling in other chapters which represent the amount of water that would be available to the EWA and conveyed through the Delta. These values differ due to release limitations for Shasta Reservoir. In order to provide fishery protection, releases for the EWA Program are limited until after May. Consequently, the EWA Program may lose a portion of water acquired through the groundwater substitution transfers.

groundwater substitution or purchase every year, and less likely that a groundwater transfers would occur for consecutive years in a given area. This alternative would not result in long-term groundwater effects.

The Flexible Purchase Alternative could involve the purchase of up to 600,000 acre-feet of water from all sources in areas Upstream from the Delta Region. If the EWA Project Agencies were to acquire 600,000 acre-feet in areas from the Upstream from the Delta Region, they would need to utilize most available sources, which would include stored reservoir water, groundwater substitution, groundwater purchase, and crop idling. The amount that could be purchased would be limited by the excess capacity of the Delta export pumps to move the water to export areas south of the Delta.

During wet years, pump capacity available for EWA asset water may be limited to as little as 50,000 – 60,000 acre-feet because the Projects would primarily use their pumps to deliver to their users in the Export Service Area. The potential for groundwater effects during wet years for the Flexible Purchase Alternative would be very similar to effects of the Fixed Purchase Alternative. Acquisitions would most likely be from stored surface water sources and not from groundwater sources, and there would be no groundwater effects.

The Flexible Purchase Alternative's greater reliance on groundwater substitution and purchase acquisitions during dry years would result in a greater potential for groundwater effects than with the Fixed Purchase Alternative. During dry years, when the Projects have less water available for pumping to users in the Export Service Area, the pumps would have greater available capacity for the EWA. The EWA Program would acquire up to 600,000 acre-feet from areas Upstream from the Delta Region; to reach this quantity, the EWA agencies would rely more on groundwater resources for the additional EWA acquisitions. The potential for groundwater effects could increase if multi-year groundwater transfers occur in the same area for a consecutive number of years. Also, the potential of adverse effects would increase if there were an annual net decline in groundwater levels or if there were several consecutive dry (drought) years when water users would rely more heavily on groundwater supplies. Implementing the groundwater mitigation measures would reduce the significance of these effects to less than significant.

6.2.6.2 Export Service Area

EWA asset acquisitions in the Export Service Area under the Fixed Purchase Alternative would be 150,000 acre-feet from stored groundwater and crop idling sources. The EWA Project Agencies would acquire stored groundwater only from agencies that have previously stored water in the ground (e.g., Kern Water Bank). As discussed in Section 6.2.4.2, the amount of water available for transfers outside of Kern County is limited. The purchase of banked groundwater for a consecutive number of years may reduce the amount of water available for future years.

EWA asset acquisitions in the Export Service Area under the Flexible Purchase Alternative would be dependent on the water year type north of the Delta. Export pump capacity during wet years would limit the ability of the EWA Project Agencies to move assets through the Delta, requiring reliance on greater purchase amounts from export area sources. During wet years, acquisitions within the Export Service Area could involve up to 540,000 acre-feet of assets assuming that quantity would be available from Export Service Area sources. Consecutive multi-year acquisitions exceeding the 150,000 acre-foot purchase cap for the Fixed Purchase Alternative would deplete groundwater reserves available for future transfers outside Kern County at a more rapid rate than the Fixed Purchase Alternative. The MOUs and agreements discussed in Sections 6.2.4.2 and 6.2.5.2 would minimize the adverse effects of these increased acquisitions and address any effects that occur.

6.2.7 Groundwater Mitigation Measures

The Purchasing Agencies Review Process and groundwater mitigation measures in Section 6.2.7.1 and Section 6.2.7.2 sets forth a framework that is designed to avoid adverse groundwater effects. The EWA agencies will adopt these mitigation measures to assure that EWA purchases do not result in significant, unmitigated adverse effects related to groundwater extraction. The EWA agencies have employed similar measures on other transfers, and are committed to implementing these measures for any groundwater-related actions. Alternative approaches to mitigation are possible and may be appropriate for water transfer projects that are undertaken by other parties and that are not part of the EWA.

6.2.7.1 EWA Project Agencies' Principles for Entering into Groundwater Based Transfers

Particular care is required to design groundwater transfers that would not have significant unmitigated effects on other users of water or have unacceptable environmental effects. In order to minimize the environmental effects of the EWA water acquisition program, the EWA agencies have developed mitigation measures to be applied prior to entering into any purchase that would involve the extraction of groundwater. The mitigation measures serve to limit the potential for significant injury to other legal users of water and effects on the environment. When negotiating water purchases, the Project Agencies would apply these mitigation measures to water acquisitions for the EWA. The mitigation measures do not represent the only viable approach to mitigation of potentially significant impacts that may result from groundwater substitution based transfers.

The following text describes the systematic process that the Project Agencies would follow when deciding whether to purchase water through groundwater based transfers. The objectives of this process are: to mitigate significant environmental effects that occur; to minimize potential effects to other legal users of water; to provide a process for review and response to reported third party effects; and to assure that a local mitigation strategy is in place prior to the groundwater transfer.

The process should be a collaborative effort between willing sellers and the Project Agencies. This process recognizes that the seller should be responsible for assessing and mitigating significant adverse effects resulting from the transfer within the source area of the transfer. It also recognizes that the EWA agencies' principles require them to determine whether the seller has an adequate mitigation plan in place. Accordingly, the Project Agencies would take on the responsibility of reviewing existing groundwater levels in the local area of transfer and approving the seller's extraction wells, monitoring, and mitigation plans prior to the initiation of a groundwater based transfer to the purchasing agencies. This review and approval process would be necessary to provide credibility to the determination by the EWA agencies that no significant environmental impacts would occur, while relying on the sellers for implementation of the local monitoring and mitigation programs.

6.2.7.1.1 Purchasing Agencies Review Process

Initially, the seller would submit the information set forth in the groundwater mitigation measures to DWR. (See Section 6.2.7.2, Information to be Submitted.) After receipt of this information, the following procedure would take place to evaluate the information provided:

- A Review Team, composed of DWR and Reclamation technical staff (that includes California Certified Hydrogeologists), would review and evaluate the information provided according to the objectives and specifications outlined in the mitigation measures. The review is intended to ensure that the wells used in the program would not pose an unacceptable risk of depleting surface water and that the seller has developed monitoring and mitigation programs necessary to recognize and avoid/mitigate for significant environmental and water user effects that could occur as a result of the groundwater transfer.

- If the Review Team concluded that the potential for effects would be relatively low and that the proposed transfers to the EWA would reasonably address mitigation of anticipated adverse effects, the process to initiate the transfer could commence. However, if modifications were necessary, the Review Team would provide recommendations to the seller regarding changes that should be made prior to the transfer in order for EWA to purchase the water proposed for transfer. The Review Team would work with the seller to identify appropriate means to address any changes to the submitted proposal to comply with the EWA purchasing principles.

- If agreement were reached on an acceptable project proposal, the Project Agencies and willing seller would negotiate a contract to implement the proposed transfer.

The Review Team would need sufficient information to evaluate whether the desired objectives are met. The mitigation measures provide recommendations on the information to be submitted for review.

The Review Team recognizes that site conditions vary agency-to-agency and the extent of information that needs to be submitted would differ. These recommendations would serve as an initial guideline to selling agencies concerning the level of detail and type of information that may be needed to evaluate the proposed well operations and programs for compatibility with the EWA purchasing principles. The Review Team may require additional information prior to project implementation, or additional studies during implementation, to verify the validity of the hydrogeologic analysis underlying the project proposal.

The primary objective of the Review Team would be to develop reasonable assurance that all significant groundwater effects that could result from groundwater transfers to the EWA Project Agencies have been identified, assessed, avoided where possible, and mitigated if avoidance were not possible.

6.2.7.2 Groundwater Mitigation Measures

The groundwater mitigation measures will apply to all EWA groundwater transfers with exception of those from established groundwater banks that have undergone environmental review (meeting CEQA/NEPA specifications) and have developed formal agreements/MOUs regarding banking operations among the banking participating agencies and if need be, among adjoining agencies. The mitigation measures consist of four components: Well Review, Pre-Purchase Groundwater Evaluation, Monitoring Program, and Mitigation Program. The sections below describe these measures.

6.2.7.2.1 Well Review

Objective: The purpose of the well review is to assure that all extraction wells used for water transfer to the EWA would be located and operated in such a manner as to minimize the potential risk of depleting surface water sources and adversely effecting groundwater quality. [20]

The well review will not be used to determine which wells can be used for private uses or independent transfers, but solely to determine whether the buyers would enter into a purchase agreement that includes the use of the proposed wells. If a well is found to be unacceptable for use in the proposed transfer, the Review Team and seller may, if desired by the seller, agree to develop additional information on the well(s) in question, conduct investigations to resolve the Review Team's concerns, adopt criteria for well operation, or develop a method for discounting the production of the well to reflect any agreed-upon depletion of surface water sources effected by the pumping. Regardless of the foregoing efforts, the seller will retain the sole discretion as to whether to accept the recommendations of the Review Team or to opt

[20] The well review in the EWA groundwater mitigation measures originated from the "Water Transfers Paper for Water Transfers in 2002 involving the Department of Water Resources" (DWR, 2002). These reviews are very similar, except that the EWA mitigation measures also addresses the degradation of water quality.

not to use the well(s) in question as part of the transfer to EWA. Following review of the well information (see description of information to be submitted below), the seller and Review Team will discuss proposed operational constraints. The seller will have the option of: (a) adhering to the proposed operational constraints, (b) conducting additional investigations to prove scientifically that the operation of the well(s) in question does not result in adverse effects, or (c) electing not to participate in the proposed transfer.

Information to be Submitted: The seller will submit a variety of information to the Review Team for the Well Review no less than one month in advance of the transfer. Well-specific data to be submitted to the Review Team includes:

1) Locations of proposed production wells and monitoring program wells plotted on USGS 7.5-minute quadrangle maps and listed in a table showing well owner, well name or owner's number, State Well Number (if known), and latitude and longitude.

2) A driller's log giving the geology and well construction details (well seals and well perforated intervals) or a letter from the drilling company giving this information. A geophysical log could be used in place of the geology on the driller's log. If the driller's log and the well construction details are not consistent, additional information may be required.

3) In the absence of the data outlined in item (2), other information, such as aquifer performance tests or other local studies, that characterizes the hydrogeologic environment near the well and allows evaluation of potential effect to nearby rivers, streams, canals or drains should be provided. In the absence of this information the Review Team may recommend additional monitoring/testing to develop the needed information while allowing interim use of the well.

The amount of information submitted for each well will depend on its location relative to surface water features and other areas that may be highly sensitive to effects. The criteria outlined below are intended to: 1) serve as a guideline for sellers on the extent of information that should be submitted to the Review Team and 2) indicate how the Review Team will perform the initial review of the wells within one to two miles of major surface water features and minor surface water features. For the Sacramento Valley these features are shown on the draft map entitled "Groundwater Substitution Water Transfers Well Approval Areas" dated January 18, 2002. In addition, any wetlands that have been formally delineated and that are dependent upon groundwater should be treated as minor surface water features.

Provided that wells are farther than two miles from major surface water features, farther than one mile from minor surface water features, and they do not appear to be located in areas that may result in additional effects mentioned above, the wells will be accepted for providing EWA assets.

Evaluation: Wells that have previously been determined to meet the well approval provisions of the mitigation measures may not need to be reviewed unless the Review Team decides that sufficient new information on the hydrogeology of the project area has been developed to merit reconsideration, or that the wells are located in proximity to an area of groundwater contamination that may be induced to migrate into previously uncontaminated areas. Sellers will be encouraged to discuss these matters with the Review Team prior to submitting well information.

The following acceptance criteria minimize the risk of harm to legal downstream water users and the potential for effects to the riverine environment.

Wells between one and two miles of a major surface water feature tributary to the Delta will be accepted unless one of the following applies:

- Insufficient information is submitted, that is, no driller's log or other sufficient information is submitted to demonstrate that the well is not connected to the surface water system tributary, or
- The well is perforated within 50 feet of the ground surface and the information submitted is insufficient to demonstrate that the well is not connected to the surface water system tributary to the Delta.

Wells within one mile or less of a major surface water feature tributary to the Delta will be accepted if the following conditions are met:

- The uppermost perforations start below 150 feet bgs; or
- The uppermost perforations start between 100 and 150 feet bgs and the well has a surface annular seal to at least 20 feet; a total of at least 50 percent fine-grained materials in the interval above 100 feet bgs; and at least one fine-grained layer that exceeds 40 feet in thickness in the interval above 100 feet bgs; or
- The seller provides other information to DWR and Reclamation that demonstrates that the well is not in connection with the surface water system tributary to the Delta.

Wells near minor surface water features tributary to the Delta that will be potentially affected by groundwater pumping will be evaluated by using the following procedure:

- Wells that are between one half and one mile from minor surface water features tributary to the Delta will be accepted using the same criteria listed for the wells that are between one and two miles from a major surface water feature above.
- Wells within one-half mile or less of a minor surface water feature tributary to the Delta will be approved using the same criteria listed for wells that are within one

mile of a major surface water feature. If it can be determined that the minor surface water feature (other than a wetland) does not flow during times when the Sacramento-San Joaquin Delta is in balanced conditions, the wells will be acceptable regardless of construction characteristics.

6.2.7.2.2 Pre-Purchase Groundwater Evaluation

Objective: The purpose of the Pre-Purchase Groundwater Evaluation is to avoid groundwater transfers that could result in regionally significant adverse effects. Within the context of the groundwater mitigation measures, regional effects will apply to groundwater effects that are experienced in the majority or large portion of a selling agency's boundaries and may also affect adjoining districts. In contrast, local well interference effects from drawdown around wells would imply a much smaller scale. For instance, if it was demonstrated that the pumping activity for a transfer is adversely affecting several neighboring wells, this will be defined as a local effect.

The Pre-Purchase Groundwater Evaluation is intended to avoid effects resulting from water transfers that could occur in consecutive years or during extended dry periods. Local effects that could occur following EWA transfers are addressed in the remaining three components of the groundwater mitigation measures.

Evaluation and Information to be Submitted to the Review Team: Prior to an EWA groundwater acquisition, groundwater levels will be assessed relative to historical levels and the proposed transfer amount. The nature of a Pre-Purchase Evaluation will vary according to whether the selling agency overlies an overdrafted subbasin or a subbasin that typically recovers either during the subsequent wet season or during the wet period following a dry year or a series of dry years. Furthermore, the level of detail needed for an evaluation will also depend on the existing hydrologic conditions and the relative potential of regional effects.

Prior to the evaluation, the selling agency and the Review Team will discuss and agree on the level of the Pre-Purchase Evaluation. The following discussion provides general guidelines on the level of evaluation needed for subbasins that typically experience full recovery during the wet season (given the potential for regional effects) and for overdrafted subbasins.

Minimal Potential for Regional Effects in a Non Overdrafted Subbasin – If existing groundwater levels are high relative to historical fluctuations, then groundwater transfers will likely not have potentially adverse effects. Selling agencies should submit regional groundwater level data to the Review Team. A regional groundwater level review, however, will not be necessary. The transfer will be performed in accordance with the remaining elements of the groundwater mitigation measures.

Intermediate Potential for Regional Effects in a Non Overdrafted Subbasin – If existing groundwater levels are within the intermediate range of historical fluctuations, then a groundwater transfer could potentially cause levels to decline below historical levels.

The willing seller will complete a pre-purchase evaluation to further investigate the potential for adverse regional effects. This evaluation will consider the following: 1) groundwater level fluctuations for existing monitoring wells, 2) surface water imports and applied water recharge, 3) recent and historical hydrology 4) expected groundwater extraction activities from local farmers and other acquisition programs, and 5) any areas of special concern, such as localized areas of poor groundwater quality. Given the results of the study, the seller can choose the following: 1) modify recovery operations to avoid areas of higher risk, 2) decrease the amount transferred, or 3) carry forward with the proposed transfer if the willing seller concludes that potentially adverse effects would be minimal. The willing seller will submit the results of this evaluation, in addition to any operational modifications, to the Review Team. The Review Team will assess the results and determine whether they agree or require additional modifications to the extraction operations to avoid effects.

Elevated Potential for Regional Effects in a Non Overdrafted Subbasin - If existing groundwater levels are at the lower range of historical fluctuations, then a groundwater transfer will increase potential for causing the groundwater levels to fall below historic levels and cause regional adverse effects. The selling agency will have the option of conducting a pre-purchase evaluation, discussed above. If the Review Team, however, concludes that there is a high risk for significant regional adverse effects, the Project Agencies will not buy groundwater for the hydrologic year.

Potential of Regional Effects in an Overdrafted Subbasin – Selling agencies overlying an overdrafted subbasin must demonstrate that they have groundwater management strategies in place to manage the groundwater resources. These strategies can include groundwater management plans, groundwater recharge facilities, conjunctive use projects, groundwater conservation efforts, monitoring programs, or other components. The selling agency will submit a summary of these management strategies to the Review Team. In addition, the selling agency will make a formal determination that the proposed transfer will not contribute to conditions of long-term overdraft and that it is consistent with any applicable groundwater management plan. The Review Team will determine whether these management efforts are suitable to avoid regional effects or whether groundwater management modifications are needed to ensure that all effects are avoided. If necessary, the Review Team can also require an evaluation of existing groundwater levels, similar to the evaluation described in Intermediate Potential for Regional Effects in a Non Overdrafted Subbasin above. EWA transfers will only take place when the Review Team has concluded that the potential for all regional effects is minimal and that transfer amounts would not contribute to additional long-term drawdown.

6.2.7.2.3 Monitoring Program

Objective: Sellers transferring water to the EWA Project Agencies via groundwater transfers will demonstrate to the Review Team that they have an established Monitoring Program to identify potential effects before they become significant. The Monitoring Program:

- Provides assurances that the quantity of water pumped in lieu of surface deliveries is accounted for properly and is delivered to the EWA Project Agencies.
- Determines the surface water/groundwater interactions in the areas where groundwater is pumped for the transfer agreement, including both pumping-induced infiltration and interception of groundwater discharge or identification of a program that addresses this issue.
- Assesses the effects of the transfer on the existing groundwater system.
- Determines the direct effects of transfer pumping on the groundwater basin, including any residual effects until full recovery of pre-project water levels occurs or seasonal high levels occur in the spring following the transfer.
- Assesses the occurrence of any third party effects and, if they occur, their magnitude and significance.
- Coordinates the monitoring program, as appropriate, with other established programs in the area.

Evaluation: The regional extent and frequency of monitoring necessary to meet the program objectives will depend on site specific factors, such as the subsurface hydrogeology, local hydrology, and operation of the extraction pumps. For instance, areas that are susceptible to land subsidence may require extensometers, while areas with groundwater quality concerns may require a more comprehensive set of groundwater quality laboratory tests. The monitoring programs will be evaluated on their ability to meet the objectives outlined above relative to site-specific conditions within the affected area. To meet the objectives, a monitoring program will, at a minimum, contain the following components: 1) a network of monitoring wells that adequately covers the area that is to be pumped, 2) periodic flow meter readings at the extraction pumps, 3) periodic measurements of groundwater levels, 4) groundwater quality testing, 5) means to detect land subsidence or a credible analysis demonstrating that subsidence is unlikely to occur, and 6) a coordinated means to collect data and cooperate with other monitoring efforts in the area.

Information to be Submitted: Each seller will submit sufficient information documenting that its proposed transfer incorporates all of the elements listed above. The seller will submit the planned monitoring program to the Review Team at least one month prior to the groundwater transfer. The following discussion provides additional detail regarding the monitoring plan components and information that the seller needs to document.

*Monitoring Wells and Locations***:** The seller will provide evidence that it has developed the monitoring well network giving consideration to the location of production wells, the construction of both the monitoring and production wells, the location of third party wells and the relationship of production wells to surface water bodies and any contaminated areas that could be affected by pumping. This ensures that the Monitoring Program incorporates a sufficient number of monitoring wells to accurately characterize groundwater levels and response in the area before, during, and after transfer pumping takes place. Selling agencies will submit a map showing the location of the monitoring wells in relation to the extraction wells that would be used during the transfer.

Groundwater Pumping: The recording of flow meter readings will be performed upon initiation of pumping and at designated times during the duration of the transfer. The seller will calculate and report the quantity of water pumped between successive readings. In addition, the seller will record electric meter readings and fuel consumption for diesel pumps and make the records available to the Review Team for audit upon request.

Groundwater Levels. The selling agency will report measurements of groundwater levels in both production and monitoring wells to the Review Team. This reporting will include the frequency of readings prior to pumping to establish background trends. Reporting will also include measurements during the transfer, and, no less frequently than monthly following the termination of pumping, continue until water levels recover to pre-pumping levels or water levels recover to seasonal highs in the spring of the year following the transfer. The selling agencies will submit a proposed schedule of readings to the Review Team for initial review.

Groundwater Quality: The extent of groundwater quality monitoring needed to access effects will depend on the potential movement of water of reduced quality in response to transfer-related pumping. The extraction of groundwater from areas that are relatively close to reduced quality conditions can require more intensive monitoring than areas that have documented good water quality. Groundwater quality testing will incorporate electrical conductivity testing and be conducted at selected production and monitoring wells. Such testing will occur prior to initial pumping, at the mid-point of the transfer, and at termination of pumping for the transfer. Testing for additional parameters may be necessary depending of the nature of the water quality concerns. The details of any additional testing will be developed cooperatively by the seller and the Review Team and will be applied in an adaptive manner. Selling agencies should submit a planned approach to sampling production wells and a sampling schedule for the monitoring wells. This schedule will indicate the monitoring wells that are to be sampled, the sampling tests to be conducted, the sampling frequency, and the schedule for sampling following the groundwater transfer. A map may also be required, identifying areas of water quality concern within the agency and in neighboring areas that are within proximity to the agency.

Land Subsidence: The extent of monitoring needed to assess effects will depend on the expected susceptibility of the area to land subsidence. Areas in which land subsidence has been documented will require more extensive monitoring than other areas. Alternatively, a plan can rely on maintaining water levels above historic lows thereby minimizing the risk of additional subsidence. The plan will range from periodic determination of elevation in strategic locations throughout the transfer area to installing extensometers and taking readings from them. The plan will include trigger levels requiring action in the event that changes in elevation are detected, as well as provisions for responding to any subsidence detected after cessation of the transfer.

Coordination of Plans: The success of a monitoring program depends on a coordinated means of collecting and organizing the information, in addition to communicating with the well operators and other decision makers. The monitoring plan should identify a contact person responsible for the monitoring and assembly of data. This contact person could be required to meet with a Review Team representative at least two weeks before the start of the groundwater pumping. Together, these parties may visit the monitoring program well sites prior to the start of pumping to measure pre-pumping groundwater levels and to read and inspect flow meters. Those implementing monitoring should attempt to coordinate their efforts with other local monitoring programs. As discussed in 6.2.9.1, coordination with other programs will be facilitated through CALFED's Water Transfer Program.

6.2.7.2.4 Mitigation Program

Objective: The groundwater activities being undertaken by the EWA will be designed to minimize potential environmental impacts through pre-transfer evaluations and the Monitoring Program. In addition, a mitigation program will be required. A number of potential impacts are sufficiently serious that they must be avoided or mitigated for a project to continue. These include:

- Contribution to long-term conditions of overdraft;
- Dewatering or substantially reducing water levels in non-participating wells;
- Measurable land subsidence;
- Degradation of groundwater quality that substantially impairs beneficial uses or violates water quality standards; and
- Affecting the hydrologic regime of wetlands and/or streams to the extent that ecological integrity is impaired.

The previous sections of this document discussed the evaluation process to be used in selecting projects to supply the EWA and the monitoring required for ongoing assessment of the effects of the operating projects. In addition, the following section describes the requirements that a seller develop a mitigation program to address potential impacts.

The mitigation strategy is essentially two-fold. First, the seller will design and implement a monitoring and mitigation plan and will be responsible for mitigating any significant environmental impacts that occur. Second, if the EWA agencies determine that the mitigation undertaken by the seller is inappropriate or ineffective, it will terminate its participation in the project.

Evaluation: Mitigation programs will be tailored to the local conditions within each region. To ensure that each plan meets this objective, the mitigation plan will include the following elements: 1) a procedure for the seller to receive reports of purported environmental or third party effects and to report that information to the Review Team, 2) a procedure for investigating any reported effect, 3) development of mitigation options, in cooperation with the affected third parties, for legitimate effects, 4) assurances that adequate financial resources are available to cover reasonably anticipated mitigation needs, and 5) commitment to avoid or mitigate such effects during future transfers to the EWA.

Information to be Submitted: Sellers will submit a mitigation plan to the Review Team at least one month prior to the groundwater transfer. The following discussion describes the level of detail that the seller must submit in order for the Review Team to determine that a mitigation plan could effectively address mitigation needs.

Reporting to the Review Team. During the transfer, reporting to the Review Team will include data summary tables each month until groundwater levels return to those prior to the start of the pumping. These tables will report the monthly and cumulative quantity pumped, the water level in each well being monitored and any surface water measurements made. In addition, the seller will report any third party effect and its resolution. The seller will prepare and submit a final summary report evaluating the effects of the water transfer program. The final report will include water level contour maps for the subbasin in which the acquisition area is located showing initial water levels, water levels at the end of the transfer, and final recovered water levels.

Response to Reported Impacts. If an effect is identified, the description of the effect and the sellers' proposed response will be submitted to the Review Team. The submittal will include the following: 1) a description of how a formal claim may be made if an impact is suspected, 2) the process to be undertaken to address the claim including if and what type of mitigation measure is necessary, and 3) how the mitigation should be accomplished.

Financial Strategy on Funding Mitigation Measures: Mitigation measures will be locally funded, unless an agreement is made otherwise. Selling agencies will provide assurance that adequate financial resources are available to accomplish any required mitigation.

Commitment to Avoid the Same Impact During Future Transfers: Following investigation, if it is determined that an effect was caused by an EWA groundwater transfer, the seller will be responsible for taking measures to avoid, or effectively mitigate, the same impact in the future, if the seller participates in additional water transfers to the EWA.

6.2.7.3 Groundwater Transfers Near Indian Trust Assets

EWA groundwater transfers may not cause significant adverse effects to nearby Federally reserved Indian Trust Assets. To ensure this, EWA groundwater extraction within 1-2 miles of Indian trust land will require a more detailed pre-purchase groundwater evaluation, which can include estimates of potential interference effects to nearby Indian wells. Before finalizing acquisition contracts, formal consultation will take place between the potentially affected Indian tribe, the willing seller, and appropriate EWA agencies. During this consultation, additional commitments will be developed to further minimize potential effects. Such commitments can include more frequent groundwater monitoring and the discontinuation of EWA groundwater pumping if groundwater levels are drawn down to a level of concern near Federally reserved Indian Trust Assets. The consultation process should ensure that all potential adverse effects are addressed prior to an EWA transfer.

6.2.8 Potentially Significant Unavoidable Impacts

There are no potentially significant unavoidable impacts.

6.2.9 Cumulative Effects

A variety of local and regional programs could cumulatively affect groundwater resources within the next 4 years. The cumulative effects analysis in this EIS/EIR, however, focuses on the regional programs that may affect groundwater rather than local projects. If the cumulative effects resulting from local projects were of concern, this concern would be addressed through the groundwater mitigation measures' pre-purchase evaluation. This section focuses on the potential cumulative effects resulting from larger scale regional programs.

6.2.9.1 Upstream from the Delta Region

Four programs, the Sacramento Valley Water Management Agreement (SVWMA), Dry Year Purchase Program, Environmental Water Program (EWP), and the Drought Risk Reduction Investment Program (DRRIP), could include crop idling as a water acquisition method during dry years. Transfers negotiated between CVP and SWP contractors and other water users, such as the Forbearance Agreement with Westlands WD and the recent crop idling acquisition by Metropolitan WD from water agencies upstream from the Delta, are part of the Dry Year Purchase Program. The above analysis concludes that idling 20 percent of rice or cotton acreage per county would result in less-than-significant effects. As explained in Chapter 11, the EWA agencies would not purchase crop idling water if other reasonably foreseeable transfers from other programs would likely purchase more than 20 percent of rice acreage in that county. Therefore, the above analysis is also consistent for the cumulative effects because the EWA would only purchase water from crop idling in counties where the total of all programs was less than 20 percent of acreage.

Five programs, the SVWMA, Dry Year Purchase Program, EWP, DRRIP, and the Central Valley Improvement Act (CVPIA) Water Acquisition Program, could acquire water via groundwater substitution and groundwater purchase upstream from the Delta. These acquisition programs are described in Chapter 22, Cumulative Effects.

Cumulative effects from these programs would be more likely during dry years than wet years. During wet years, the Dry Year Purchase Program and the DRRIP would most likely not purchase groundwater, and the amount of groundwater that may be purchased by the remaining acquisition programs would be limited because the export pumping capacity is limited. Consequently, the potential for adverse groundwater effects would be less.

In dry years, however, the programs may acquire more groundwater because the pumps would have greater available capacity. The EWA Program, in addition to the SVWMA, Dry Year Purchase Program, and the DRRIP Program, plans to purchase groundwater during dry and critically dry years. The reduction in recharge (due to the decrease in precipitation and runoff) in addition to the increase in groundwater transfers would lower groundwater levels.

Multi-year groundwater acquisition in areas that have repeatedly transferred groundwater may also be more susceptible to adverse effects. In these areas groundwater levels may not fully recover following a transfer and may experience a substantial net decline in groundwater levels over several years.

These cumulative effects could be potentially significant if these programs are not coordinated. It is assumed that each program will institute groundwater mitigation measures similar to those stipulated under the EWA Program. The EWA's groundwater mitigation measures require a pre-purchase evaluation for areas in which groundwater levels (prior to the transfer) are sufficiently low to warrant potential regional adverse effects. (See Section 6.2.7.2.) If the evaluation shows that EWA extraction would likely result in regional adverse effects, the EWA Project Agencies would not purchase groundwater from the area of concern. The groundwater mitigation measures require that the local selling agencies establish monitoring and mitigation programs prior to EWA transfers.

In addition to the monitoring and mitigation stipulations set forth under the EWA groundwater mitigation measures, the SVWMA provides further initiatives to encourage the development of local groundwater management. The local projects focus on surface water/groundwater planning and conjunctive use, including monitoring, areawide inventories and assessments, construction/improvements of conjunctive use facilities, and development of conjunctive use programs. Benefits include 1) improved knowledge of groundwater-surface water interaction, 2) enhanced understanding of groundwater resources and aquifer characteristics, and 3) improved operational flexibility. The additional knowledge and greater flexibility provided by these programs would be beneficial for the understanding of EWA asset acquisition effects (Erlewine 2002). The SVWMA Program would also include monitoring programs in the SVWMA conjunctive use project areas. The initial monitoring in 2003 would focus on identifying potential hydraulic effects. The information acquired from these monitoring programs may be useful for minimizing and/or avoiding the cumulative effects of the acquisition programs mentioned above, further minimizing the potential for cumulative effects. Consequently, the coordinated implementation of these programs together with the mitigation measures stipulated under the EWA Program would minimize any adverse effects that the EWA Program may contribute to the cumulative effects of all the programs to less than significant.

6.2.9.2 Export Service Area

The DRRIP, together with the EWA Program, would also include the option of crop idling south of the Delta. The DRRIP could increase the amount of idled acres if this program and the EWA Program were acquiring water via crop idling at the same time in the same area. Coordination among the asset acquisitions programs would minimize adverse effects, and would be facilitated through CALFED's Water Transfers Program. Also, if the total amount of land idled by all programs, including the EWA, exceeds 20 percent of the county's cotton acreage, the EWA Program would avoid adverse effects by not idling land for that year. Furthermore, due to economic effect considerations, crop idling action would be distributed throughout the agencies, reducing a potential for local groundwater recharge effects due to reduced surface water application to grow crops. Based on this assumption, all potential groundwater recharge effects would be less than significant.

Groundwater purchase and groundwater substitution transfers are components of the DRRIP and the CVPIA Water Acquisition Program. Groundwater purchases for these two programs, in addition to the EWA Program, could result in lower groundwater levels in the Kern County groundwater banks (Section 6.2.4.2). All groundwater purchases must adhere to the local groundwater banking MOUs and agreements discussed in Section 6.2.4.2. These agreements are intended to minimize effects and provide assurances that the local agencies would mitigate effects to less than significant should they occur.

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Chapter 7
Geology, Soils, and Seismicity

This chapter presents the potential effects on geology and soils resulting from the planned Flexible and Fixed Purchase Alternatives of the Environmental Water Account (EWA). Because the EWA does not involve the construction or modifications of infrastructures that could be adversely affected by seismic events, seismicity is not discussed. Furthermore, because the EWA does not include a construction component, program actions would not expose people or structures to geologic hazards such as ground failure or liquefaction; geologic features are discussed primarily to provide background, not as a part of effects analysis. The focus of this chapter is on the potential erodibility of soils due to crop idling. Factors such as surface soil texture, precipitation, and wind velocity and duration are considered in this evaluation because these factors may affect soils. This chapter also discusses the potential of soils to release toxic substances and salts onto adjacent lands and/or into the atmosphere. Section 7.1 is the affected environment/existing conditions that describe conditions without the project. Section 7.2 analyzes the effects of the No Action/No Project Alternative, Flexible Purchase Alternative, and Fixed Purchase Alternative on air quality. Section 7.2 also includes a comparative analysis of the alternatives, a cumulative effects discussion, and mitigation measures.

Figure 7-1
Geology and Soils Area of Analysis

7.1 Affected Environment/ Existing Conditions

7.1.1 Area of Analysis

Key variables described in this section include geology, chemical processes, and soil properties. As stated above, the potential effects associated with seismicity are not included in this discussion because the EWA would not involve any infrastructure that could be affected by seismic events. Chapter 6, Groundwater Resources, discusses other subjects including geomorphology and land subsidence. As the remaining EWA action that would affect geology and soils, specifically crop idling, is not occurring in the Delta Region, the Delta Region is not included in the existing conditions or effect analysis. The discussion of geology and soils is presented by county in the Upstream from the Delta Region and in the Export Service Area. This chapter focuses on the counties in which crop idling would take place (Figure 7-1):

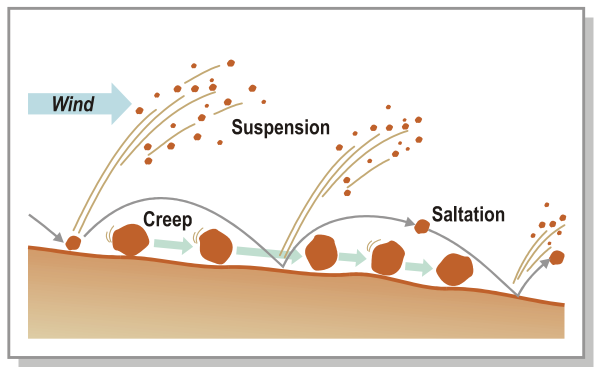
- **Upstream from the Delta Region:** Glenn, Colusa, Yolo, Sutter, Butte, and Placer Counties; and
- **Export Service Area:** Fresno, Kern, Kings, and Tulare Counties.

Potential effects associated with EWA actions relate to soil erodibility, as discussed below. The characteristics of expansive soils, which have the potential to cause damage by swelling and shrinking, are also presented below.

Soil erodibility, climatic factors, soil surface roughness, width of field, and quantity of vegetative coverage affect the susceptibility of soils to wind erosion. (These factors also affect the susceptibility of soils to water erosion. EWA actions, however, would only take place during dry periods; there would be no effects on soil from water erosion due to EWA actions. Water erosion is therefore not discussed further.) Wind erosion reduces soil depth and can remove organic matter and needed plant nutrients by dispersing the nutrients contained in the surface soils.

7.1.2 Wind Erosion

Wind transports soil particles in three ways: saltation, surface creep, and suspension (Figure 7-2).



Source: NRCS 1998

Figure 7-2
Wind Erosion Processes

- *Saltation* occurs when particles ranging in size from 0.1 to 0.5 mm in diameter are lifted from the ground, follow distinct paths influenced by air resistance and gravity, fall back to the ground, and cause the movement of additional particles. Generally, saltation occurs within one foot of the soil surface (based on velocity and other factors) and typically travels a distance about 10 times the height. Fifty to eighty percent of total soil transport is by saltation.
- *Surface creep* moves sand-sized particles set in motion by the effect of saltating particles. During high winds, the soil particles roll across the ground surface as the particles are pushed by the flow. Surface creep can account for 7 to 25 percent of the total soil transport.
- *Suspension* is defined as the wind moving finer particles, less than 0.1 mm in diameter, upward by diffusion. These particles can remain in the air mass for lengthened periods of time. Suspension accounts for 20 to 60 percent of the total soil transport, depending on soil texture and wind velocity.

The wind erodibility group (WEG) is a grouping of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The WEG ranges from values1 through 8, 1 indicating the greater erosion potential and 8 the least. The WEG indicates the potential for soil erosion based on several factors, such as soil texture and aggregate stability.

7.1.3 Expansive Soils

Expansive soils are soils with the potential to experience considerable changes in volume, either shrinking or swelling, with changes in moisture content. The shrink-swell capacity of the soil refers to the potential of soil to shrink when desiccated and swell or expand when rehydrated. Shrinking and swelling can damage roads, dams, building foundations, and other structures and can also harm plant roots (Soil Conservation Service 1986). The magnitude of shrink or swell in expansive soils is influenced by a number of factors:

- Amount of expansive silt or clay in the soil;
- Thickness of the expansive soil zone;
- Thickness of the active zone (depth at which the soils are not affected by dry or wet conditions); and
- Climate (variations in soil moisture content as attributed to climatic or man-induced changes).

Soils composed primarily of sand and gravel are not considered expansive soils (the soil volume does not change with a change in moisture content). Soils containing silts and clays may possess expansive characteristics. The Natural Resource Conservation Service classifies these soils as low, moderate, and high potential for volume changes (Sutter County 1996):

- **Low** - This class includes sands and silts with relatively low amounts of clay minerals. Sandy clays may also have low expansion potential if the clay is kaolinite. Kaolinite is a common clay mineral.
- **Moderate** - This class includes silty clay and clay textured soils if the clay is kaolinite and also includes heavy silts, light sandy clays, and silty clays with mixed clay minerals.
- **High** - This class includes clays and clay with mixed montmorillonite, a clay mineral which expands and contracts more than kaolinite.

7.1.4 Upstream from the Delta Region

There are four major landform types in the Upstream from the Delta Region (each with its own characteristic soils): floodplain, basin rim/basin floor, terrace, and foothill and mountain. The characteristics of these landforms are summarized below.

- **Floodplain:** Floodplain alluvial soils make up some of the best agricultural land in the State.

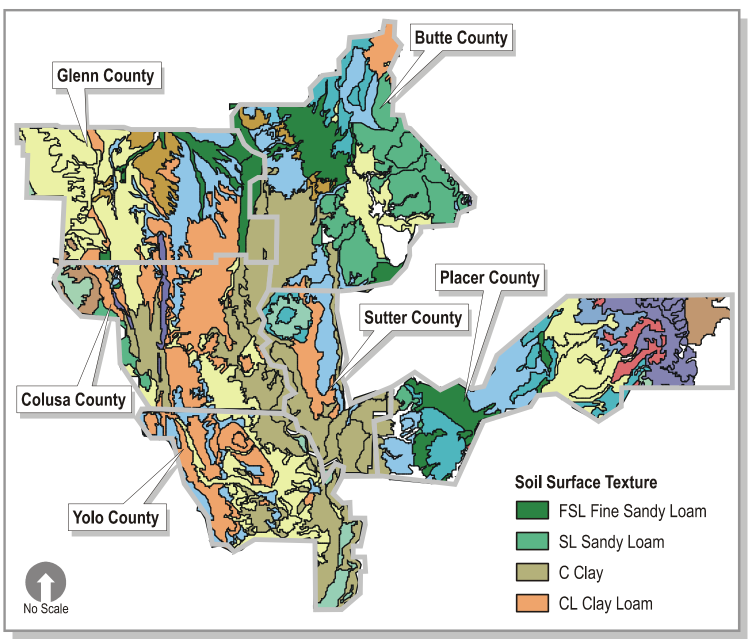
- **Basin rim/basin floor:** Basin landforms consist of poorly drained soils; saline and alkali soils are found in the valley trough and on the basin rims. These soils are used mainly for pasture, rice, and cotton. Areas above the valley floor have terrace and foothill soils, which are predominantly used for grazing and timberland.
- **Terrace and foothill:** The upper watersheds of the Sacramento Valley area primarily drain foothill soils. These soils are found on the hilly to mountainous terrain surrounding the Sacramento Valley and are formed in place through the decomposition and disintegration of the underlying parent material. The most prevalent foothill soil groups are those with a deep depth (>40 inches), shallow depth (<20 inches), and very shallow depth (<12 inches) to bedrock.

7.1.4.1 Glenn County

The terrain in the western portion of Glenn County is steeper than in the eastern portion. Two major geologic provinces within the county define the overall topography of the area, the Sacramento Valley and the Coast Range.

Elevations of the Sacramento Valley range from approximately 100 feet above mean sea level (msl) at the Sacramento River to approximately 300 feet above msl at the western edge of the valley. A small area in southeastern Glenn County lies on the eastern side of the Sacramento River; this portion of the county has little discernable slope.

Rock types in Glenn County are divided into three categories, increasing in age from east to west. Geologic materials in the east consist mostly of unconsolidated Pleistocene and Recent sediments, including alluvial fan deposits, stream channel deposits of the Sacramento River, and inland basin deposits. The middle portion of the County consists of Tertiary sediments, primarily Pliocene sediments, with some continental volcanics. At higher elevations, such as the foothill region, Cretaceous and Jurassic marine and non-marine sedimentary rocks are common, while in the mountainous region, deformed Jurassic marine sediments and volcanics are the primary rock type.



Source: USDA, Soil Conservation Service

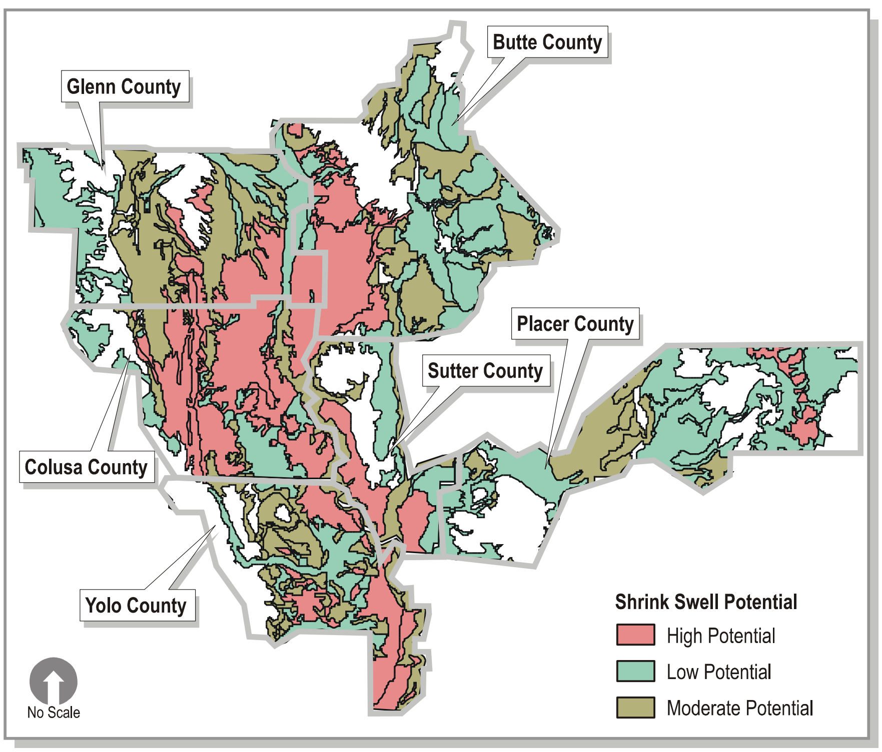
Figure 7-3
Soil Surface Texture in Upstream from the Delta Region

The eastern third of Glenn County contains a majority of prime and statewide-important farmland. Farmland of local importance is concentrated toward the central portion of the county. Western soils are designated as cobbly-loam with a WEG of 6 (Figure 7-3). The southeastern area includes silty clay soils of WEG 4. The central portion of the county contains clay loam soils also of WEG 4. Weathered bedrock is found specifically in the northern central part of the county.

Soil types in Glenn County can be divided into five general land categories defined by physiographic position, soil texture, soil profile, and slope. These land categories are:

- **Mountain soils** - These soils are shallow to deep, well drained to excessively drained, and mostly steep to very steep.
- **Soils of the foothills** - In the foothills, the soils are formed mainly from hard, unaltered sedimentary rock of the Knoxville formation and other formations of the Cretaceous period and from poorly consolidated siltstone of the Tehama formation.
- **Soils of Older Alluvial Fans and Low Terraces** - Soils of older and low terraces are well drained to somewhat poorly drained and are mostly moderately permeable to very slowly permeable.
- **Basin Soils** - The soils of the basins are in the southwestern part of the County. Soils of the basins are characteristically fine textured and poorly drained. Slopes are nearly level, and runoff is very slow.
- **Soils of the More Recent Alluvial Fans and Flood Plains** - Most of the soils on the more recent alluvial fans and flood plains of the county are along Stony Creek and the Sacramento River. The soils generally consist of shallow to deep, well-drained to excessively-drained gravelly and non-gravelly stratified material.

Glenn County contains soils with low, medium, and high shrink-swell potential (Figure 7-4). Western Glenn County has soils with predominantly low to medium shrink-swell potential, while the southeastern portion of the County contains soils with higher expansive potential.



Source: USDA, Soil Conservation Service

Figure 7-4
Soil Shrink Swell Potential in Upstream from the Delta Region

7.1.4.2 Colusa County

Colusa County is surrounded by the Sacramento River to the east, the Coast Range and foothills to the west, Cache Creek to the south, and Stony Creek to the north. The eastern third of Colusa County is virtually flat with a gently increasing elevation gradient towards the northwest. The central portion of Colusa is characterized by level to gently rolling valley lands. The high, steep ridges of the Coast Range make up the western third of Colusa County. Deep alluvial valleys, such as Bear Valley, Indian Valley, and Antelope Valley, cut horizontally across the north-south Coast Range. Elevations range from 40 feet above msl in the east to 7,056 feet at the summit of Snow Mountain in the northwestern corner of the county.

The region consists of low alluvial plains and alluvial fans. These alluvial deposits are divided into several different sub-basins based on geologic composition. These include the Stony Creek Fan, Cache Creek Floodplain, Arbuckle and Dunnigan Plains, and the Willows-to-Williams Plain.

Northwestern Colusa County consists of very gravelly sandy loam soils (Figure 7-3). This section of Colusa has a WEG of 3. The area is surrounded by unweathered bedrock. The majority of the western half of the county consists of very gravelly-sandy loam and very gravelly loam with a WEG of 6. The eastern half of Colusa is dominated by silty clay. The eastern portion of the county also has stratified soil made up of silty clay loam and fine sandy loam. Southern Colusa is gravel-loam with a WEG of 6.

The eastern portion of Colusa County contains unique farmland and prime farmland. Central Colusa County is dominated by locally important farmland. The majority of Colusa County has expansive soils with a high shrink-swell potential; a portion of southern Colusa contains soils with a low shrink-swell potential (Figure 7-4).

7.1.4.3 Yolo County

Yolo County lies within the California Coast Range and the Sacramento Valley. The western part of the county is in the Coast Range and is characterized by hilly to steep, mountainous uplands. The soils vary from moderately deep to very shallow, though much of the area is bare. The soils in this part of the county are used principally for range; the less productive areas are used as wildlife habitat (Soil Conservation Service 1972).

The gradient becomes more gradual moving east across the county from the Coast Range. Rounded hills and broad slopes become the dominant feature. The soils are moderately deep to softly consolidated material, or are shallow to a claypan[1]. They are used for dryland small grains and pasture (Soil Conservation Service 1972). Most of the county, approximately two-thirds, lies within the Sacramento Valley. The

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1 A claypan as defined by the NRCS (formerly the Soil Conservation Service) is, “A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.”

topography is nearly level and soils are used for irrigated and dryland crops as well as orchards.

The soils of western Yolo County are predominantly loams to silty clay loams (Figure 7-3). Northern and eastern Yolo soils are silt loams to silty clay loams. Clay soils are present in northeastern Yolo County. The majority of the WEG's classifications for Yolo County range from 4 to 6. The majority of Yolo County is classified as containing locally important farmland and prime farmland. Central and western Yolo County contains soils with low to moderate shrink swell potential (Figure 7-4). Southeastern Yolo County soils are classified as containing high shrink swell potential.

7.1.4.4 Butte County

Butte County includes valley, foothill, and mountain zones. The surface geology of the Sacramento Valley portion of Butte County comprises primarily alluvial deposits resulting from the eroded material from surrounding mountain ranges. Along the base of the foothills, alluvial fan and terrace deposits of the Riverbank and Modesto Formations indicate the edge of the valley sedimentary units.

The soils associated with the valley area and alluvial fans of Butte County are deep, nearly level, very fertile, and support agricultural practices. The Butte Basin was, prior to the implementation of flood control on the Feather and Sacramento Rivers, an area of extensive seasonal flooding. Early reports depict a slow-moving body of water covering from 30 to nearly 150 square miles. This slow-moving floodwater deposited the fine clay that now provides the rich agricultural soil utilized primarily for rice production.

The Foothill region occupies the transitional geologic zone between Tertiary sediments in the west part of Butte County and Mesozioc-Paleozoic rocks in the east part of the county. Jurassic and Cretaceous sedimentary rocks outcrop in the northern Foothill region. Soils in the foothills are shallow, gentle to steep sloping, less fertile, and residual.

The Mountain region is the easternmost region in Butte County. Mesozoic and Paleozoic age plutonic, volcanic, and metamorphic rocks make up the majority of the surface and subsurface geology. Other geologic formations consist of Tertiary volcanic sediments, including the Tuscan formation. High mountain soils in Butte County are shallow to deep, moderate to steep sloping, and residual. These soils support forestry and wildlife habitat including rangeland.

The western third of the county is classified as irrigated farmland. The northern tip of the county is underlain by weathered bedrock of the Tuscan Formation. Sandy loams dominate the eastern portion of the county with a WEG of 3 (Figure 7-3). Sandy clay loam and clay loam are also present in this area. The central portion of the county is primarily unweathered bedrock of the Modesto Formation. Loams are present in the northern and southern areas and have a WEG of 6. Silty clays are confined to the southwestern portion of Butte County with a WEG classification of 4.

Soils in eastern Butte County have a low to moderate shrink swell potential (Figure 7-4). The edge of western Butte County contains soils that are highly expansive.

7.1.4.5 Sutter County

The topography of Sutter County mimics the gradual slopes of the Sacramento River Valley. The only prominent topographic feature within the County is the Sutter Buttes, a Pliocene volcanic plug that rises 2,000 feet above the surrounding valley floor (Sutter County 1996). In Sutter County, the sedimentary rocks are of both marine and continental origin frequently imbedded within tuff-breccias. Beneath 125 feet of recent alluvial fan, floodplain, and stream channel deposits are as much as 100 feet of Pleistocene sands and gravels which together make up the continental sediments of the Pleistocene and Recent ages (Sutter County 1996).

The western and southern portions of the County contain areas of prime farmland. The eastern portion of the county is designated largely as statewide important farmland. The western and southern portion of Sutter County contain silty clay soils with a WEG of 4, stratified soils of silty clay loam, and fine sandy loam (Figure 7-3). The eastern portion of the county contains loam soils.

Approximately 83 percent of Sutter County soil types have been identified in the Soil Survey for Sutter County as having slight erodibility and generally consist of those soil types with slopes of 0 to 9 percent (Sutter County 1996). About 10 percent of Sutter County soils have moderate erodibility. These soil types usually have slopes of 9 to 30 percent. About 6 percent of Sutter County soil types have high to very high erodibility and generally consist of those soils types with slopes of 30 to 75 percent. The moderate and high erodibility groups contain soil types found in the Sutter Buttes (Sutter County 1996).

Expansive soils within Sutter County are most likely in basins and on basin rims (Figure 7-4). Soils with no or low expansion potential occur along the rivers and river valleys and on steep mountain slopes (Sutter County 1996).

7.1.4.6 Placer County

The topography of Placer County varies greatly. Placer County has flat areas and rolling grasslands in the west, foothills in its central portion, and steeper mountain terrain in the east.

The western half of Placer County (area considered for EWA actions) has three physiographic regions: terraces and alluvial bottoms, foothills, and mountainous uplands. The soils in the western portion of Placer County are characterized as Farmland of Local Importance and Unique Farmland. Soils in Placer County generally have a loam to clay-loam texture (Figure 7-3). These soils have a medium erosion potential, with WEGs of 4 to 6.

As shown in Figure 7-4, the majority of the expansive soils in Placer County have low to moderate shrink-swell potential.

7.1.5 Export Service Area

The following discussion addresses the generalities of the area and then concentrates on the four counties that could be affected by EWA actions, Fresno, Kings, Tulare, and Kern.

The geologic provinces composing the San Joaquin River area of analysis include the Coast Range, Central Valley, and Sierra Nevada. This area contains four major landform types (each with its own characteristic soils): floodplain, basin rim/basin floor, terraces, and foothills and mountains.

- **Floodplain:** Floodplain lands contain two main soil types: alluvial soils and aeolian soils (soils that have accumulated by the deposition of sand-sized particles by wind action). The alluvial soils make up some of the best agricultural land in the State, whereas the aeolian soils are prone to wind erosion and are deficient in plant nutrients.

- **Basin rim/basin floor:** Basin lands consist of poorly drained soils; saline and alkali soils are found in the valley trough and on the basin rims. Basin soils are used mainly for pasture, rice, and cotton.

- **Terraces:** Terrace soils are located above the valley floor and are used primarily for grazing.

- **Foothills and mountains:** Like the Sacramento Valley, the upper watersheds of the San Joaquin Valley drain mainly foothills soils, which are found on hilly to mountainous topography. Moderate depth to bedrock (20 to 40 inches) soils occur on both sides of the northern part of the San Joaquin Valley, where the annual rainfall is intermediate to moderately high. Deep (>40 inches) soils are the important timberlands of the area and occur in the high rainfall zones at the higher elevations in the mountains east of the valley. Shallow (<20 inches) soils, used for grazing, occur in the medium- to low-rainfall zone at lower elevations on both sides of the valley. Very shallow (<12 inches) soils are found on steep slopes, mainly at higher elevations. These soils are not useful for agriculture, grazing, or timber because of their very shallow depth, steep slopes, and stony texture.

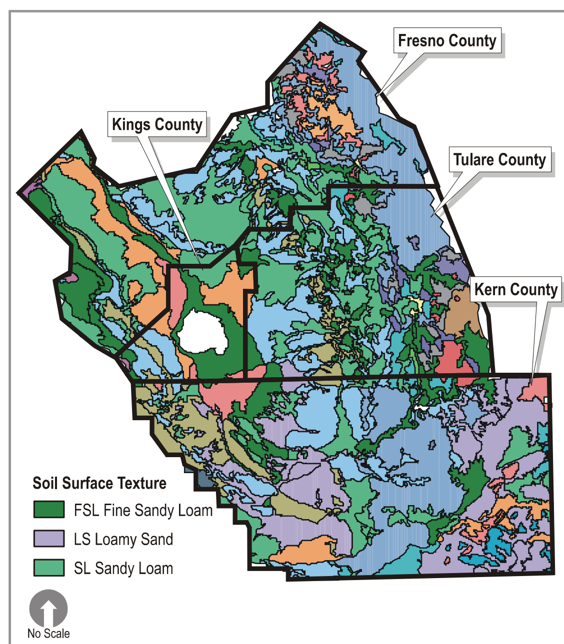
Marine sediments in the Tulare Basin (source of the majority of the soils in the basin) contain salts and potentially toxic naturally occurring trace elements such as arsenic, boron, molybdenum, and selenium (Reclamation et al. 1990). These elements dissolve and become mobilized when irrigated, contributing to contamination of groundwater or nearby water bodies due to runoff. Selenium is a problem predominantly on the western side of the basin. Salinity is also a concern on the western side of the basin; soils from the Coast Range sediments have higher salt concentrations than those from Sierran sediments. Elevated concentrations of boron and molybdenum are found throughout the basin (elevated concentrations of molybdenum are found particularly in Tulare and Kern Counties). Both of these elements are essential at low levels to the nutrition of plants; however, high concentrations can be harmful for plant growth. Arsenic, a known toxicant, is found at high levels in evaporation ponds within the basin (Reclamation et al. 1990).

7.1.5.1 Tulare County

The western part of Tulare County is in the San Joaquin Valley. Western Tulare soils were formed primarily from alluvial material deposited as rivers drained from the Sierra Nevada. The western part of the county is predominantly level and is divided into three basic geomorphic units:

- **Alluvial fans and floodplains** - These areas formed from the material deposited from the Kings River, Kaweah River, Tule River, White River, Cross Creek, and Deer Creek as runoff from the Sierra Nevada. The soils associated with these landforms represent over half the acreage in the county. The majority of these soils are classified as prime farmland.
- **Older fan remnants** - This landform occurs far from rivers and streams in areas where recent alluvial deposition has not occurred.
- **Basin rims and floodplains** - This area is on the eastern edge of Tulare Lake, which is largely dry.

Figure 7-5 shows the soil surface texture for soils in Tulare County. Highlighted are the soils that have low WEGs: loamy sand, sandy loam, and fine sandy loam (WEGs 2 and 3). These are areas that have high erosion potential. Soils in western Tulare County include loam, sandy loam, silty loam, clay, and silty clay with WEGs ranging from 3 to 6. The majority of Tulare County contains soils with low shrink-swell potential; however, a thin, vertical band of soils with high shrink-swell potential exists in western Tulare County (Figure 7-6).

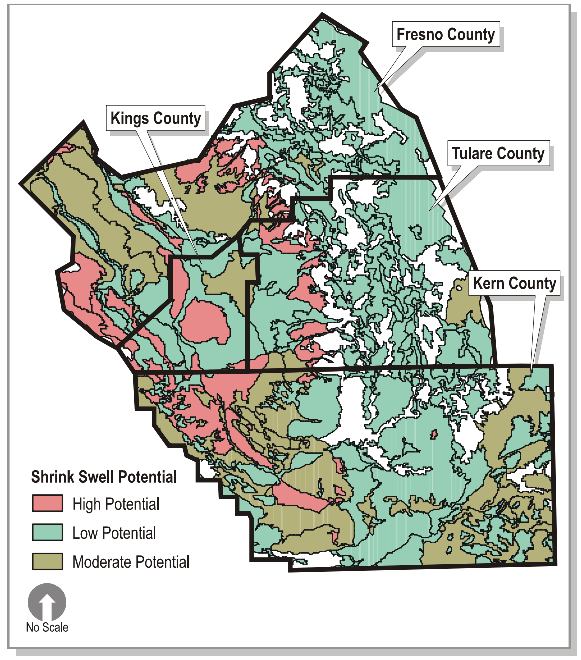


Source: USDA, Soil Conservation Service

Figure 7-5
Soil Surface Texture in the Export Service Area

7.1.5.2 Kern County

The Kern County basin is surrounded by granitic bedrock from the Sierra Nevada foothills on the east, the granitic Tehachapi Mountains on the southeast, marine sediments of the San Emigdio on the southwest, and marine sediments of the Coast Ranges on the west. The northern border of the basin is also the border for Kern County. The major streams that traverse the basin are the Kern River and Poso Creek.



Source: USDA, Soil Conservation Service

Figure 7-6
Soil Shrink Swell Potential in the Export Service Area

Eastern Kern County includes soils that have a WEG of 2 (Figure 7-5). These soils are typically loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, ash material, and/or sapric soil material. A WEG of 2 indicates soils that are highly susceptible to wind erosion. Western Kern contains loamy sands, loams, and sandy loams; southwestern Kern includes an area of clay loam soils. The WEGs of these soils range from 2 to 6.

Central Kern County contains soils with a low shrink-swell potential (Figure 7-6). Eastern and western Kern County contain soils with moderately expansive soils; eastern Kern also contains soils with high shrink-swell potential.

7.1.5.3 Fresno County

Fresno County features the Kings sub-basin, which is surrounded by the San Joaquin River to the north, Delta-Mendota and Westside sub-basins to the west, and alluvium-granitic rock of the Sierra Nevada foothills to the east. The two major rivers within the sub-basin are the San Joaquin and Kings Rivers. The Fresno Slough and James Bypass are along the sub-basin's western edge, connecting the Kings River with the San Joaquin River.

Only the central portion of Fresno County has been inventoried for prime farmland. One-third of the approximately 1 million acres inventoried is designated as prime farmland. In Fresno County, 140,000 acres of farmland is of statewide importance, 95,000 acres is classified as unique farmlands, and 45,000 acres is of local importance.

The western third of Fresno County contains silty clay soils with a WEG of 4 (Figure 7-5). The western third also contains sandy clay loam, silty loam, sandy loam, loam, and clay loam. A large portion of the central part of the county is loam with a

WEG of 6, along with clay, sandy loam, clay loam, and stony loam soils. Eastern Fresno County contains very cobbly soils and coarse sand and very gravelly soils.

Eastern Fresno County contains soils with a low shrink-swell potential (Figure 7-6). Western Fresno County contains soils with moderate to highly expansive soils.

7.1.5.4 Kings County

More than three-fourths of Kings County is in the San Joaquin Valley; the remainder is in the hills and mountains west of the valley. The Kings River alluvial fan and floodplain, located in the northeastern portion of the county, were formed from the deposition of alluvial material from the Sierra Nevada. The highest point on the Kings River alluvial fan is about 295 feet. As a comparison, the Diablo Range in the southwestern corner of the county has a high point on Table Mountain of 3,473 feet (Soil Conservation Service 1986).

Prime farmland exists in the northern tip as well as the western portion of Kings County. About half the acreage in Kings County is farmland of statewide importance. Central and eastern Kings County have clay soils with a WEG of 4 (Figure 7-5). The northern portion consists of sandy loam soils with a slightly greater WEG of 3. Sandy loams and clays are also found in the southwest. The majority of Kings County contains soils that have a low shrink-swell potential. However, the Tulare Lakebed near Corcoran contains soils with a large clay component and therefore has highly expansive soils (Figure 7-6).

7.1.5.5 Soil Erosion from Cotton Farming Practices

Soil can be eroded by wind during cotton crop cycles. Land preparation activities, discing, and harvesting cause soil particles to be broken down and increase potential for erosion. The T-factor is the soil loss tolerance expressed in tons per acre per year. Soil loss tolerance is the maximum amount of soil loss that can be tolerated and still permit a high level of crop productivity to be sustained economically and indefinitely. T-factor values of 1 through 5 tons are used where food, feed, and fiber plants are grown. A T-factor of 1 ton per acre per year is generally assigned to shallow or otherwise fragile soils; 5 tons per acre per year is assigned to deep soils that are least subject to damage by erosion. Fresno, Kern, Kings, and Tulare Counties contain soils that range from a T-factor of 1 ton up to 5 tons. Given the soil type in a specific location, the T-factor for that location can be determined. However, because the EWA program area spans four counties, only the T-factor range can be provided.

Table 7-1 lists the amount of soil erosion caused by cotton framing practices. The data in Table 7-1 consider land preparation, harvesting, soil moisture, and climatic factors in the determination of soil loss.

Table 7-1 *Monthly Estimates of Soil Erosion Under Existing Conditions*													
County	***APR***	***MAY***	***JUN***	***JUL***	***AUG***	***SEP***	***OCT***	***NOV***	***DEC***	***JAN***	***FEB***	***MAR***	***Annual Total***
Fresno	204	176	83	87	112	103	198	231	102	13	25	34	1368
Kern	143	111	63	65	71	53	179	235	102	14	27	33	1096
Kings	257	133	60	63	75	81	209	262	105	15	26	35	1321
Tulare	79	72	42	55	59	41	162	222	97	12	21	29	891

Source: CARB 1997a, Attachment A (nonpasture)
All values are in pounds/acre/year

The high percentage of soil erosion in April and May corresponds to land preparation activities; harvest takes place in October and November, also times of relatively high soil erosion rates.

7.2 Environmental Consequences/Environmental Impacts

7.2.1 Assessment Methods

Under each alternative, the EWA Project Agencies would negotiate contracts with willing sellers based on a number of factors, including price, water availability, and location. These factors would change from year-to-year; therefore, the EWA Project Agencies may choose to vary their acquisition strategy in each year. To provide maximum flexibility, this analysis includes many potential transfers when the EWA Project Agencies would likely not need all transfers in a given year. Chapter 2 defines the transfers that are included in this analysis.

The effects of large-scale crop idling on soils have not been studied in detail or well documented. This analysis uses methodology developed by the California Air Resources Board for an emission inventory of windblown dust from unpaved roads. The methodology includes use of the wind erosion equation. Although the methodology is used to determine erosion off unpaved roads, the input data and assumptions were based on the soil properties of adjacent agricultural fields (no additional gravel or other treatments have been applied to the unpaved roads). Additionally, the use of the wind erosion equation factors soil characteristics and climatic variables into the analysis; no other variables such as truck traffic are considered. Therefore, the results are applicable to this analysis.

The wind erosion equation is expressed as: E = f[(IKC)LV] where:

E = the estimated average annual soil loss expressed as tons per acre per year.

f is a function and indicates that the equation includes functional relationships that are not straight-line mathematical calculations.

I factor – Soil erodibility index. Under erosive conditions, the surface crust and surface clods on fine sand and loamy fine sands tend to break down readily. On silt loams and silty clay loams the surface crust and surface clods may persist. A fully crusted soil will erode an average of only one-sixth as much as non-crusted soil. Because of the temporary nature of crusts, no adjustment for crusting is made in the annual method calculation, since it is based on the critical wind erosion period. Adjustments to the I factor can be as much as a 70 percent reduction for silty clay loams with a WEG of 7 to a 30 percent reduction for very fine sands with a WEG of 1.

K factor – Ridge roughness. The K factor is a measure of the effect of patterns of ridges and furrows created by tillage and planting implements. Ridges absorb and defect wind energy and trap moving soil particles. It is expressed as a value ranging from 0.5 to 1.0. The angle of deviation, including prevailing wind erosion direction and ridge furrow direction, ridge height, and ridge spacing, needs to be calculated to determine the K factor.

C factor – Climatic factor. The C factor is an index of the relative climatic erosivity, specifically wind speed and surface soil moisture. It is based on long-term data (temperature, precipitation, and windspeed) and is expressed as a percentage.

L factor – Unsheltered distance. The L factor represents the unsheltered distance along the prevailing wind erosion direction for the field or area to be evaluated.

V factor – Vegetative cover. The V factor is expressed by relating the kind, amount, and orientation of vegetative material to its equivalent in pounds per acre of flat small grain residue.

7.2.2 Significance Criteria

Effects on geology and soils are considered significant if the action causes:

- A substantial risk to life or property due to location on an expansive soil;
- A substantial release of toxic substances and salts present in the erosive soil to adjacent lands and/or to the atmosphere; or
- Greater than 1 ton/acre/year topsoil loss in agricultural fields.

Although there are some areas where the soil tolerance factor is greater than 1 ton/acre/year, the significance criteria encompasses the lowest value to provide a conservative approach to significance determination.

7.2.3 Environmental Consequences/Environmental Impacts of the No Action/No Project Alternative

Under the No Action/No Project Alternative, water transfers for the EWA would not occur. Crop idling would occur, as it exists without the project; some fields would be idled because of unreliable water supplies, economic factors, or as part of a crop rotation. Because there would be no change under this alternative, the No Action/No Project Alternative is considered equivalent to the description in Section 7.1. The No Action/No Project Alternative and the Affected Environment/Existing Conditions are collectively referred to as the Baseline Condition in the following sections.

7.2.4 Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative

The Flexible Purchase Alternative allows transfers up to 600,000 acre-feet and does not specify transfer limits in the Upstream from the Delta Region or the Export Service Area. Transfers in the Upstream from the Delta Region would range from 50,000 to 600,000 acre-feet, limited by hydrologic year and conveyance capacity through the Delta. Although all potential transfers would not occur in one year, this section discusses all transfers to the EWA from willing sellers (a transfer amount that would result in greater than 600,000 acre-feet) to provide an effect analysis of a maximum transfer scenario. Similarly, the evaluation includes an analysis of up to 540,000 acre-feet in the Export Service Area to cover a maximum transfer scenario for that region.

This impact analysis focuses on soil erodibility, both in the Upstream from the Delta Region (Glenn, Colusa, Yolo, Sutter, Butte, and Placer Counties) and in the Export Service Area (Fresno, Kern, Kings, and Tulare Counties). The potential for soils, especially those containing a clay component, to shrink and swell, depending on moisture content, can cause adverse effects to structures within or on top of the soil. EWA actions would potentially cause soils to shrink due to the reduction in applied irrigation water. Soils would swell during the winter rains. Because the lands that are being idled are agricultural, there are minimal structures that could be affected by expansive soils. Under the Baseline Condition, soils would also be exposed to shrinking and swelling during cycles of irrigation. (Soils are irrigated, then left to dry out, then irrigated again.) Because the shrinking and swelling of soils would not have adverse effects on structures or roads, and the soils undergo similar scenarios under the Baseline Condition, the effect on geology and soils is considered less than significant. No further discussion regarding expansive soils is included in Sections 7.2.4.1 or 7.2.4.2, Upstream from the Delta Region and Export Service Area, respectively.

7.2.4.1 Upstream from the Delta Region

7.2.4.1.1 Butte, Colusa, Glenn, Placer, Sutter, and Yolo Counties

The potential effects on geology and soils due to crop idling would not differ by county. Therefore, the effects of the EWA action are evaluated for the Upstream from the Delta Region as a whole.

EWA acquisition of water via crop idling in the Sacramento Valley would result in temporary conversion of lands from rice crops to bare fields. Idling of rice crops would potentially take place in Butte, Colusa, Glenn, Placer, Sutter, and Yolo Counties. Areas that have exposed earth and lack vegetative cover can be possible sites for soil erosion. Crop management practices, soil texture, wind velocity and direction are key factors in the determination of erosion potential.

The only potential adverse effect on geology and soils from idled rice fields would be from potential erosion of barren fields (caused by wind or vehicles driving on the fields). However, the rice crop cycle and soil texture reduces the potential for erosion. The process of rice cultivation includes incorporating the leftover rice straw into the soils after harvest. (The incorporation of rice straw is a common practice by farmers and is not unique to the EWA. Therefore, potential effects on soil and drainage are not discussed in this section.) The fields are then flooded during the winter to aid in decomposition of the straw. If no irrigation water is applied to the fields after this point, the soils will remain moist until approximately mid-May. Once dried, the combination of the decomposed straw and clay soils produces a hard, crust-like surface. This surface texture would remain until the following winter rains if not disturbed. In contrast to sandy topsoil, this surface type would not be conducive to soil loss from wind erosion. Therefore, there would be little to no soil loss from wind erosion off the idled rice fields, resulting in a less-than-significant impact on geology and soils.

7.2.4.2 Export Service Area

7.2.4.2.1 Fresno, Kern, Kings, and Tulare Counties

The potential effects on geology and soils due to crop idling would not differ by county. Therefore, the effects of the EWA action are evaluated for the Export Service Area as a whole.

EWA acquisition of water via crop idling in Fresno, Kern, Kings, and Tulare Counties would result in temporary conversion of lands from cotton crops to bare fields. Willing sellers would idle fields that would have grown cotton in the Baseline Condition to use the irrigation water supply as an EWA asset. Potential adverse effects result from the lack of groundcover to control soil erosion caused by strong winds.

Under EWA program conditions, no cotton would be planted and no irrigation water would be supplied to the field. The barren fields would be dry, without cover, and susceptible to erosion from strong winds. Figure 7-7 illustrates the soil texture post-harvest. Discing and plowing under residual plant matter has been completed. The resulting soil surface is slightly furrowed.

Source: CDM

Figure 7-7
Soil Surface Texture Post-Harvest
Kings County, CA

Attributes associated with each soil type, such as surface texture, erodibility, and expansion potential, define a soil's potential for impact. For example, a fine sandy soil is highly erodible, whereas a clay soil would have less erosion potential. The California Air Resources Board assumes the I factor (soil erodibility) is that of the predominant soil type in the county. Actual erosion rates for a specific field could be higher or lower, depending on soil texture. Based on averages and conservative estimates for the I factor and all parts of the wind erosion equation, the following amounts of soil (tons/acre/year) would erode from an idled field (Table 7-2).

Table 7-2
Monthly Estimates of Soil Erosion with the EWA (tons/acre/year)

County	*APR*	*MAY*	*JUN*	*JUL*	*AUG*	*SEP*	*OCT*	*NOV*	*DEC*	*JAN*	*FEB*	*MAR*	*Annual Total*
Fresno	.53	.64	.64	.64	.64	.64	.55	.31	.24	.16	.18	.14	5.31
Kern	.41	.41	.41	.41	.41	.41	.41	.34	.22	.16	.17	.11	3.87
Kings	.61	.61	.61	.61	.61	.61	.61	.52	.34	.22	.20	.16	5.71
Tulare	.23	.25	.27	.27	.27	.27	.27	.13	.09	.06	.07	.05	2.23

Source: CARB 1997a, Attachment A (nonpasture)
All values are in tons/acre/year

Based on all modes of soil movement (saltation, surface creep, and suspension), the amount of soil eroded has the potential to travel different distances. Up to 60 percent of the soil particles become suspended in the air mass for a long period of time. Suspension moves soil not only from one part of a field to another, but potentially to adjacent fields, waterways, or streets. The deposition of soil into waterways or streets (which eventually drain into waterways) represents a permanent soil loss. Crop idling in Fresno, Kern, Kings, and Tulare Counties would produce soil erosion quantities greater than 1 ton/acre/year. This is a potentially significant effect. Implementation of mitigation measures described in Section 7.2.7 would lessen the amount of soil erosion, lower the T factor value, and reduce the potentially significant effect to less than significant.

EWA acquisition of water via crop idling would reduce the amount of water applied to the fields. Crop idling would reduce applied water to agricultural fields, thereby reducing the potential of salts and other trace elements to leach into the groundwater or be mobilized as runoff and enter nearby water bodies. This is considered a beneficial impact. Trace elements bound to soil particles however, could be mobilized by wind; and these soil particles could travel to adjacent lands in situations of wind erosion of idled fields. Mobilized soil particles by saltation, surface creep, or suspension would move from one field and replace the soil lost on an adjacent field. Because the soil particles would be randomly blown, it would be unlikely that these particles would concentrate in a single area. Therefore, the potential for trace elements bound to soil particles to collect at a particular site and affect the soil quality at that site compared to the Baseline Condition is considered less than significant.

The analysis thus far has been based on a 1-year water transfer; however, the EWA agencies and willing sellers may agree to multi-year transfers. No effects as discussed would accumulate from one year to another. Therefore, the effects presented in Sections 7.2.4.1 and 7.2.4.2 would be the same whether agencies sold water for one or multiple years.

7.2.5 Environmental Consequences/Environmental Impacts of the Fixed Purchase Alternative

The Fixed Purchase Alternative specifies purchases of 35,000 acre-feet in the Upstream from the Delta Region, and 150,000 acre-feet in the Export Service Area. While the amounts in each region are fixed, the acquisition types and sources could vary. To allow the EWA Project Agencies maximum flexibility when negotiating purchases with willing sellers, this section analyzes the effects of each potential transfer. These transfers are the same actions as those described for the Flexible Purchase Alternative, but the amounts are limited by the total acquisition amount in each region (35,000 acre-feet in the Upstream from the Delta Region and 150,000 acre-feet in the Export Service Area).

7.2.5.1 Upstream from the Delta Region

7.2.5.1.1 Butte, Colusa, Glenn, Placer, Sutter, and Yolo Counties

The potential effects on geology and soils due to crop idling would not differ by county. Therefore, the effects of the EWA action are evaluated for the Upstream from the Delta Region as a whole.

EWA acquisition of water via crop idling in the Sacramento Valley would result in temporary conversion of lands from rice crops to bare fields. Crop idling of rice crops would potentially take place in Butte, Colusa, Glenn, Placer, Sutter, and Yolo Counties. Areas that have exposed earth and lack vegetative cover can be possible sites for soil erosion. Crop management practices and soil texture are key factors in the determination of erosion potential.

The rice crop cycle and soil texture reduces the potential for erosion. If no irrigation water were applied to the rice fields after being flooded the previous winter, the soils would remain moist until approximately mid-May. Once dried, the combination of the decomposed straw and clay soils produces a hard, crust-like surface, not conducive to soil loss from wind erosion. Therefore, there would be little to no soil loss from wind erosion off of the idled rice fields, resulting in a less-than-significant effect on geology and soils.

7.2.5.2 Export Service Area

7.2.5.2.1 Fresno, Kern, Kings, and Tulare Counties

The potential effects on geology and soils due to crop idling would not differ by county. Therefore, the effects of the EWA action are evaluated for the Export Service Area as a whole.

EWA acquisition of water via crop idling in Fresno, Kern, Kings, and Tulare Counties would result in temporary conversion of lands from cotton crops to bare fields. The effects described under the Flexible Purchase Alternative are equivalent to the effects that would occur under the Fixed Purchase Alternative because the amount of soil loss is analyzed on a per-acre basis. The estimated quantity of soil loss (2.2 to 5.7 tons/acre/year) is listed in Table 7-2. This is a potentially significant effect. As stated for the Flexible Purchase Alternative, implementation of mitigation measures listed in Section 7.2.7 would reduce potentially significant effects to less than significant.

EWA acquisition of water via crop idling would reduce the amount of water applied to the fields. Crop idling would reduce applied water to agricultural fields, thereby reducing the potential of salts and other trace elements to leach into the groundwater or be mobilized as runoff and enter nearby water bodies. This is considered a beneficial impact. Mobilized soil particles by saltation, surface creep, or suspension would move from one field and replace the soil lost on an adjacent field. Because the soil particles would be randomly blown, it would be unlikely that these particles would concentrate in a single area. Therefore, the potential for trace elements bound to soil particles to collect at a particular site and affect the soil quality at that site compared to the Baseline Condition is considered less than significant.

The analysis thus far has been based on a 1-year water transfer; however, the EWA agencies and willing sellers may agree to multi-year transfers. No effects as discussed would accumulate from one year to another. Therefore, the effects presented in

Sections 7.2.5.1 and 7.2.5.2 would be the same whether agencies sold water for one or multiple years.

7.2.6 Comparative Analysis of Alternatives

This chapter has thus far analyzed the effects of many potential transfers, looking at the "worst-case scenario" that would occur if all acquisitions happened in the same year. This approach ensures that all effects of transfers are included, and provides the EWA Project Agencies the flexibility to choose transfers that may be preferable in a given year. The EWA agencies, however, would not actually purchase all of this water in the same year. This section provides information about how EWA would more likely operate in different year types. A further comparison of the alternatives is listed in Table 7-3.

Table 7-3
Comparison of the Effects of the Flexible and Fixed Purchase Alternatives on Geology and Soils

Region	*Asset Acquisition or Management*[(1)]	*Result*	*Effects*	*Flexible Alternative Change from Baseline*	*Fixed Alternative Change from Baseline*	*Significance of Flexible Alternative*	*Significance of Fixed Alternative*
Upstream from the Delta	Crop Idling Flex: 242 TAF Fixed: 35 TAF	Conversion of rice crops to bare fields.	Reduced rice crop acreage in Glenn, Colusa, Yolo, Butte, Sutter, and Placer Counties.	Soil erosion from 89,600 idled acres.	Soil erosion from 15,100 idled acres.	LTS	LTS
Export Service Area	Crop Idling Flex: 420 TAF Fixed: 150 TAF	Conversion of cotton crops to bare fields.	Reduced cotton crop acreage in Fresno, Kern, Kings, and Tulare Counties.	Soil erosion from 182,800 idled acres.	Soil erosion from 65,200 idled acres.	PS; LTS with mitigation measures.	PS; LTS with mitigation measures.

(1) Although maximum acquisition and management for the Fixed and Flexible Purchase Alternatives ranges from 50,000 acre-feet to 600,000 acre-feet, this column shows the potential maximum from crop idling sources only; therefore, it is less than can be acquired from all sources.

PS = Potentially Significant

LTS = Less than Significant

7.2.6.1 Upstream from the Delta Region

In the Upstream from the Delta Region, under the No Project Alternative, crop idling could occur because of unreliable water supplies, economic factors, or as part of a crop rotation. In very dry years, water supplies would be less as compared to wet years. Reduced supplies could cause an increase in crop idling and an increase in soil erosion. Under the No Project Alternative, there are no measures in place that reduce soil erosion off the idled fields.

The Fixed Purchase Alternative would be limited to a maximum acquisition of 35,000 acre-feet from all sources of water. This amount could typically be obtained from stored reservoir water purchases in most year types. The Fixed Purchase Alternative would therefore not likely involve acquisition of water via crop idling and thus would have no effect on geology and soils. In very dry years, stored reservoir water may not be available, and the EWA would acquire water first from groundwater substitution and/or groundwater purchase, followed by crop idling. Therefore, during dry years, effects on geology and soils could be possible; however, the effects would be less than significant as discussed in Section 7.2.4.1.

The Flexible Purchase Alternative could involve the purchase of up to 600,000 acre-feet of water from all sources in the Upstream from the Delta Region. EWA agencies would prefer to purchase water from upstream sources because the water is generally less expensive. The amount that could be purchased would be limited by the capacity of the Delta export pumps to move the water to the Export Service Area. During wet years, excess pump capacity may be limited to as little as 50,000 to 60,000 acre feet of EWA asset water because the pumps primarily would be used to export Project water to Export Service Area users. During dry years, when less Project water would be available for pumping (and therefore the pumps would have greater availability capacity), the EWA Project Agencies could acquire up to 600,000 acre-feet of water from sources in the Upstream from the Delta Region.

The potential for effects on geology and soils during wet years for the Flexible Purchase Alternative would be very similar to the Fixed Purchase Alternative. That is, during wet years, acquisition would most likely be from stored reservoir water; EWA Project Agencies would not acquire water from groundwater and crop idling. As rainfall amounts for areas north of the Delta decrease, reflecting dry year conditions, the greater capacity of the export pumps to move EWA assets could result in a greater reliance on groundwater substitution and crop idling for additional EWA acquisitions. If the EWA Project Agencies were to acquire 600,000 acre-feet in the Upstream from the Delta Region, they would need to utilize most available sources, including stored reservoir water, groundwater substitution, stored groundwater purchase, and crop idling. Therefore, during dry years, effects on geology and soils could be possible; however, the effects would be less than significant as discussed in Section 7.2.4.1.

7.2.6.2 Export Service Area

Under the No Project Alternative, effects in the Export Service Area in dry years compared to wet years would be the same as described under the Upstream from the Delta Region.

EWA asset acquisitions in the Export Service Area under the Fixed Purchase Alternative would be limited to 150,000 acre-feet from stored groundwater purchase and crop-idling sources. The EWA agencies would purchase stored groundwater initially; however, the amount of water in storage may not be sufficient to supply the EWA with water for multiple years. Crop idling would supplement water needs beyond what could be acquired from stored groundwater. Stored groundwater purchase would not cause topsoil loss or a release of potentially toxic substances; therefore, the actions would have no effect on soils. Crop idling could cause a potentially significant impact from the soil loss off idled fields. Mitigation measures however, would reduce the effects to less than significant.

EWA asset acquisitions in the Export Service Area under the Flexible Purchase Alternative would be dependent on the water year type north of the Delta. Export pump capacity during wet years would limit the availability of the EWA Project Agencies to move assets through the Delta, requiring reliance on greater purchase amounts from the Export Service Area. During wet years, acquisitions within the Export Service Area could involve up to 600,000 acre-feet of assets. The EWA agencies would acquire assets from stored groundwater purchase and idled cropland. As under the Fixed Purchase Alternative, stored groundwater purchase would have no effect on geology and soils. During wet years, the Flexible Purchase Alternative could have a greater effect on soils because a larger number of acres could be idled than under the Fixed Purchase Alternative. Mitigation measures for both alternatives reduce the effects to less than significant.

7.2.7 Mitigation Measures

According to the mitigation measures listed in Chapter 8, Air Quality, Section 8.2.7, if the EWA agencies obtain water from idling cotton crops, the San Joaquin Valley APCD must approve a Dust Suppression Plan that results in less than significant air quality effects. The Dust Suppression Plan would also reduce soil erosion potential. As stated in Section 8.2.7, willing sellers will work with EWA agencies and the APCD to establish these plans, using mitigation measures described in Table 7-4 that are appropriate for each site.

Table 7-4 Mitigation Measures	
Measure	***Feasibility***
1. Crop shift (e.g., winter wheat). Wheat would be harvested between mid June and mid-July. The stubble and chaff would be left on the fields to maintain a vegetative cover and reduce the surface area exposed to wind. Additionally, the root system would serve to hold the topsoil in place.	Winter wheat is a common crop alternated with growing cotton. There is no requirement for a plowdown of the stubble as is required for cotton plants. Crop shifting to winter wheat would greatly reduce soil erodibility. This mitigation measure would increase surface roughness, vegetative cover, and soil moisture and would reduce the impact to less than significant.
2. Increase surface roughness, which reduces wind speed at the soil surface so that the wind is less able to move soil particles. Ripping clay soil using spikes will usually bring up non-erodible clods, creating a rough surface. If soils are sandy, listing instead of ripping is used because sandy soils do not produce durable clods. Listing ridges the soil and brings up firmer subsoil. Furrowing fields also increases surface roughness. Depending on soil texture, the above methods may need to be repeated throughout the summer.	These practices would reduce soil erodibility and associated entrainment of particulate matter. Depending on soil properties, this mitigation measure alone may not reduce effects to less than significant.
3. Establish wind breaks, which consist of trees or bushes that aid in reducing wind velocity across fields. As a general rule, for every 1 foot in height, the wind break will afford protection to 10 feet of field.	Due to the short-term nature of the transfer, 1 year, newly planted wind breaks would not have grown to sufficient height to substantially reduce impacts. However, wind breaks could be planted as mitigation for the future. The effect of this mitigation measure alone would not reduce the impact to less than significant.
4. After harvest the year before the transfer, leave crop residue on the fields to decrease surface area exposed to strong winds.	Due to required pest management activities for cotton crops, farmers must plow crop residue under by mid-December. Therefore, the crop residue would not be available afterward as a cover to prevent soil loss due to wind erosion.
5. Restrict motorized vehicles or the times of operation for certain off-road vehicles on idled agricultural land.	Farmers' preference is to disc throughout the summer to avoid weeds from producing seeds that can be a nuisance the following year.
6. Water fields prior to especially windy periods.	Under program alternatives, farmers would have sold their irrigation water to the EWA and could not apply water to the fields.

7.2.8 Potentially Significant Unavoidable Impacts

There would be no potentially significant unavoidable impacts.

7.2.9 Cumulative Effects

7.2.9.1 Upstream from the Delta Region

Four non-EWA programs (Dry Year Purchase Program, Drought Risk Reduction Investment Plan (DRIPP), Environmental Water Program, and Central Valley Project Improvement Act Water Acquisition Program) include crop idling as a water-acquisition method. Although erodible soils exist in the Upstream from the Delta Region, conditions (both existing management practices and weather conditions) are not favorable for erosion of soils in this region. Therefore, soil loss from EWA actions in combination with other programs would not likely produce a significant impact.

7.2.9.2 Export Service Area

Two non-EWA programs, the DRIPP and the Central Valley Project Improvement Act Water Acquisition Program, include crop idling in the Export Service Area. Additional water transfer programs also could include crop idling. Crop acreage idled under different programs would not cause more soil erosion per acre; therefore, the amount of eroded soil per acre, as described in Table 7-2, would stay the same with the EWA or in conjunction with other idling programs. Because the EWA is contributing to mitigation measures to lessen impacts, the program's contribution is considered less than cumulatively considerable and thus not significant.

7.3 References

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Chapter 8
Air Quality

The air quality of a particular area is influenced by several factors, including the amount of pollutants released into the atmosphere and the atmosphere's ability to transport and dilute the pollutants. Wind, atmospheric stability, terrain, and geographic isolation influence air pollution transport. This chapter analyzes the effects on air quality related to the No Action/No Project Alternative, the Flexible Purchase Alternative, and the Fixed Purchase Alternative.

8.1 Affected Environment/Existing Conditions

The following paragraphs provide a brief explanation of the regulatory setting for air quality. Sections 8.1.3 through 8.1.5 describe the factors that influence pollutant levels on a regional level, including geographical location, weather patterns, and pollutant sources.

8.1.1 Area of Analysis

This chapter focuses on the areas where EWA actions would take place. Effects are assessed in the Upstream from the Delta Region and in the Export Service Area as described below and presented in Figure 8-1.

- Upstream from the Delta Region: Shasta, Glenn, Colusa, Yolo, Sutter, Butte, Yuba, Placer, Sacramento, and Merced Counties; and
- Export Service Area: Fresno, Kern, Kings, and Tulare Counties.

Figure 8-1
Air Quality Area of Analysis

8.1.2 Regulatory Setting

Air quality in California is regulated by the United States Environmental Protection Agency, (USEPA) and the California Air Resources Board (CARB), and locally by Air Pollution Control or Air Quality Management Districts (APCD and AQMD respectively). The following APCD/AQMDs regulate air quality within the area of analysis:

- Butte County AQMD
- Colusa County APCD
- Feather River AQMD
- Glenn County APCD
- Sacramento Metro AQMD
- San Joaquin Valley APCD
- Shasta County AQMD
- Yolo-Solano AQMD

The Federal Clean Air Act (CAA) requires the USEPA to establish and maintain standards for common air pollutants. These standards are used to manage air quality across the country. The State of California has also adopted standards for these pollutants. In most cases, California standards are more stringent than USEPA standards. Pollutants for which national and State standards have been established are termed "criteria" pollutants, because the standards are based on studies of health effects criteria that show a relationship between the pollutant concentration and its effect. From this relationship the USEPA and the State also establishes acceptable pollutant concentration levels and ambient air quality standards. Table 8-1 describes the criteria pollutants of primary concern (ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, and particulate matter). Table 8-2 lists the California and Federal ambient air quality standards for these criteria pollutants.

If pollutant concentration levels of any of the criteria pollutants exceed the State or Federal standards established for those pollutants, the area is designated as being in "nonattainment" for those pollutants. An area can be designated as a moderate, severe, serious, or extreme nonattainment area depending upon the level of pollutant concentrations. Likewise, if standards for pollutants are met in a particular area, the area is designated as being in "attainment" for those pollutants. Where standards may not have been established for certain criteria pollutants, the areas are considered "unclassified" for those pollutants.

The Federal CAA requires states with nonattainment areas to develop plans, known as State Implementation Plans, (SIPs) describing the measures the State will take to achieve attainment with national ambient air quality standards. Local air districts and other agencies prepare SIP elements for the areas under their regulatory jurisdiction, and submit these elements to CARB for review and approval. CARB incorporates the individual air district elements into a statewide SIP and the plan is then submitted to USEPA for approval and publication in the Federal Register.

Table 8-1
Criteria Pollutants

Pollutant	***Characteristics***	***Health Effects***	***Major Sources***
Ozone	A highly reactive photochemical pollutant created by the action of sunshine on ozone precursors (reactive organic gasses and oxides of nitrogen).	• Eye irritation. • Respiratory function impairment.	Combustion sources, such as factories and automobiles, and evaporation of solvents and fuels.
Carbon Monoxide	Odorless, colorless gas that is highly toxic. Formed by the incomplete combustion of fuels.	• Impairment of oxygen transport in the bloodstream. • Aggravation of cardiovascular disease. • Fatigue, headache, dizziness.	Automobile exhaust, combustion of fuels, and combustion of wood in woodstoves and fireplaces.
Nitrogen Dioxide	Reddish-brown gas formed during combustion.	• Increased risk of acute and chronic respiratory disease.	Automobile and diesel truck exhaust, industrial processes, fossil-fueled powerplants.
Sulfur Dioxide	Colorless gas with a pungent odor.	• Increased risk of acute and chronic respiratory disease.	Diesel vehicle exhaust, oil-powered powerplants, industrial processes.
PM_{10}	Small particles that measure 10 microns or less are termed PM_{10}. Solid and liquid particles of dust, soot, aerosols, smoke, ash, and pollen and other matter that are small enough to remain suspended in the air for a long period.	• Aggravation of chronic disease and heart/lung disease symptoms.	Dust, erosion, incinerators, automobile and aircraft exhaust, and open fires.

Table 8-2
Ambient Air Quality Standards

Pollutant	***Averaging Time***	***California Standard***	***Federal Standard***
Ozone	1 Hour	0.09 ppm	0.12 ppm
	8 Hour	--	0.08 ppm
PM_{10}	Annual Mean	30 (20 ug/m^3)[(1)]	50 ug/m^3
	24 Hour	50 ug/m^3	150 ug/m^3
$PM_{2.5}$	Annual Mean	12 ug/m^3 [(1)]	15 ug/m^3
	24 Hour	--	65 ug/m^3
Carbon Monoxide	1 Hour	20 ppm	35 ppm
	8 Hour	9.0 ppm	9.0 ppm
Nitrogen Dioxide	Annual Arithmetic Mean	--	0.053 ppm
	1 Hour	0.25 ppm	--
Sulfate	24 Hour	25 ug/m^3	--
Sulfur Dioxide	24 Hour	0.04 ppm	0.14 ppm
	Annual Arithmetic Mean	--	0.03 ppm
	1 Hour	0.25 ppm	--

Source: California Air Resources Board.
[(1)] Adopted by the California Air Resources Board on June 20, 2002; however, final action has not been taken to fully implement standard. For the purposes of this document, 30 ug/m^3 is used as the State standard for PM_{10}.

In addition to a description of the measures to be taken to reduce pollutant levels within the State, the SIP also includes an inventory of existing and projected emissions, by source for each County within the State. Because agricultural irrigation pumps have been exempt from air quality permit requirements however, local air districts have limited quantitative data regarding the number of irrigation pumps and the total emissions estimated from the pumps within their districts. CARB has recently developed an updated statewide population and emission inventory for diesel-fueled agricultural irrigation pumps. This inventory is presented in Table 8-3. CARB obtained the agricultural pump population estimates through coordination with air district staff and a survey of pump sale information from pump manufacturers and suppliers. CARB has collected the information shown in Table 8-3 for use in the next SIP. While the inventory may be modified prior to adoption of the next SIP, this inventory represents the best available data on agricultural irrigation pump emissions within the State.

Under the conformity provisions of the Federal CAA, no Federal agency can approve a project unless the project has been demonstrated to conform to Federal Ambient Air Quality Standards. These conformity provisions were put in place to ensure that Federal agencies would contribute to the efforts of attaining the National Ambient Air Quality Standards. The USEPA has issued two conformity guidelines: transportation conformity rules that apply to transportation plans and projects; and general conformity rules that apply to all other Federal actions. A conformity determination[1] is only required for the alternative that is ultimately approved and selected.

The conformity determination is submitted in the form of a written finding, issued after a minimum 30-day public comment period on the draft determination. A project that produces emissions that exceed conformity standards is required to be mitigated. A project is exempt from the conformity rule if the project-related emissions are less than the *de minimis* thresholds established by the conformity rule. The threshold for a severe ozone nonattainment area is 25 tons/year. The threshold for PM_{10}[2] moderate and serious nonattainment areas is 100 and 70 tons/year, respectively.

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1 A conformity determination is a process that demonstrates how an action would conform to the applicable implementation plan. If the emissions cannot be reduced sufficiently, and if air dispersion modeling cannot demonstrate conformity, then either a plan for mitigating or a plan for offsetting the emissions would need to be pursued.

2 PM_{10} = small particles that measure 10 microns or less.

Table 8-3
Statewide Population and Annual Average Emissions for Diesel-Fueled Agricultural Irrigation Pumps

Region	Air District	County	County Totals Annual Average Emissions (TPD)					Region Totals Annual Average Emissions (TPD)			
			Population	ROG	NOx	PM	Source[1]	Population	ROG	NOx	PM
North Central Coast	Monterey Bay Unified APCD	Monterey	450	0.09	0.72	0.05	ADJ-ARB				
North Central Coast	Monterey Bay Unified APCD	Santa Cruz	62	0.01	0.10	0.01	ARB				
North Central Coast	Monterey Bay Unified APCD	San Benito	56	0.01	0.09	0.01	ARB	568	0.12	0.91	0.06
Sacramento Nonattainment	El Dorado County APCD	El Dorado	20	<0.01	0.05	<0.01	DIS				
Sacramento Nonattainment	Feather River AQMD	Sutter	181	0.18	2.06	0.15	DIS				
Sacramento Nonattainment	Placer County APCD	Placer	64	0.02	0.21	0.02	DIS				
Sacramento Nonattainment	Sacramento Metropolitan AQMD	Sacramento	122	0.03	0.38	0.03	DIS				
Sacramento Nonattainment	Yolo/Solano AQMD	Solano	134	0.05	0.65	0.05	DIS				
Sacramento Nonattainment	Yolo/Solano AQMD	Yolo	643	0.32	3.64	0.26	DIS	1164	0.60	6.98	0.50
Sacramento Valley Attainment	Butte County AQMD	Butte	163	0.03	0.26	0.02	ARB				
Sacramento Valley Attainment	Colusa County APCD	Colusa	100	0.02	0.16	0.01	ARB				
Sacramento Valley Attainment	Glenn County APCD	Glenn	130	0.03	0.21	0.01	ARB				
Sacramento Valley Attainment	Tehama County APCD	Tehema	200	0.04	0.32	0.02	ADJ-ARB	593	0.12	0.95	0.07
Salton Sea	Imperial County APCD	Imperial	200	0.04	0.32	0.02	ADJ-ARB	200	0.04	0.32	0.02
San Diego	San Diego County APD	San Diego	75	0.02	0.12	0.01	ADJ-ARB	75	0.02	0.12	0.01
San Francisco	Bay Area AQMD	Alameda	35	0.01	0.06	<0.01	ARB				
San Francisco	Bay Area AQMD	Contra Costa	44	0.01	0.07	0.01	ARB				
San Francisco	Bay Area AQMD	Marin	17	<0.01	0.03	<0.01	ARB				
San Francisco	Bay Area AQMD	Napa	74	0.01	0.12	0.01	ARB				
San Francisco	Bay Area AQMD	San Francisco	0	0.00	0.00	0.00	ARB				
San Francisco	Bay Area AQMD	San Mateo	21	<0.01	0.03	<0.01	ARB				
San Francisco	Bay Area AQMD	Santa Clara	82	0.02	0.13	0.01	ARB				
San Francisco	Bay Area AQMD	Solano	0	0.00	0.00	0.00	ARB				
San Francisco	Bay Area AQMD	Sonoma	147	0.03	0.23	0.02	ARB	420	0.08	0.67	0.04

Table 8-3 Statewide Population and Annual Average Emissions for Diesel-Fueled Agricultural Irrigation Pumps											
Region	***Air District***	***County***	***County Totals Annual Average Emissions (TPD)***					***Region Totals Annual Average Emissions (TPD)***			
			Population	***ROG***	***NOx***	***PM***	***Source***	***Population***	***ROG***	***NOx***	***PM***
San Joaquin Valley	San Joaquin Valley Unified APCD	Fresno	1415	0.42	5.09	0.39	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Kern	1066	0.44	4.15	0.30	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Kings	525	0.15	1.91	0.16	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Madera	414	0.13	1.48	0.11	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Merced	270	0.10	0.98	0.07	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	San Joaquin	412	0.12	1.47	0.11	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Stanislaus	111	0.03	0.40	0.03	DIS				
San Joaquin Valley	San Joaquin Valley Unified APCD	Tulare	286	0.47	1.79	0.08	DIS	4500	1.85	17.25	1.26
South Central Coast	Santa Barbara County APCD	Santa Barbara	100	0.14	1.71	0.12	DIS				
South Central Coast	Ventura County APCD	Ventura	335	0.15	1.87	0.15	DIS	435	0.29	3.57	0.28
South Coast	South Coast AQMD	Los Angeles	54	0.02	0.35	0.02	DIS				
South Coast	South Coast AQMD	Orange	28	0.01	0.18	0.01	DIS				
South Coast	South Coast AQMD	Riverside	139	0.06	0.90	0.06	DIS				
South Coast	South Coast AQMD	San Bernardino	36	0.02	0.23	0.02	DIS	257	0.12	1.67	0.12
Grand Total (tons/day)			8212	3.23	32.44	2.38		8212	3.22	32.44	2.37

Source: Benjamin 2003

[1] Data Source:

DIS = District Estimate

ARB – ARB OFFROAD Model

ADJ – ARB – ARB OFFROAD Model adjusted reflect district estimate

The CAA includes provisions for prevention of significant deterioration (PSD) of air quality in areas designated as in attainment or unclassifiable. The basic goals of the USEPA's PSD rules, as published at 40 CFR 52.21, are:

- To ensure that clean air resources are preserved during economic growth;
- To protect human health and welfare from adverse effects of air pollution; and
- To preserve, protect, and enhance air quality in especially sensitive areas such as national parks or wilderness.

The PSD rules distinguish between two thresholds: (1) 28 major sources that are held to 100 tons per year and (2) remaining stationary sources that emit, or have the potential to emit, 250 tons per year. Emissions above either threshold require a PSD permit.

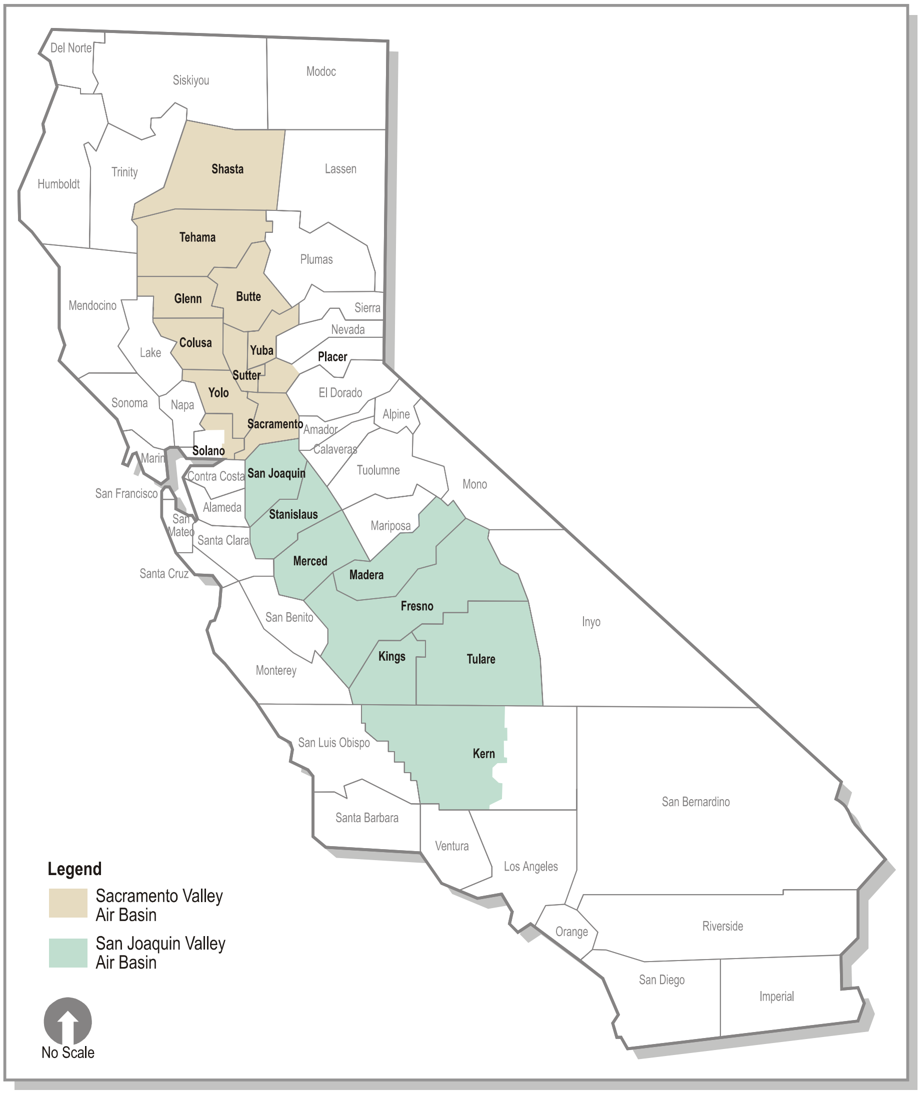
As discussed above, on a local basis, AQMDs or APCDs set regulatory standards for new stationary emission sources. AQMD and APCD boundaries are based on meteorological and geographic conditions and, where possible, jurisdictional boundaries such as a County area.

8.1.3 Upstream from the Delta Region

The Upstream from the Delta Region includes portions of the Sacramento Valley Air Basins (Figure 8-2). During the summer in the Sacramento Valley Air Basin, the Pacific high-pressure system can create low-elevation inversion layers that prevent the vertical dispersion of air.

As a result, air pollutants can become concentrated during summer, lowering air quality. During winter, when the Pacific high-pressure system moves south, stormy, rainy weather dominates the region intermittently. Prevailing winter winds from the southeast disperse pollutants, often resulting in clear, sunny weather and good air quality over most of this portion of the region.

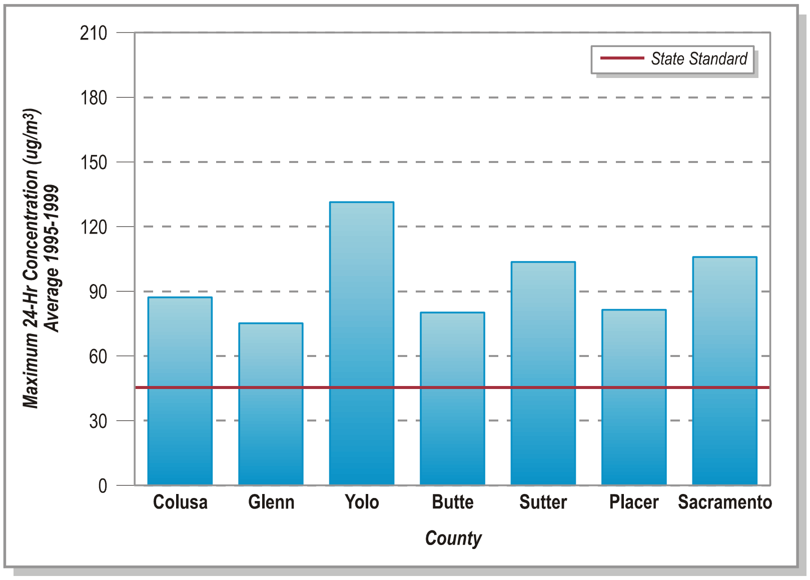
In the Sacramento Valley Air Basin, ozone and PM_{10} are pollutants of concern because concentrations of these pollutants have been found to exceed standards; ozone is a seasonal problem from approximately May through October.



Source: California Air Resources Board 2002

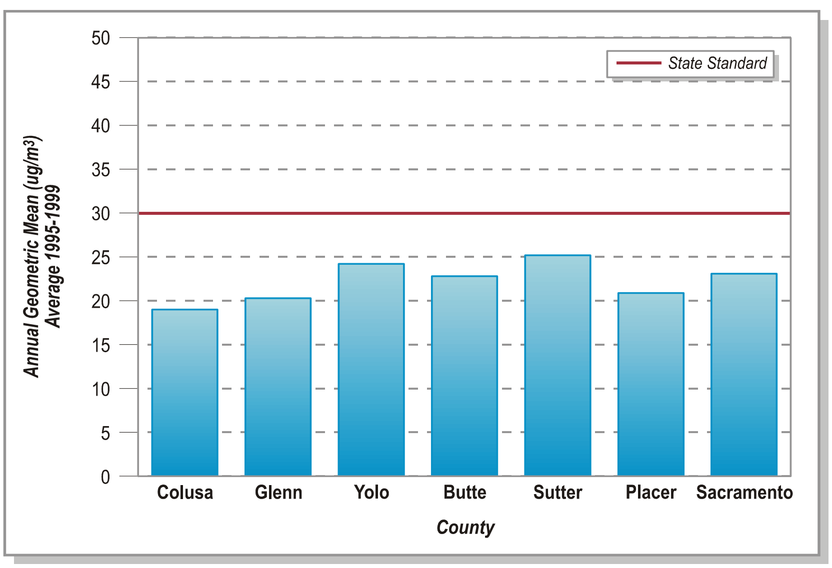
Figure 8-2
California Air Basins and Counties

The following discussion presents information on Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Sutter, Yolo, and Yuba Counties. For each county, Figures 8-3 through 8-5 show maximum PM_{10} and ozone concentrations as compared to the State standard. Monitoring data for Shasta, Yuba, and Merced are not represented on Figures 8-3 through 8-5; however, attainment status is discussed under the associated areas. Figure 8-3 displays the maximum 24-hour PM_{10} concentration, the highest levels that occurred in a single day. The Annual Geometric Mean, Figure 8-4, is an average concentration over the course of a year. Ozone and PM_{10}, as opposed to other criteria pollutants, are highlighted in this discussion because they are the potential pollutants of concern given the proposed Environmental Water Account (EWA) actions.



Source: CARB 2002

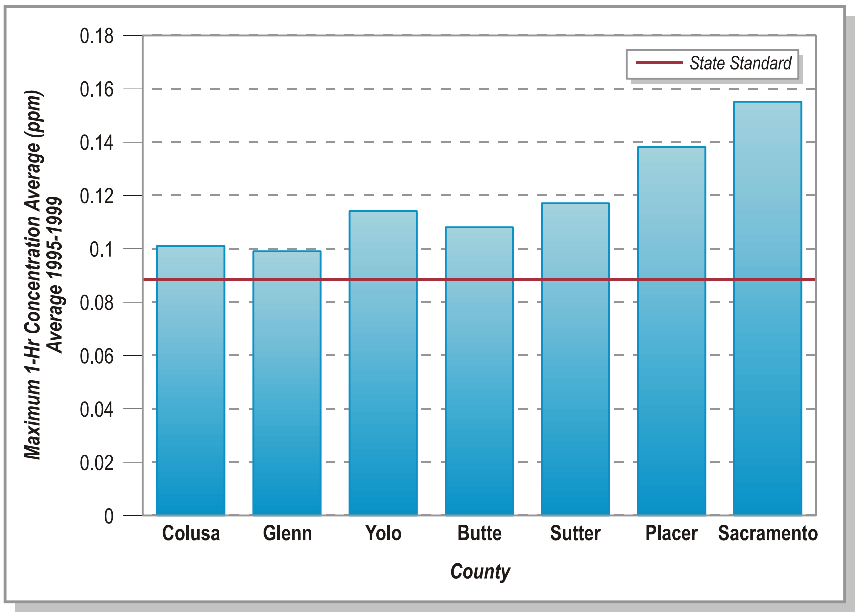
Figure 8-3
PM_{10} Concentrations (Maximum 24-hour) Upstream from the Delta Region



Source: CARB 2002

Figure 8-4
PM_{10} Concentrations (AGM)–Upstream from the Delta Region

Seasonal conditions, such as agricultural harvesting and summer forest fires, affect peak PM_{10} concentrations, which are much higher than the annual average, as the two figures illustrate. Figure 8-5 shows the maximum 1-hour concentration of ozone in relation to the State standard. The region exceeded the national 1-hour standard on 5 days in the year 2000.



Source: CARB 2002

Figure 8-5
Ozone Concentrations – Upstream from the Delta Region

8.1.3.1 Shasta, Glenn, Colusa, Yolo, Butte, Sutter, Yuba, Sacramento, and Placer Counties

Shasta, Glenn, Colusa, Butte, Sutter, Sacramento, Placer, Yuba, and Yolo Counties are nonattainment areas for State PM_{10} standards. All counties are in attainment for Federal standards except Sacramento, which is classified as a moderate nonattainment area for PM_{10}.

On a State level, Yolo County is a serious nonattainment area for ozone; Colusa, Glenn, and Shasta Counties are moderate nonattainment areas for ozone. According to Federal standards, Yolo County is a severe nonattainment area for ozone; Colusa, Glenn, and Shasta Counties are in attainment.

Butte, Sacramento, Placer, and Sutter Counties are nonattainment areas for ozone concentrations. On the Federal level, Butte County is classified as transitional for ozone, Placer, Sacramento, and Sutter Counties are severe nonattainment. Yuba County is a State nonattainment area for ozone, but is in attainment for Federal standards. No monitoring data are available for either PM_{10} or ozone historical concentrations in Yuba County.

8.1.3.2 Merced County

Although Merced County lies upstream from the Delta, the county will be discussed in Section 8.1.5, Export Service Area. Merced County is within the San Joaquin Valley Air Basin, as are all other counties discussed in Section 8.1.5.

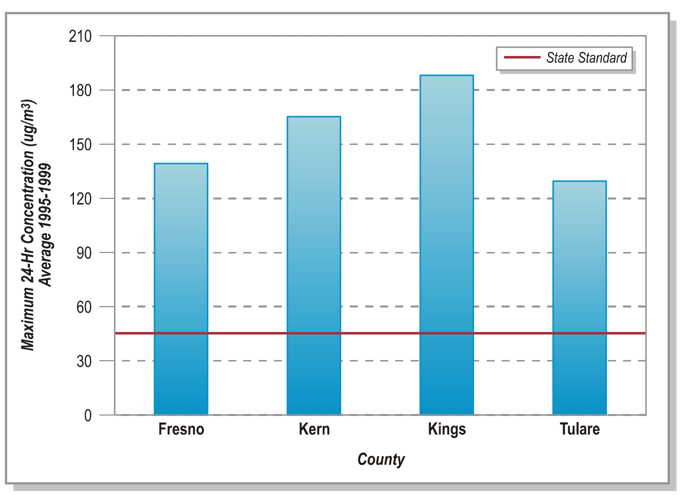
8.1.4 Delta Region

Because no EWA actions that affect air quality would take place in the Delta, a discussion of this region is not included.

8.1.5 Export Service Area

Merced, Fresno, Kern, Kings, and Tulare Counties are within the San Joaquin Valley Air Basin. During the summer, the Pacific high-pressure system moves north, and no precipitation or major storms occur, creating daily inversion layers of cool air over warm air. Surrounding mountains and upper watersheds of the region are at higher elevations than summer inversion layers. As a result, the region is highly susceptible to pollutant accumulation over time. In winter, the Pacific high-pressure system influence moves south and causes alternate periods of unsettled, stormy weather and stable, rainless conditions with winds from the southwest. Most of the San Joaquin Valley is in the rain shadow of the Coast Range and depends on cold, unstable northwesterly flow for its precipitation, consisting of showers following frontal passages.

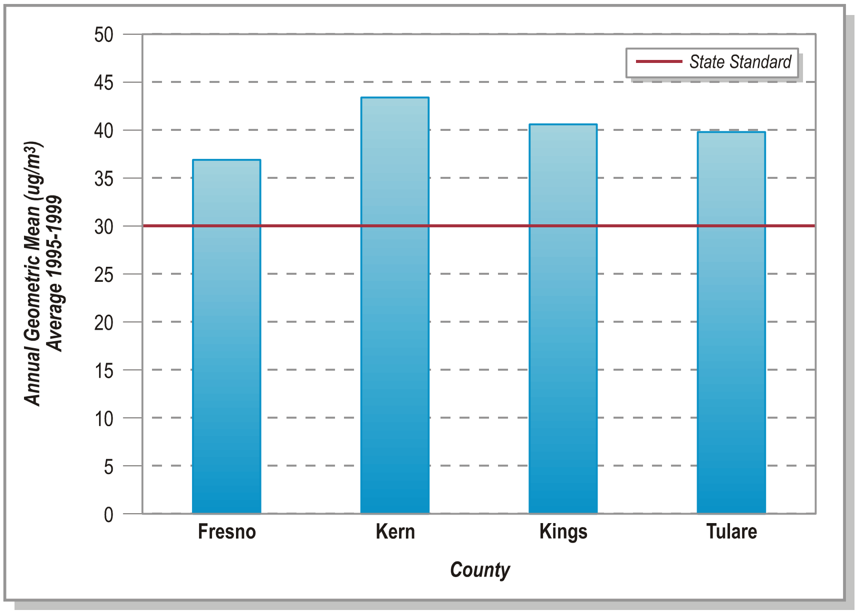
Merced, Fresno, Kern, Kings, and Tulare Counties are classified as nonattainment areas for State and Federal PM_{10} standards. Fresno, Kern, Kings, and Tulare Counties have exceeded the maximum 24-hour PM_{10} concentration and are above State standards (Figure 8-6). (There is no monitoring data available for PM_{10} for Merced County.)



Source: CARB 2002

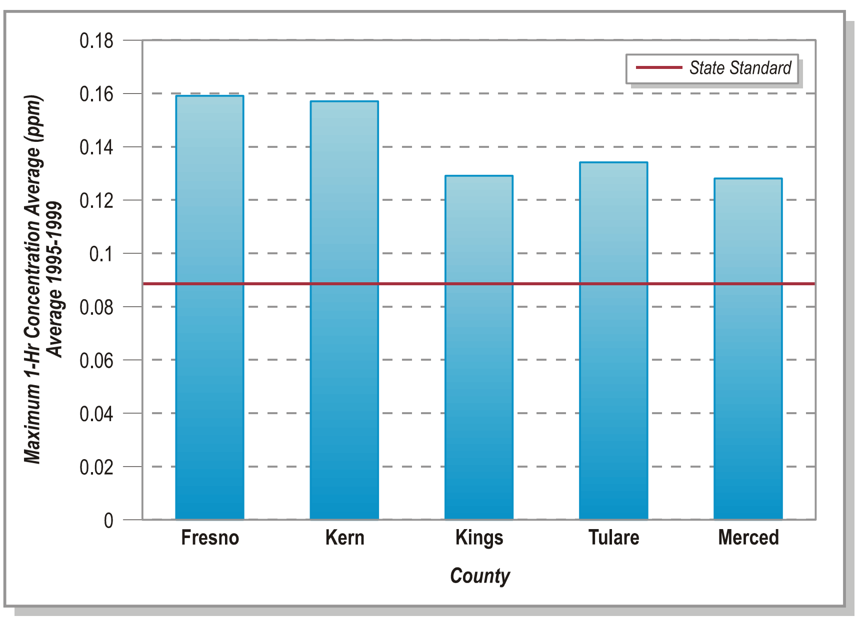
Figure 8-6
PM_{10} Concentrations (Maximum 24-hour) – Export Service Area

Annual PM_{10} concentrations are closer to State standards than the maximum 24-hour concentrations; however, they still exceed the threshold (Figure 8-7). Merced, Fresno, Kern, Kings, and Tulare Counties are severe nonattainment areas for ozone concentrations by State and Federal standards. Figure 8-8 shows ozone concentrations for these counties.



Source: CARB 2002

Figure 8-7
PM_{10} Concentration (AGM) – Export Service Area



Source: CARB 2002

Figure 8-8
Ozone Concentrations– Export Service Area

8.2 Environmental Consequences/Environmental Impacts

8.2.1.1 Assessment Methods

Under each alternative, the EWA Project Agencies would negotiate contracts to purchase water with willing sellers based on a number of factors, including price, water availability, and location. These factors would change from year-to-year; therefore, the EWA Project Agencies may choose to vary their acquisition strategy in each year. To provide maximum flexibility, this analysis includes many potential transfers when the EWA Project Agencies would likely not need all transfers in a given year. Chapter 2 defines the transfers that are included in this analysis.

EWA activities with the potential to contribute to air quality effects include the use of fossil fuel driven pumps to pump groundwater, and crop idling. The exact location of these activities will depend on a number of variables as described in Section 2 of this document. Because of this uncertainty, quantitative dispersion modeling of air pollutants from EWA activities could not be conducted. This analysis focuses on an estimate of the total mass emissions related to EWA actions.

8.2.1.1 Groundwater Substitution

Air quality effects resulting from groundwater substitution activities are limited primarily to generation of criteria pollutants from fossil-fueled pumps. This analysis discusses these effects both qualitatively and quantitatively. The extent of variables that differ across the area of analysis prevents a purely quantitative approach. In developing the projected mass emissions related to groundwater substitution activities, the following assumptions were made:

- Irrigation pumps are powered by 115-horsepower diesel engines;
- Diesel engines are assumed to be 'dirty' operating at 8.75 g NO_x/hp-hr.;
- Irrigation pumps operate for 2,000 hours over the course of the irrigation season;
- Irrigation pumps operate 24 hours/day[3];
- Average depth-to-groundwater ranges from 60 to 100 feet[4];
- A 115-horsepower diesel irrigation pump with a depth to groundwater of 60 to 100 feet can produce 3,000 gallons/minute[5]; and

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3 Although pumping hours/day varies, it is assumed that pumps run 24 hours/day as a conservative estimate.

4 Depth to groundwater was approximated based on groundwater maps of the Sacramento Valley.

5 Irrigation pump engine size and capacity was approximated based on personal communication with pump manufacturer and field verified through discussions with farmers.

- Irrigation efficiency is 70 percent.

The above assumptions provide a conservative, (worst case) estimate of mass emissions.

8.2.1.2 Crop Idling

Air quality effects related to crop idling activities are primarily generation of PM_{10} emissions associated with soil erosion. Some beneficial effects will be generated due to a reduction in emissions associated with general agricultural activities such as the use of diesel-fueled tractors, etc.

The effects of large-scale crop idling on air quality have not been studied in detail or well documented. Although there are equations that can predict soil loss, and thus estimate PM_{10} emissions, these equations are either very specific (for a given field), or very general (based on assumptions that are not accurate for the EWA study area) (Sheldon 2002). The analysis presented in Section 8.2.4.4 assesses the effects of crop idling on air quality using a close approximation based on CARB methods for estimating windblown dust from unpaved roads and compares the results with an estimation of windblown dust from agricultural lands.

Estimates of PM_{10} emissions under existing conditions (agricultural lands under cultivation) have been made based on methodology and data presented in the CARB Emission Inventory, Area Source Categories, Section 7.12, (Windblown Dust – Agricultural Lands) (CARB 1997a). Additionally, emission estimates from mechanical equipment used for cotton land preparation (8.9 lbs/acre/year) and cotton harvest (3.37 lbs/acre/year) (Gaffney 2003) have been applied to the total pounds of PM_{10}/acre/year. The monthly pounds/acre of PM_{10} produced for each of the 12 months was calculated using the normalized monthly emission profiles for land preparation, growth, and harvest presented in the CARB Emission Inventory, Area Source Categories Sections 7.4, 7.5, and 7.12 (CARB 1997a).

The methodology and data presented in the CARB Emission Inventory, Area Source Categories, Section 7.13 (Windblown Dust – Unpaved Roads) (CARB 1997a) have been used to estimate PM_{10} emissions with the EWA (crop idling). In calculating the emissions factors for windblown dust from unpaved roads, the CARB assumed that soil characteristics of the unpaved roads are approximately the same as the soil characteristics in the vicinity of the unpaved roads that are not used for vehicular travel; the CARB states that no additional gravel or amendments have been applied to the soils in the unpaved roads. Therefore, the emissions factors provide good estimates for PM_{10} emissions resulting from idled cropland. The total annual PM_{10} emissions for Fresno, Kern, Kings, and Tulare Counties in pounds/acre/year are taken from the CARB Emission Inventory, Area Source Categories Section 7.13 (CARB 1997a). The monthly pounds/acre of PM_{10} produced for each of the 12 months were calculated using the monthly windblown dust emissions seasonal profile also in Section 7.13.

8.2.2 Significance Criteria

The criteria used to evaluate potential air quality effects are based on standardized air emission levels. Potential air quality effects are considered significant if the implementation of the alternative would cause substantial adverse changes to the baseline (ambient) air quality conditions in the affected area. The range of such changes includes producing pollutants that would either on their own, or when combined with baseline emissions:

- Cause a lowering of attainment status;
- Conflict with an adopted air quality management plan, policy, or program;
- Violate any air quality standard or contribute to an existing or projected air quality violation; or
- Exceed visible dust emissions of 20 percent opacity (San Joaquin Valley Air Pollution Control District regulation).

8.2.3 Environmental Consequences/Environmental Impacts of the No Action/No Project Alternative

Baseline trends in air quality can reasonably be expected to continue if no action is taken. Total air emissions are expected to increase, even assuming that emissions allowable from individual and mobile sources would be regulated more strictly. Increased population and associated increases in the need for more vehicles would be a contributor to the rise in pollutant emissions. Given the short-term duration of the EWA program however, increases (or decreases) beyond current trends would likely be unnoticeable. Therefore, there are no air quality effects of the No Action Alternative. Because the description of the Affected Environment and the No Action/No Project Alternative are the same, they are collectively referred to as the Baseline Condition in the following sections.

8.2.4 Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative

The Flexible Purchase Alternative allows transfers up to 600,000 acre-feet and does not specify transfer limits from the Upstream from the Delta Region or the Export Service Area. Transfers from the Upstream from the Delta Region would range from 50,000 to 600,000 acre-feet, limited by hydrologic year and conveyance capacity through the Delta. Although all potential transfers would probably not be done in 1 year, this section evaluates the effects of a 1-year transfer of 600,000 acre-feet in order to provide a worst case effect analysis of a maximum transfer scenario. Similarly, the evaluation includes an analysis of up to 540,000 acre-feet in the Export Service Area to cover a maximum transfer scenario for that region.

8.2.4.1 Upstream from the Delta Region

8.2.4.1.1 Shasta, Glenn, Colusa, Yolo, Butte, Sutter, Yuba, Sacramento, and Placer Counties

The potential effects on air quality due to groundwater substitution, stored groundwater purchase, and crop idling would not differ by county. Therefore, the effects of the EWA actions are evaluated for the Upstream from the Delta Region as a whole.

Groundwater substitution would require use of groundwater pumps to retrieve groundwater. Groundwater substitution would take place in Glenn, Colusa, Yolo, Butte, Sutter, Sacramento, Shasta, and Yuba Counties. Agricultural users would use groundwater instead of surface water for their water supply. The use of groundwater would require pumps to lift the groundwater to the surface. Groundwater pumps can be driven by many different means. Table 8-4 shows the estimated NO_x and PM_{10} emissions for a 115 hp pump with electric, propane, and diesel motors, operating under the assumptions described in Section 8.2.1.1. NO_x and PM_{10} emissions are presented because several counties are in nonattainment for ozone and PM_{10} and NO_x is considered an ozone precursor. This information is for comparison purposes, but actual pollutants emitted depend on how the pump is powered, the size of the pump, the efficiency of the well, the length of time the pump is running, and the depth to groundwater.

Table 8-4
Groundwater Pump Emissions by Motor Type

Motor Type	NO_x (lbs/year)	PM_{10} (lbs/year)
"Dirty" Diesel	2,544	236
"Clean" Diesel	2,007	236
Electric	84	5.6
Propane	562	66

Source: California Farm Bureau Federation 1999.
These calculations assume that the pump would operate 2,000 hours in an average year.

Electric pumps do not emit pollutants at the pump; the source of pollutants can be traced to emissions from the powerplant. Powerplants are given permits based on their maximum operating potential. Although the electricity required to power the groundwater pumps would not be needed under the Baseline Condition, the additional electricity would not cause any powerplant to exceed operating capacity. A majority of power is derived from fossil fuel combusted at powerplants to generate electricity required to run the groundwater pumps. CO_2 is the primary pollutant emitted as a result of the oxidation of the carbon in the fuel. NO_x and PM_{10} are also emitted. As mentioned previously, these pollutants are noteworthy because many of the counties in the Upstream from the Delta Region are nonattainment areas for ozone and PM_{10}.

Diesel pump engines emit air pollutants through the exhaust. The primary pollutants from the pumps are NO_x, TOC, CO, and particulates (including visible and nonvisible emissions). Pumps that run on propane burn much cleaner than diesel, but still contribute NO_x, CO_2, VOCs, and trace amounts of SO_2 and particulate matter[6].

The pumps that would be used for groundwater substitution are existing pumps; no new pumps would be installed as a result of this alternative. The pumps have most likely been used in the past and will be used in the future; thus, the pumps are not a new source of emissions. However, groundwater substitution activities would result in use of the pumps at times when they would otherwise not be used. It is therefore necessary to quantify the project-related emissions to determine effects.

Table 8-5 shows the NO_x and PM_{10} emissions generated as a result of pump operation based on the assumptions listed above and in Section 8.2.1.1. The amounts represent pollutant emissions if the maximum transfer in each county was pumped using "dirty diesel" motors. This assumption represents a conservative worst-case estimate.

The values presented in Table 8-5 include the CARB estimated daily emissions from diesel-fueled groundwater pumps. This analysis assumes that the groundwater pumps will be operating from April through September. CARB's estimated emissions over this same time period were calculated using a temporal profile developed by CARB. According to CARB surveys, approximately 74.7 percent of groundwater pump emissions occur between April and September.

The project-related emissions, both NO_x and PM_{10}, in Sacramento, Yolo, Sutter, Glenn, and Colusa Counties have been accounted for within CARB's inventory as is demonstrated by the fact that the annual average EWA project emissions produced from groundwater pumping would fall below the diesel-fueled groundwater pump emission inventory. However, because the project-related emissions would be produced in a nonattainment area, the project would contribute to an existing air quality violation, which is a significant impact. Butte, Shasta, and Yuba Counties exceed CARB's inventory, also producing a significant impact. The mitigation measures listed in Section 8.2.7 would lower emissions to a negligible amount; therefore, these significant impacts would be reduced to a less-than-significant level.

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[6] NO_x = Nitrogen oxides, TOC = Total organic carbon, CO = Carbon monoxide, CO_2 = Carbon dioxide, VOCs = Volatile organic compounds, SO_2 = Sulfur dioxide.

Table 8-5
Groundwater Pump Emissions – Flexible Purchase Alternative – Upstream from the Delta Region

	CARB Average Daily Emissions (Tons/day)		***CARB Annual Emissions (Tons/year)***		***CARB Apr – Sep Daily Emissions (Tons/day)***		***Project Average Daily Emissions (Tons/day)***		***Project Annual Emissions (Tons/year)***		***Project Apr – Sep Daily Emissions (Tons/day)***		***Difference between Project and CARB Apr – Sep Daily Emissions (Tons/day)***	
County	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**
Sacramento	0.38	0.03	138.7	10.95	0.57	0.04	0.05	<0.01	18.25	<3.00	0.07	<0.01	-0.50	0
Yolo	4.29	0.31	1565.9	113.15	6.39	0.46	0.02	<0.01	7.30	<3.00	0.03	<0.01	-6.36	0
Feather River (Sutter)	2.06	0.15	751.9	54.75	3.07	0.22	0.07	<0.01	25.55	<3.00	0.10	<0.01	-2.97	0
Butte County	0.26	0.02	94.90	7.3	0.39	0.03	0.37	0.01	135.05	3.65	0.55	0.01	0.16	-0.02
Shasta County	0.088	0.001	32.12	0.365	0.13	<0.01	0.18	<0.01	65.70	<3.00	0.27	<0.01	0.14	0
Colusa	0.16	0.005	58.40	1.825	0.24	0.01	0.14	<0.01	51.10	<3.00	0.21	<0.01	-0.03	0
Glenn County	0.21	0.01	76.65	3.65	0.31	0.01	0.19	0.01	69.35	3.65	0.28	0.01	-0.03	0
Feather River (Yuba)	0.176	0.01	64.24	3.65	0.26	0.01	0.38	0.02	138.70	7.30	0.57	0.03	0.31	0.02

Notes:
CARB April – September Daily Emissions were calculated by taking 74.7 percent of the total annual emissions and dividing by 183 days (# of days from April through September).
Shasta and Yuba Counties are not included in CARB's estimate. For these Counties, the emissions were estimated using average emission values per pump.
Exceeds Statewide Inventory

EWA acquisition of water via crop idling in the Sacramento Valley would result in temporary conversion of lands from rice crops to bare fields. The overall effects on air quality are based on the effects of the reduction of air emissions due to declining use of farming equipment and pesticide applications and the effects, if any, of leaving rice fields idled.

During a typical calendar year of operation for rice production, farm equipment is required for preparing seedbeds, plowing and discing in March and April, harvesting in late September and October, and disposing of residue and discing in late October through November. Rice farmers apply fertilizers and pesticides during the spring. The equipment required for these activities produces both dust from disturbed soils and combustion emissions, which contribute to poor air quality. Additionally, burning of rice fields contributes to particulate matter and ground-level ozone concentrations. Idling rice fields would reduce the use of farm equipment and associated pollutant emissions, resulting in a beneficial impact on air quality.

The only potential adverse effect on air quality from idled rice fields would be PM_{10} from potential erosion of barren fields (caused by wind or vehicles driving on the fields). The soil texture in the Sacramento Valley reduces the potential for erosion. Highly erodible lands are those with fine soil texture and correspond to increased soil erosion. Increased soil erosion creates a larger amount of soil particulates entrained into the air; a percentage of which are particles small enough to be considered PM_{10}. Soil types in the Sacramento Valley are generally not considered highly erodible.

The rice crop cycle also reduces the potential for erosion. The process of rice cultivation includes incorporating the leftover rice straw into the soil after harvest. Farmers flood the rice fields during the winter to aid in decomposition of the straw. If no additional irrigation water were applied to the fields after this point (because the farmers would sell water to the EWA agencies), the soils would remain moist until approximately mid-May. Once dried, the combination of the decomposed straw and clay soils produces a hard, crust-like surface. This surface type, in contrast to sandy topsoil, would not be conducive to soil loss from wind erosion (Mutters 2002). Therefore, there would be little to no fugitive dust from wind erosion off the idled rice fields. Effects on sensitive receptors, such as nearby residents, would also be minimal. Therefore, effects on air quality from idled rice fields would be less than significant.

8.2.4.2 Delta Region

There are no EWA actions within the Delta; therefore, the EWA would cause no impacts on air quality in this region.

8.2.4.3 Export Service Area

EWA acquisition of water via stored groundwater purchase would require increased pumping. Stored groundwater would be purchased from Kern County Water Agency, Arvin Edison, and Semitropic. Air quality effects from operation of Semitropic's facilities were found to be less than significant in the 1994 Semitropic Banking Project EIR. The majority of the extraction pumps are electrical. The pumps at Semitropic are approximately 75 percent electric and 25 percent diesel/natural gas (Boschman 2002), and the pumps at Arvin Edison and Kern County Water Agency are 100 percent electric (Lewis 2002 and Iger 2002). Electric pumps are not a considerable source of NO_x or PM_{10}. Additional pumping using primarily electric motors would slightly increase NO_x and PM_{10}, but not substantially above the Baseline Condition. Therefore, the effects of stored groundwater purchase on air quality are less than significant.

EWA acquisition of water via groundwater substitution from Merced Irrigation District would require increased pumping. Agricultural users would use groundwater instead of surface water for their water supply. The use of groundwater would require pumps to lift the groundwater to the surface. As stated in Section 8.2.4.1, groundwater pumps can be driven by electric, propane, or diesel motors. Pollutants emitted depend on how the pump is powered, the size of the pump, the efficiency of the well, the length of time the pump is running, and the depth to groundwater. Electric pumps do not emit pollutants at the pump; the source of pollutants can be traced to emissions from the powerplant. Table 8-6 shows the NO_x and PM_{10} emissions related to pump generation based on the assumptions listed in Section 8.2.1.1. The amounts represent pollutant emissions if the maximum transfer in the Export Service Area (Merced County) was pumped using "dirty diesel".

The project-related NO_x emissions in Merced County have been accounted for in CARB's inventory as is demonstrated by the fact that the annual EWA project emissions produced from groundwater pumping would fall below the diesel-fueled agricultural pump emission inventory. However, because the project-related emissions would be produced in a nonattainment area, the project would contribute to an existing air quality violation, which is a significant impact. The mitigation measures listed in Section 8.2.7 would lower emissions to a negligible amount; therefore, these significant impacts would be reduced to a less-than-significant level.

Table 8-6
Groundwater Pump Emissions – Flexible Purchase Alternative – Export Service Area

	CARB Average Daily Emissions (Tons/day)		***CARB Annual Emissions (Tons/year)***		***CARB Apr – Sep Daily Emissions (Tons/day)***		***Project Average Daily Emissions (Tons/day)***		***Project Annual Emissions (Tons/year)***		***Project Apr – Sep Daily Emissions (Tons/day)***		***Difference between Project and CARB Apr – Sep Daily Emissions (Tons/day)***	
County/ Region	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**
San Joaquin Valley														
Merced	0.98	0.07	357.7	25.55	1.46	0.10	0.11	<0.01	40.15	<3.0	0.16	<0.01	-1.30	-<0.09

Notes:

CARB April – September Daily Emissions were calculated by taking 74.7 percent of the total annual emissions and dividing by 183 days (# of days from April through September).

EWA acquisition of water via crop idling in the Export Service Area would result in temporary conversion of lands from cotton crops to bare fields. Under the Baseline Condition, farmers would continue to grow cotton. PM_{10} emissions would result from land preparation, harvesting, and to some extent wind erosion; however, the cotton plants would serve as vegetative cover to control a majority of the erosion.

Using the assessment method discussed in Section 8.2.1.2, Table 8-7shows the PM_{10} emissions for the Baseline Condition (cotton cultivation). As would be expected, PM_{10} emissions for the Baseline Condition are lowest during January and highest during April/May (land preparation) and October/November (harvest).

Table 8-7
Monthly Estimates of PM_{10} Emissions under the Baseline Condition

County	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	Total
Fresno	3.88	3.35	1.58	1.66	2.13	1.96	3.76	4.39	1.93	0.24	0.47	0.64	25.99
Kern	2.71	2.11	1.20	1.23	1.34	1.07	3.41	4.46	1.94	0.27	0.52	0.62	20.88
Kings	4.89	2.53	1.14	1.20	1.43	1.53	3.98	4.97	2.00	0.28	0.49	0.67	25.11
Tulare	1.50	1.37	0.80	1.04	1.12	0.78	3.08	4.22	1.85	0.22	0.40	0.55	16.93

All values are in pounds/acre/year
Emission factors from CARB 1997a, Attachment A (nonpasture)

Willing sellers would idle fields that would have grown cotton in the Baseline Condition to use the irrigation water supply as an EWA asset. Beneficial air quality effects of this action include a reduction of air emissions due to less use of farming equipment and reduced pesticide applications. Potential adverse air quality effects result from the production of fugitive dust and PM_{10} through soil erosion on areas with no groundcover.

Using the assessment method discussed in Section 8.2.1.2, Table 8-8 shows PM_{10} emissions from idling cotton fields. Generally, PM_{10} emissions in May through October are higher than in the rest of the year. Little to no precipitation, low soil moisture, and windy conditions contribute to high PM_{10} emissions during this time of the year. EWA actions would produce 5 to 9 times more PM_{10} emissions/acre/year compared to the emissions under the Baseline Condition. These additional emissions would contribute to an existing air quality violation because Kern, Kings, Fresno, and Tulare Counties are nonattainment for PM_{10}. Implementation of the mitigation measures described in Section 8.2.7 would lessen the soil erosion potential and therefore fugitive dust and PM_{10} emissions. The potentially significant impact would be reduced to less than significant.

Table 8-8
Monthly Estimates of PM_{10} Emissions under Program Conditions

County	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	Total
Fresno	19.95	24.38	24.38	24.38	24.38	24.38	20.96	11.69	9.27	6.05	6.65	5.24	201.5
Kern	15.53	15.53	15.53	15.53	15.53	15.53	15.53	12.75	8.35	6.15	6.45	4.25	146.5
Kings	23.00	23.00	23.00	23.00	23.00	23.00	23.00	19.99	12.9	8.39	7.53	6.02	215
Tulare	8.74	9.66	10.16	10.16	10.16	10.16	10.16	4.87	3.28	2.35	2.69	1.76	84

All values are in pounds/acre/year
Emission factors from CARB 1997b, Table 2

The analysis thus far has been based on a 1-year water transfer; however, the EWA agencies and willing sellers may agree to multi-year transfers. No effects as discussed would accumulate from one year to another. Therefore, the effects presented in Sections 8.2.4.1 and 8.2.4.3 would be the same whether agencies sold water for one or multiple years.

8.2.5 Environmental Consequences/Environmental Impacts of the Fixed Purchase Alternative

The Fixed Purchase Alternative specifies purchases of 35,000 acre-feet from the Upstream from the Delta Region and 150,000 acre-feet from the Export Service Area. Although the amounts in each region are fixed, the acquisition types and sources could vary. This section analyzes the effects of each potential transfer to allow the EWA Project Agencies maximum flexibility when negotiating purchases with willing sellers. These transfers are the same actions as those described for the Flexible Purchase Alternative, but the amounts are limited by the total acquisition amount in each region (35,000 acre-feet from the Upstream from the Delta Region and 150,000 acre-feet from the Export Service Area).

8.2.5.1 Upstream from the Delta Region

Groundwater substitution would require use of groundwater pumps to retrieve groundwater. Table 8-9 shows the NO_x and PM_{10} emissions generated as a result of pump operation based on the assumptions listed in Section 8.2.1. The amounts represent pollutant emissions if the maximum transfer in each county was pumped using "dirty diesel" motors. This assumption represents a conservative worst- case estimate. The values presented in Table 8-9 include the CARB estimated daily emissions from diesel-fueled agricultural irrigation pumps. This analysis assumes that the groundwater pumps will be operating from April through September. CARB's estimated emissions over this same time period were calculated using a temporal profile developed by CARB. According to CARB surveys, approximately 74.7 percent of groundwater pump emissions occur between April and September.

Table 8-9
Groundwater Pump Emissions – Fixed Purchase Alternative – Upstream from the Delta Region

	CARB Average Daily Emissions (Tons/day)		CARB Annual Emissions (Tons/year)		CARB Apr – Sep Daily Emissions (Tons/day)		Project Average Daily Emissions (Tons/day)		Project Annual Emissions (Tons/year)		Project Apr – Sep Daily Emissions (Tons/day)		Difference between Project and CARB Apr – Sep Daily Emissions (Tons/day)	
County	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**	**NO_x**	**PM_{10}**
Sacramento	0.38	0.03	138.7	10.95	0.57	0.04	0.05	<0.01	18.25	<3.00	0.07	<0.01	-0.50	0
Yolo	4.29	0.31	1565.9	113.15	6.39	0.46	0.02	<0.01	7.30	<3.00	0.03	<0.01	-6.36	0
Feather River (Sutter)	2.06	0.15	751.9	54.75	3.07	0.22	0.07	<0.01	25.55	<3.00	0.10	<0.01	-2.97	0
Butte County	0.26	0.02	94.90	7.3	0.39	0.03	0.16	0.01	57.00	3.65	0.23	0.01	-0.08	-0.02
Shasta County	0.088	0.001	32.12	0.365	0.13	<0.01	0.16	<0.01	57.00	<3.00	0.23	<.01	0.10	0
Colusa	0.16	0.005	58.40	1.825	0.24	0.01	0.14	<0.01	50.00	<3.00	0.20	<.01	-0.04	0
Glenn County	0.21	0.01	76.65	3.65	0.31	0.01	0.16	0.01	57.00	3.65	0.23	0.01	0.00	0
Feather River (Yuba)	0.176	0.01	64.24	3.65	0.26	0.01	0.16	0.02	57.00	7.30	0.23	0.03	-0.03	0.02

Notes:
CARB April – September Daily Emissions were calculated by taking 74.7 percent of the total annual emissions and dividing by 183 days (# of days from April through September).
Shasta and Yuba Counties are not included in CARB's estimate. For these Counties, the emissions were estimated using average emission values per pump.
Exceeds Statewide Inventory

The project-related NO_x emissions in all counties except Shasta County have been accounted for within CARB's inventory as is demonstrated by the fact that the annual average EWA project emissions produced from groundwater pumping fall below the diesel-fueled agricultural pump emission inventory. The project-related PM_{10} emissions in all counties except Yuba County have also been accounted for within CARB's inventory. However, because all project-related emissions would be produced in nonattainment areas, the project would contribute to an existing air quality violation, which is a significant impact. Shasta and Yuba Counties exceed CARB's inventory, also producing a significant impact. The mitigation measures listed in Section 8.2.7 would lower emissions to a negligible amount; therefore, these significant impacts would be reduced to a less-than-significant level.

EWA acquisition of water via crop idling in the Sacramento Valley would result in temporary conversion of lands from rice crops to bare fields. Crop idling upstream from the Delta could potentially cause significant impacts on air quality because idling a maximum of 15,100 acres would increase PM_{10} emissions. As stated in Section 8.2.4.2, the only potential adverse effect on air quality from idled rice fields would be PM_{10} from erosion of barren fields (caused by wind or vehicles driving on the fields). The rice crop cycle and soil texture reduces the potential for erosion. If no irrigation water were applied to the rice fields after their being flooded the previous winter, the soils would remain moist until approximately mid-May. Once dried, the combination of the decomposed straw and clay soils produces a hard, crust-like surface, not conducive to soil loss from wind erosion. Therefore, wind would erode little to no fugitive dust off the idled rice fields. Effects on sensitive receptors, such as nearby residents, would also be minimal. Therefore, effects on air quality from idled rice fields would be less than significant.

8.2.5.2 Export Service Area

EWA acquisition of water via stored groundwater purchase would require increased pumping. Stored groundwater would be purchased from Kern County Water Agency, Arvin Edison, and Semitropic. Air quality effects from operation of Semitropic's facilities were found to be less than significant in the 1994 Semitropic Banking Project EIR. The majority of the extraction pumps are electrical. The pumps at Semitropic are approximately 75 percent electric and 25 percent diesel/natural gas (Boschman 2002), and the pumps at Arvin Edison and Kern County Water Agency are 100 percent electric (Lewis 2002 and Iger 2002). Electric pumps are not a considerable source of NO_x or PM_{10}. Additional pumping using primarily electric motors would slightly increase NO_x and PM_{10}, but not substantially above the Baseline Condition. Therefore, the effects of stored groundwater purchase on air quality would be less than significant.

EWA acquisition of water via groundwater substitution from Merced Irrigation District would require increased pumping. Because the same amount of water could be purchased under the Fixed Purchase Alternative as described in the Flexible Purchase Alternative, the effects on air quality as listed in Section 8.2.4.3 would be the same.

Therefore, the significant impacts on air quality from groundwater substitution in Merced County would be less than significant with mitigation.

EWA acquisition of water via crop idling in the Export Service Area would result in temporary conversion of lands from cotton crops to bare fields. As stated in Section 8.2.4.3, program effects produce both beneficial and adverse effects on air quality. Beneficial air quality effects of this action include a reduction of air emissions due to less use of farming equipment and reduced pesticide applications. Potential adverse air quality effects result from the production of fugitive dust and PM_{10} through soil erosion on areas with no groundcover.

The potential production of PM_{10} is discussed in Section 8.2.4.3. The effects described under the Flexible Purchase Alternative are equivalent to the effects under the Fixed Purchase Alternative because the amount of PM_{10} produced is analyzed on a per-acre basis. The estimated quantity of PM_{10} produced ranges from 84 to 215 pounds of PM_{10}/acre/year, as listed in Table 8-8. Given that Fresno, Kern, Kings, and Tulare Counties are nonattainment areas for PM_{10}, increased PM_{10} could contribute to the nonattainment status in these counties, resulting in a potentially significant impact. The implementation of mitigation measures listed in Section 8.2.7 would reduce the impact of crop idling to less than significant.

The analysis thus far has been based on a 1-year water transfer; however, the EWA agencies and willing sellers may agree to multi-year transfers. No effects as discussed would accumulate from one year to another. Therefore, the effects presented in Sections 8.2.5.1 and 8.2.5.3 would be the same whether agencies sold water for one or multiple years.

8.2.6 Comparative Analysis of Alternatives

This chapter has thus far analyzed the effects of many potential transfers, looking at the "worst-case scenario" that would occur if all acquisitions happened in the same year. This approach ensures that all effects of transfers are included and provides the EWA Project Agencies the flexibility to choose transfers that may be preferable in a given year. The EWA, however, would not actually purchase all this water in the same year. This section provides information about how EWA would more likely operate in different year types. A further comparison of the alternatives is listed in Table 8-10.

Table 8-10 Comparison of the Effects of the Flexible Purchase and Fixed Purchase Alternatives on Air Quality							
Region	**Asset Acquisition or Management**	**Result**	**Effects**	**Flexible Alternative Change from Baseline**	**Fixed Alternative Change from Baseline**	**Significance of Flexible Purchase Alternative**	**Significance of Fixed Purchase Alternative**
Upstream from the Delta	Crop Idling	Conversion of rice crops to bare fields.	Reduced rice crop acreage in Glenn, Colusa, Yolo, Butte, Sutter, and Placer Counties.	Idle acres that could contribute to fugitive dust emissions.	Idle acres that could contribute to fugitive dust emissions.	LTS	LTS
	Groundwater Substitution	Groundwater used in place of surface water.	Increased emissions from use of groundwater pumps.	Increased groundwater pumping	Increased groundwater pumping.	PS; LTS with mitigation.	PS; LTS with mitigation.
	Stored groundwater purchase	Extraction of water from groundwater storage.	Increased emissions from extraction pumps.	Slight increase in PM_{10} and NO_x.	Slight increase in PM_{10} and NO_x.	LTS	LTS
Export Service Area	Crop Idling	Conversion of cotton crops to bare fields.	Reduced cotton crop acreage in Fresno, Kern, Kings, and Tulare Counties.	Idle acres that could contribute to fugitive dust emissions.	Idle acres that could contribute to fugitive dust emissions.	PS; LTS with mitigation.	PS; LTS with mitigation.
	Groundwater Substitution	Groundwater used in place of surface water.	Increased emissions from use of groundwater pumps.	Increased groundwater pumping	Increased groundwater pumping.	PS; LTS with mitigation.	PS; LTS with mitigation.
	Stored Groundwater Purchase	Extraction of water from groundwater storage.	Increased emissions from extraction pumps.	Slight increase in PM_{10} and NO_x.	Slight increase in PM_{10} and NO_x.	LTS	LTS

8.2.6.1 Upstream from the Delta Region

In the Upstream from the Delta Region, under the No Project Alternative, crop idling could occur because of unreliable water supplies, economic factors, or as part of a crop rotation. In very dry years, water supplies would be less as compared to wet years. Reduced supplies could cause an increase in crop idling and an increase in PM_{10} emission. Reduced surface water supplies could also lead to increased groundwater pumping and NO_x emissions.

The Fixed Purchase Alternative would be limited to a maximum acquisition of 35,000 acre-feet from all sources of water. This amount could typically be obtained from stored reservoir water purchases in most year types. The Fixed Purchase Alternative would therefore not likely involve acquisition of groundwater or crop idling and thus would have no effect on air quality. In very dry years, stored reservoir water may not be available, and the EWA would acquire water first from groundwater substitution and/or groundwater purchase, followed by crop idling. Therefore, during dry years, effects on air quality could be possible; however, the effects would be less than significant.

The Flexible Purchase Alternative could involve the purchase of up to 600,000 acre-feet of water from all sources upstream from the Delta. EWA agencies would prefer to purchase water from upstream sources because the water is generally less expensive. The amount that could be purchased would be limited by the capacity of the Delta export pumps to move the water to the Export Service Area. During wet years, excess pump capacity may be limited to as little as 50,000 to 60,000 acre-feet of EWA asset water because the pumps primarily would be used to export Project water to Export Service Area users. During dry years, when less Project water would be available for pumping (and therefore the pumps would have greater availability capacity), the EWA Project Agencies could acquire up to 600,000 acre-feet of water from sources in the Upstream from the Delta Region.

The potential for effects on air quality during wet years for the Flexible Purchase Alternative would be very similar to the Fixed Purchase Alternative. That is, during wet years, acquisition would most likely be from stored reservoir water; EWA Project Agencies would not acquire water from groundwater and crop idling. As rainfall amounts for areas upstream from the Delta decrease, reflecting dry-year conditions, the greater capacity of the export pumps to move EWA assets could result in a greater reliance on groundwater substitution and crop idling for additional EWA acquisitions. If the EWA Project Agencies were to acquire 600,000 acre-feet from the Upstream from the Delta Region, they would need to utilize most available sources, including stored reservoir water, groundwater substitution, stored groundwater purchase, and crop idling. Therefore, effects on air quality could be possible; however, the effects would be less than significant with the exception of groundwater substitution in Yuba County, which is a significant impact. Implementation of mitigation measures listed in Section 8.2.7 would reduce the impact to a less-than-significant level.

8.2.6.2 Export Service Area

Under the No Project Alternative, effects in the Export Service Area in dry years compared to wet years would be the same as described under the Upstream from the Delta Region.

EWA asset acquisitions in the Export Service Area under the Fixed Purchase Alternative would be limited to 150,000 acre-feet from stored groundwater purchase and crop-idling sources. The EWA agencies would purchase stored groundwater initially; however, the amount of water in storage may not be sufficient to supply the EWA with water for multiple years. Crop idling would supplement water needs beyond what could be acquired from stored groundwater. Stored groundwater purchase would not produce a substantial amount of pollutants because electric pumps are used to lift the water. Crop idling could cause a potentially significant impact from the production of PM_{10} off idled fields. Mitigation measures however, would reduce the effects to less than significant.

EWA asset acquisitions in the Export Service Area under the Flexible Purchase Alternative would be dependent on the water year type upstream from the Delta. Export pump capacity during wet years would limit the availability of the EWA Project Agencies to move assets through the Delta, requiring reliance on greater purchase amounts from the Export Service Area. During wet years, acquisitions within the Export Service Area could involve up to 540,000 acre-feet of assets. The EWA agencies would acquire assets from stored groundwater purchase and idled cropland. As under the Fixed Purchase Alternative, stored groundwater purchase would not produce a substantial amount of pollutants because electric pumps are used to lift the water. During wet years, the Flexible Purchase Alternative would potentially have a greater effect on air quality because a larger number of acres could be idled than under the Fixed Purchase Alternative. However, mitigation measures would reduce both the Flexible and Fixed Purchase Alternatives to a less-than-significant level.

8.2.7 Mitigation Measures

8.2.7.1 Groundwater Substitution

If the EWA agencies obtain water from groundwater substitution, increased groundwater pumping would increase NO_x emissions. The EWA agencies and willing sellers would work together to implement one, or a combination, of the following mitigation measures that is appropriate to reduce impacts to a less-than-significant level. The mitigation measures will be implemented within the willing seller's air district.

- EWA agencies will require willing sellers to use only electric pumps.
- EWA agencies will require willing sellers to use electric or propane-fueled pumps. For each propane-fueled pump, a diesel engine within the district that is not a part of the EWA must be replaced with a propane or electric pump to 'offset' the emissions from the project-related pump.
- EWA agencies will require the willing sellers to purchase offsets to compensate for producing project-related emissions.

8.2.7.2 Crop Idling

If the EWA agencies obtain water from idling cotton crops, the San Joaquin Valley APCD must approve a Dust Suppression Plan that results in less-than-significant air quality effects. Willing sellers will work with EWA agencies and the APCD to establish these plans, using mitigation measures described in Table 8-11 that are appropriate for each site.

Table 8-11
Mitigation Measures

Measure	Feasibility
1. Crop shift (for example, shift to winter wheat). Wheat would be harvested between mid-June and mid-July. The stubble and chaff would be left on the fields to maintain a vegetative cover and reduce the surface area exposed to wind. Additionally, the root system would serve to hold the topsoil in place. Less soil erosion corresponds to less particulate matter entrained into the air.	Winter wheat is a common crop alternated with cotton crops. There is no requirement for a plowdown of the stubble as is required for cotton plants. Crop shifting to winter wheat would greatly reduce soil erodibility. This mitigation measure would increase surface roughness, vegetative cover, and soil moisture and would reduce the impact to less than significant.
2. Increase surface roughness, which reduces wind speed at the soil surface so that the wind is less able to move soil particles. Ripping clay soil using spikes will usually bring up non-erodible clods, creating a rough surface. If soils are sandy, listing, instead of ripping, is used because sandy soils do not produce durable clods. Listing ridges the soil and brings up firmer subsoil. Furrowing fields also increases surface roughness. Peaked furrows would control erosion more effectively than flat furrows. Depending on soil texture, the above methods may need to be repeated throughout the summer.	These practices would reduce soil erodibility and associated entrainment of particulate matter. Depending on soil properties, this mitigation measure alone may not reduce effects to less than significant.
3. Establish wind breaks, which consist of trees or bushes that aid in reducing wind velocity across fields. As a general rule, for every 1 foot in height, the wind break will afford protection to 10 feet of field.	Due to the short-term nature of the transfer, 1 year, newly planted wind breaks would not have grown to sufficient height to substantially reduce impacts. However, wind breaks could be planted as mitigation for the future. The effect of this mitigation measure alone would not reduce the impact to less than significant.
4. After harvest the year before the transfer, leave crop residue on the fields to decrease surface area exposed to strong winds.	Due to required pest management activities for cotton crops, farmers must plow crop residue under by mid-December. Therefore, the crop residue would not be available afterward as a cover to prevent fugitive dust due to wind erosion.
5. Restrict motorized vehicles or the times of operation for certain off-road vehicles on idled agricultural land.	Farmers' preference is to disc a few times throughout the summer to prevent weeds from producing seeds that can be a nuisance the following year.
6. Water fields prior to especially windy periods.	Under program alternatives, farmers would have sold their irrigation water to the EWA and could not apply water to the fields.

8.2.8 Potentially Significant Unavoidable Impacts

There are no potentially significant unavoidable impacts.

8.2.9 Cumulative Effects

8.2.9.1 Upstream from the Delta Region

In the Upstream from the Delta Region, five programs (Sacramento Valley Water Management Agreement, Dry Year Purchase Program, Drought Risk Reduction Investment Program, Environmental Water Program, and Central Valley Project Improvement Act Water Acquisition Program) would contribute to NO_x emissions from groundwater pumping (three of the five would only occur during dry years). In the Upstream from the Delta Region, ozone attainment status is an issue of concern; additional emissions of ozone precursors from other programs would contribute to already high ozone concentration areas, creating a potentially significant cumulative impact. However, the EWA is implementing mitigation measures listed in Section 8.2.7, which would also alleviate the cumulative impact. Therefore EWA's contribution is less than cumulatively considerable and thus not significant.

Four programs (Sacramento Valley Water Management Agreement, Dry Year Purchase Program, Environmental Water Program, and Drought Risk Reduction

Investment Program) would include crop idling as a water acquisition method (during dry years only). Due to the lack of highly erodible soils in the Upstream from the Delta Region, the emission of PM_{10} from EWA actions in combination with other programs would not produce a significant effect.

8.2.9.2 Export Service Area

Groundwater substitution would take place as part of two programs, the Drought Risk Reduction Investment Program and the Central Valley Project Improvement Act Water Acquisition Program. As stated above, increased groundwater pumping corresponds to increased NO_x emissions. Merced County is a severe nonattainment area for ozone. The production of ozone precursors by several programs could lead to a potentially significant cumulative impact. However, the EWA is implementing mitigation measures listed in Section 8.2.7, which would also alleviate the cumulative impact. Therefore EWA's contribution would be less than cumulatively considerable and thus not significant.

One program, the Drought Risk Reduction Investment Program, would include crop idling in the Export Service Area. Crop idling causes increased fugitive dust emissions and associated PM_{10} emissions, as discussed above. Both fugitive dust and PM_{10} are currently at high concentrations in this region. The production of PM_{10} by several programs (e.g., water transferred to Metropolitan Water District to replace reduced Colorado River supply) could lead to a potentially significant cumulative impact. However, Fresno, Kern, Kings, and Tulare Counties are within the San Joaquin Valley APCD. The APCD regulates fugitive dust emissions and requires adherence to mitigation measures in the form of a dust suppression plan. It is anticipated that the Drought Risk Reduction Investment Program, or any other crop idling program, would also be required to comply with the APCD regulations so as not to produce a cumulative effect; however, this cannot be stated definitively. Because the EWA is contributing to mitigation measures to lessen impacts, their contribution would be less than cumulatively considerable and thus not significant.

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Chapter 9
Fisheries and Aquatic Ecosystems/Hydrologic Modeling

Aquatic ecosystems in the Bay-Delta support important recreational and commercial fisheries worth millions of dollars and provide substantial intangible cultural, scientific, and social value. The role of aquatic species in ongoing conflicts over beneficial uses of water in the Bay-Delta ecosystem is testimony to their value, especially for species listed under the Federal and State Endangered Species Acts (ESAs). Conserving the values provided by aquatic species for future generations requires maintenance and enhancement of ecosystem health, but is complicated by existing and increasing human demands for water supply, flood control, and other aquatic ecosystem functions.

This chapter describes the fisheries-related resources located within the EWA area of analysis. Section 9.1, Affected Environment/Existing Conditions, defines and includes an overview of the fish species of primary management concern, as well as provides a description, on a regional basis, of the water bodies these species inhabit. Section 9.2, Environmental Consequences/Environmental Impacts, includes a discussion of the methods utilized to assess potential impacts on reservoir and riverine fish species based on their individual lifestages (adult immigration; spawning, egg incubation, and initial rearing; and juvenile rearing and emigration), outlines the impact indicators and significance criteria used in the analyses, and provides a detailed analysis of potential impacts related to implementation of the Flexible Purchase Alternative. Section 9.2, Environmental Consequences/Environmental Impacts, also presents a qualitative assessment of the Fixed Purchase Alternative, provides a comparative analysis of alternatives, and discusses potential cumulative impacts. The analysis and underlying modeling assumptions incorporate evaluation of the variable operational assets of the EWA Program. The analysis relied on both printed documents and personal communication citations, which are included in Section 9.3, References.

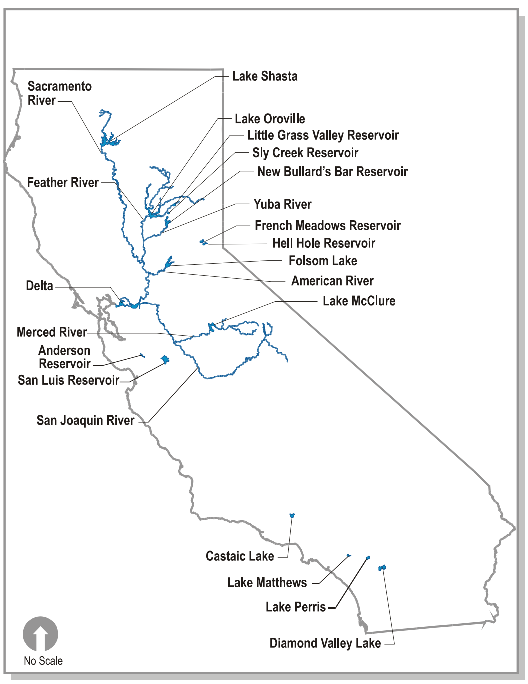

Figure 9-1
Fisheries and Aquatic Ecosystems Area of Analysis

9.1 Affected Environment/Existing Conditions

This section describes the affected environment/existing conditions related to fisheries and aquatic ecosystems in all water bodies that may be influenced by implementation of the EWA Program (Figure 9-1). This includes the Sacramento, Feather, Yuba, American, Merced, and San Joaquin rivers and associated reservoirs, the Sacramento-San Joaquin Delta, San Luis Reservoir, Anderson Reservoir, and Department of Water Resources (DWR) and Metropolitan Water District (Metropolitan WD) reservoirs in southern California. The EWA area of analysis is defined in Section 3.2 and shown on Figure 3-1. The area of analysis related to potential impacts on fisheries and aquatic ecosystems is more specifically defined in Section 9.1.1, Upstream from the Delta Region, Section 9.1.2, Sacramento-San Joaquin Delta Region, and 9.1.3, Export Service Area.

Species of primary management concern evaluated in this analysis include those that are recreationally or commercially important (fall-run Chinook salmon[1] (*Oncorhynchus tshawytscha),* steelhead (*Oncorhynchus mykiss*), American shad (*Alosa sapidissima*), and striped bass (*Morone saxatilis*)), Federal- and/or State-listed species within the area (winter- and spring-run Chinook salmon, steelhead, delta smelt (*Hypomesus transpacificus*), and Sacramento splittail (*Pogonichthys macrolepidotus*)), and candidate species under the Federal ESA (late-fall-run Chinook salmon).

Special emphasis is placed on these species to facilitate compliance with applicable laws, particularly, the State and/or Federal ESA, and to be consistent with State and Federal restoration/recovery plans and Federal biological opinions. This focus is consistent with: 1) CALFED's 2000 Ecosystem Restoration Program Plan (ERPP) and Multi-Species Conservation Strategy (MSCS); 2) the programmatic determinations for the CALFED program, which include CDFG's Natural Community Conservation Planning Act (NCCPA) approval and the programmatic biological opinions (BOs) issued by National Marine Fisheries Service (NOAA Fisheries) and USFWS; 3) USFWS's 1997 Draft Anadromous Fish Restoration Program (AFRP), which identifies specific actions to protect anadromous salmonids; 4) CDFG's 1996 Steelhead Restoration and Management Plan for California, which identifies specific actions to protect steelhead; and 5) CDFG's Restoring Central Valley Streams, A Plan for Action (1993), which identifies specific actions to protect salmonids. Improvement of habitat conditions for these species of priority management concern will likely protect or enhance conditions for other fish resources, including native resident species.

Evaluating potential impacts on fishery resources within the EWA area of analysis requires an understanding of fish species' life histories and lifestage-specific environmental requirements. Therefore, general information is provided below regarding life histories of species that occur within the EWA area of analysis.

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[1] NMFS recognizes the late-fall-run Chinook salmon in the Central Valley fall-run ESU (Moyle 2002).

Commercially, Chinook salmon are one of the most important species of anadromous fish in California. Chinook salmon have evolved a broad array of life history patterns that allow them to take advantage of diverse riverine conditions throughout the year. Four principal life history variants are recognized and are named for the timing of spawning runs: fall-run, late-fall-run, winter-run and spring-run. The Sacramento River supports all four runs of Chinook salmon. The larger tributaries to the Sacramento (American, Yuba, and Feather rivers) and rivers in the San Joaquin Basin also provide habitat for one or more of these distinct runs. A separate discussion on each of these four runs is provided below. Table 9-1 illustrates the general differences among the timing of life stages of the four Central Valley Chinook salmon runs. Slight differences in timing may occur depending on the river and are discussed in the following narratives.

Table 9-1
Generalized Life History Timing of Central Valley Chinook Salmon Runs

Run	Adult Migration Period	Peak Migration Period	Spawning Period [1]	Peak Spawning Period	Fry Emergence Period	Juvenile Stream Residency	Juvenile Emigration Period
Late-fall	October-April	December	Early January - April	February - March	April - June	7-13 months	June-December
Winter	December-July	March	Late April - Early August	May - June	July - October	5-10 months	July-March
Spring	Mid-February-July	April-May	Late August - October	Mid-September	November - March	3-15 months	October-April
Fall	June-December	September-October	Late September-December	October - November	December - March	1-7 months	January-July

Sources: Moyle 2002, Vogel and Marine 1991, and CDFG 1998.
[1] The time periods identified for spawning include the time required for incubation and initial rearing, prior to emergence of fry from spawning gravels.

Fall-run Chinook Salmon. In the Central Valley, fall-run Chinook salmon are the most numerous of the four salmon runs, and consequently, they continue to support commercial and recreational fisheries of significant economic importance. Fall-run Chinook salmon are currently the largest run of Chinook salmon utilizing the Sacramento River system, and are the primary run of Chinook salmon using the lower American River. The Feather, Yuba, San Joaquin, and Merced Rivers also support runs of fall-run Chinook salmon. Litigation over proposed water diversions in the American River has prompted the intensive study of fall-run Chinook salmon within the lower American River. As a result, additional information pertaining to the life history and environmental requirements specific to the lower American River fall-run population is provided below, and serves as a general guide to the remaining rivers in the regional setting.

Adult Chinook salmon begin migrating upstream annually in August and September, with immigration continuing through December in most years and January in some years. Adult Chinook salmon immigration generally peaks in November, and typically, greater than 90 percent of the run has entered the river by the end of November (CDFG 1992, 1995). The immigration timing of fall-run Chinook salmon tends to be temporally similar year-to-year because it is largely dictated by cues (photoperiod, maturation, and other season environmental cues) that exhibit little year-to-year variation.

The timing of adult Chinook salmon spawning activity is strongly influenced by water temperature. When daily average water temperatures decrease to approximately 60°F, female Chinook salmon begin to construct nests (redds) into which their eggs (simultaneously fertilized by the male) are eventually released. Fertilized eggs are subsequently buried with streambed gravel. Due to the timing of adult arrivals and occurrence of appropriate spawning temperatures, spawning activity in recent years in the lower American River, for example, has peaked during mid- to late-November (CDFG 1992, 1995).

The intragravel residence period of incubating eggs and alevins (yolk-sac fry) is highly dependent upon water temperature. The intragravel egg and fry incubation lifestage for Chinook salmon generally extends from about mid-October through March. Egg incubation survival rates are dependent on water temperature and intragravel water movement. CDFG (1980) reported egg mortalities of 80 percent and 100 percent for Chinook salmon at water temperatures of 61°F and 63°F, respectively. Egg incubation survival is highest at water temperatures at or below 56°F.

Within the EWA area of analysis, fall-run Chinook salmon fry emergence generally occurs from late-December through mid-May. In the Sacramento River basin, fall-run Chinook salmon juvenile emigration occurs from January through July (Vogel and Marine 1991; Yoshiyama et al. 1998). Emigration surveys conducted by CDFG have shown no evidence that peak emigration of Chinook salmon is related to the onset of peak spring flows in the lower American River (Snider et al. 1997). Temperatures required during emigration are believed to be about the same as those required for successful rearing, as discussed below.

Water temperatures between 45°F and 58°F have been reported to be optimal for rearing of Chinook salmon fry and juveniles (Reiser and Bjornn 1979; Rich 1987). Raleigh et al. (1986) reviewed the available literature on Chinook salmon thermal requirements and suggested a suitable rearing temperature upper limit of 75°F and a range of approximately 53.6°F to 64.4°F.

Late-fall-run Chinook Salmon. The majority of late-fall-run Chinook salmon spawn in the Sacramento River; therefore, this species account is specific to the Sacramento River (USFWS 1995a). Adult immigration of late fall-run Chinook salmon in the Sacramento River generally begins in October, peaks in December, and ends in April (Moyle 2002). Late fall-run Chinook salmon spawn during periods of high flows, when flow fluctuations can be damaging to redds constructed in high terraces, which can be exposed as water recedes (USFWS 1995a). Spawning also has been observed in tributaries to the upper Sacramento River (e.g., Battle, Cottonwood, Clear, Big Chico, Butte and Mill creeks) and the Feather and Yuba rivers, although these fish do not comprise a large proportion of the late-fall run Chinook population (S. Cantrell, pers. comm. 2003; USFWS 1995a). Spawning in the main-stem Sacramento River occurs primarily from Keswick Dam (RM 302) to Red Bluff Diversion Dam (RM 258), and generally occurs from December through April (USBR 1991b). Post-emergent fry and juveniles emigrate from their spawning and rearing grounds in the upper Sacramento River and its tributaries during the June through December period (Vogel and Marine 1991). NOAA Fisheries recognizes the late-fall-run Chinook salmon in the Central Valley fall-run ESU (Moyle 2002).

Winter-run Chinook Salmon. Of all water bodies that may be influenced by the EWA Program, winter-run Chinook salmon occur only in the Sacramento River; therefore, this species account is specific to the Sacramento River. The Sacramento River winter-run Chinook salmon evolutionarily significant unit (ESU) is listed as "endangered" under both the Federal and State ESA. Under Section 7 of the ESA, Federal agencies are required to ensure that their actions are not likely to result in the harm, destruction, or adverse affects to a listed species or its critical habitat. Similarly, Section 2080 of the Fish and Game code prohibits take (hunting, pursuing, catching, capturing, killing, or attempts to do these actions) of endangered or threatened species. CESA allows for incidental take and requires early consultation and the development of mitigation for potential impacts on species and essential habitats. In 1993, critical habitat for winter-run Chinook was designated to include the Sacramento River from Keswick Dam, (River Mile [RM] 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta. Also included are waters west of the Carquinez Bridge, Suisun Bay, San Pablo Bay, and San Francisco Bay north of the Oakland Bay Bridge (NMFS 1993).

Adult winter-run Chinook salmon immigration (upstream spawning migration) through the Delta and into the lower Sacramento River occurs from December through July, with a peak during the period extending from January through April (USFWS 1995a). Winter-run Chinook salmon primarily spawn in the main-stem Sacramento River between Keswick Dam (RM 302) and Red Bluff Diversion Dam (RM 243). Winter-run Chinook salmon spawn between late-April and mid-August, with a peak generally in June.

Winter-run Chinook salmon fry rearing in the upper Sacramento River exhibit peak abundance during September, with fry and juvenile emigration past Red Bluff Diversion Dam occurring from July through March (Vogel and Marine 1991; USBR 1992). Emigration (downstream migration) of winter-run Chinook salmon juveniles past Knights Landing, approximately 155.5 river miles downstream of the Red Bluff Diversion Dam, reportedly occurs between November and March peaking in December with some emigration continuing through May in some years (Snider and Titus 2000a; Snider and Titus 2000b). The numbers of juvenile winter-run Chinook salmon caught in rotary screw traps at the Knights Landing sampling location were reportedly dependent on the magnitude of flows during the emigration period (Snider and Titus 2000a; Snider and Titus 2000b). Additional information on the life history and habitat requirements of winter-run Chinook salmon is contained in the NOAA Fisheries Biological Opinion for this species, which was developed to specifically evaluate impacts on winter-run Chinook salmon associated with CVP and SWP operations (NMFS 1993).

Spring-run Chinook Salmon. Historically, spring-run Chinook salmon occurred in the headwaters of all major river systems in the Central Valley where natural barriers were absent. Beginning in the 1880s, harvest, water development, construction of dams that prevented access to headwater areas, and habitat degradation significantly reduced the number and range of spring-run Chinook in the Central Valley. Today, Mill, Deer, and Butte creeks in the Sacramento River system support self-sustaining, persistent populations of spring-run Chinook. The upper Sacramento, Yuba, and Feather rivers, streams that may be affected by EWA water management also are reported to support spring-run Chinook. However, documentation of these populations is weak, and these populations may be hybridized to some degree with fall-run Chinook. Due to the significantly reduced range and small size of remaining spring-run populations, the Central Valley spring-run Chinook salmon ESU is listed as "threatened" under both the State and Federal endangered species acts.

Adult spring-run Chinook salmon immigration into the Delta and lower Sacramento River occurs from mid-February through July, and peaks during April-May (Moyle 2002: CDFG 1998). Suitable water temperatures for adult upstream migration reportedly range between 38ºF and 56ºF (CDFG 1998). In addition to suitable water temperatures, adequate flows are required to provide migrating adults with olfactory and other cues needed to locate their spawning reaches (CDFG 1998).

The primary characteristic distinguishing spring-run Chinook salmon from the other runs of Chinook salmon is that adult spring-run Chinook salmon hold in areas downstream of spawning grounds during the summer months until their eggs fully develop and become ready for spawning. In streams potentially affected by the EWA Program, spring-run Chinook salmon spawn in the upper Sacramento River upstream of Red Bluff Diversion Dam, the lower Yuba River, and the lower Feather River. Spawning has been reported to primarily occur during late- August through October, peaking in mid-September (Moyle 2002). Although some portion of an annual year-class may emigrate as post-emergent fry (individuals less than 45 mm in length), most are believed to rear in the upper Sacramento river and tributaries during the winter and spring and emigrate as juveniles (individuals greater than 45 mm in length, but not having undergone smoltification) or smolts (silvery colored fingerlings having undergone the smoltification process in preparation for ocean entry). The timing of juvenile emigration from the spawning and rearing grounds varies among the tributaries of origin, and can occur during the period extending from October through April (Vogel and Marine 1991). In the Feather River, data on juvenile spring-run emigration timing and abundance have been collected sporadically since 1955 and suggests that November and December may be key months for spring-run emigration (Painter et al. 1977; DWR 1999). In Butte Creek, the bulk of emigration is reported to occur between December and January, with some emigration continuing through May (CDFG 1998). Some juveniles continue to rear in Butte Creek through the summer and emigrate as yearlings from October to February, with peak yearling emigration occurring in November and December (CDFG 1998).

Steelhead. The Central Valley steelhead ESU is listed as "threatened" under the Federal ESA, and has no State listing status. The Central Valley steelhead occurs in the Sacramento, Feather, Yuba and San Joaquin Rivers. Steelhead are produced at the Coleman Fish Hatchery on Battle Creek, the Nimbus Hatchery on the American River, and the Feather River Hatchery on the Feather River (Reynolds et al. 1990).

Most wild, indigenous populations of steelhead occur in upper Sacramento River tributaries below the Red Bluff Diversion Dam (RBDD) (including Antelope, Deer, Mill, and Butte creeks) (McEwan and Jackson 1996). Naturally spawning populations also occur in the American, Feather, and Yuba Rivers, and possibly the upper Sacramento and Mokelumne Rivers, but these populations have had substantial hatchery influence and their ancestry is not clearly known (Busby et al. 1996). Steelhead runs in the Feather and American Rivers are sustained largely by Feather River and Nimbus (American River) Hatcheries (McEwan and Jackson 1996).

Estimates of steelhead run sizes have been sporadic and limited to only a few locations over the last 50 years. The average annual run size in the Sacramento River above the mouth of the Feather River during 1953 through 1958 was estimated at 20,540 fish (Hallock 1989). Although an accurate estimate is not available, the present annual run size for the entire Sacramento River Basin, based on RBDD counts, hatchery counts, and available natural spawning escapement estimates, is probably fewer than 10,000 fish (McEwan and Jackson 1996). The most reliable indicators of recent declines in hatchery and wild stocks are trends reflected in RBDD and hatchery counts. Annual counts at the RBDD declined from an average of 11,187 adult fish in the late 1960s and 1970s to 2,202 adult fish in the 1990s. Recent counts at Coleman, Feather River, and Nimbus Hatcheries also are well below the historical average. Frank Fisher (CDFG) estimated that 10 to 30 percent of adults returning to spawn in the Sacramento River system are of hatchery origin (McEwan and Jackson 1996), although trapping by CDFG at the GCID intake since 1986 would suggest that a far greater proportion of upper Sacramento River steelhead populations are of hatchery origin (S. Cantrell 2003).

Adult steelhead immigration into Central Valley streams typically begins in December and continues into March. Steelhead immigration generally peaks during January and February (Moyle 2002). Optimal immigration temperatures have been reported to range from 46°F to 52°F (CDFG 1991). Spawning usually begins during late-December and may extend through March, but also can range from November through April (CDFG 1986). Optimal spawning temperatures have been reported to range from 39°F to 52°F (CDFG 1991). Unlike Chinook salmon, many steelhead do not die after spawning. Those that survive return to the ocean, and may spawn again in future years.

Optimal egg and fry incubation temperatures have been reported to range from 48°F to 52°F (CDFG 1991). Optimal temperatures for fry and juvenile rearing is reported to range from 45°F to 60°F (CDFG 1991). Similar to Chinook salmon, it is believed that temperatures up to 65°F are suitable for steelhead rearing. Each degree increase between 65°F and the upper lethal limit of 75°F becomes increasingly less suitable and thermally more stressful for the fish (Bovee 1978). The primary period of steelhead emigration occurs from March through June (Castleberry et al. 1991).

American Shad. American shad occur in the Sacramento River, its major tributaries, the San Joaquin River and the Delta. Because of its importance as a sport fish, American shad have been the subject of investigations by CDFG (Moyle 2002). American shad are native to the Atlantic coast and were planted in the Sacramento River in 1871 and 1881 (Moyle 2002).

Adult American shad typically enter Central Valley streams from April through early July (CDFG 1986), with the spawning migration peaking from mid-May through June (CDFG 1987). Water temperature is an important factor influencing the timing of spawning. American shad are reported to spawn at water temperatures ranging from approximately 46°F to 79°F (USFWS 1967), although optimal spawning temperatures are reported to range from about 60ºF to 70°F (Leggett and Whitney 1972; Painter et al. 1979; CDFG 1980; Bell 1986; Rich 1987). Spawning takes place mostly in the main channels of rivers; and generally about 70 percent of the spawning run is made up of first time spawners (Moyle 2002).

In contrast to salmonids, distributions of spawning American shad are determined by river flow rather than homing behavior (Painter et al. 1979). Shad have remarkable abilities to navigate and to detect minor changes in their environment (Leggett 1973). Although homing is generally assumed in the Sacramento River and its tributaries, there is some evidence that numbers of fish spawning are proportional to flows of each river at the time the shad arrive. Snider and Gerstung (1986) recommended flow levels of 3,000 to 4,000 cfs in the lower American River during May and June as sufficient attraction flows to sustain the river's American shad fishery. When suitable spawning conditions are found, American shad school and broadcast their eggs throughout the water column. The optimal temperature for egg development occurs at 62°F. At this temperature, eggs hatch in six to eight days; at temperatures near 75°F, eggs would hatch in three days (MacKenzie et al. 1985). Egg incubation and hatching, therefore, are coincident with the primary spawning period, May to June.

Striped Bass. Striped bass occur in the Sacramento River, its major tributaries, and the Delta. Substantial striped bass spawning and rearing occurs in the Sacramento River and Delta, although striped bass can typically be found upstream as far as barrier dams (Moyle 2002). Striped bass are native to the Atlantic coast. They were first introduced to the Pacific coast in 1879, when they were planted in the San Francisco Estuary (Moyle 2002).

Adult striped bass are present in Central Valley streams throughout the year, with peak abundance occurring during the spring months (DeHaven 1977, 1979; CDFG 1971). Striped bass spawn in warmer temperature ranging from 59°F to 68°F (Moyle 2002). Therefore, spawning may begin in April, but peaks in May and early-June (Moyle 2002). In the Sacramento River, most striped bass spawning is believed to occur between Colusa and the mouth of the Feather River. In years of higher flow, spawning typically occurs further upstream than usual since striped bass continue migrating upstream while waiting for temperatures to rise (Moyle 2002). No studies have definitively determined whether striped bass spawn in certain tributaries including the lower American and Feather River (CDFG 1971; CDFG 1986; DWR 2001a). However, the scarcity of sexually ripe adults among sport-caught fish indicates that minimal, if any, spawning occurs in the lower American River, and that adult fish which entered the river probably spawned elsewhere or not at all (DeHaven 1977; 1978). Successful spawning occurs in the San Joaquin River, upstream from the Delta, during years of high flow, when the large volume of runoff dilutes any salty irrigation wastewater present in the river flow. During years of low flow, spawning occurs in the Delta (Moyle 2002). Sacramento River currents carry striped bass embryos and larvae to rearing habitats in the Delta. Interactions between San Joaquin River outflow and tidal currents cause embryos and larvae to remain in the same general area where spawning occurred for rearing (Moyle 2002).

The number of striped bass entering Central Valley streams during the summer is believed to vary with flow levels and food production (CDFG 1986). For example, Snider and Gerstung (1986) suggested that flows of 1,500 cfs at the mouth during May and June would be sufficient to maintain the striped bass fishery in the lower American River. However, these investigators reported that, in any given year, the population level of striped bass in the Delta was probably the greatest factor determining the relative number of striped bass occurring in the lower American River.

Sacramento River tributaries seem to be a nursery area for young striped bass (CDFG 1971; 1986). Numerous schools of 5- to 8-inch-long fish have been reported in the river during the summer months (CDFG 1971). In addition, juvenile and sub-adult fish have been reported to be abundant in the lower American River and lower Yuba River during the fall (DeHaven 1977). Optimal water temperatures for juvenile striped bass rearing have been reported to range from approximately 61°F to 73°F (USFWS 1988).

Sacramento Splittail. Sacramento splittail are treated as a Federally listed threatened species[2], and are currently listed as a State species of special concern (Moyle et al. 1995). Splittail occur in the Sacramento River, its major tributaries, the San Joaquin River and the Delta.

Adult splittail usually reach sexual maturity in their second year, and migrate upstream in the late fall to early winter prior to spawning activities. They begin spawning in January, with peak spawning occurring from February through March, and may continue until May. Splittail reportedly spawn at water temperatures from

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[2] Under a Federal District Court ruling, the splittail rule has been remanded to USFWS. Splittail continue to be treated as a listed species, however no actions that may harm water users may be taken to protect splittail (DOI 2003).

48°F to 68°F (Wang 1986). Splittail prefer to spawn over flooded streambank vegetation or beds of aquatic plants, and the timing of their upstream movements and spawning corresponds to the historically high-flow period associated with snowmelt and runoff each spring. The mouth of the Feather River provides spawning habitat for splittail because upstream flow releases have the potential to influence the inundation of benches that could potentially serve as splittail spawning habitat. The precise timing and location of spawning varies among years, and the timing and magnitude of winter and spring runoff may play a substantial role in determining the temporal and spatial distribution of spawning in any given year. Water temperature and photoperiod also influence the timing of spawning.

Historically, splittail could be found in the upper reaches of the Sacramento River. Today, Red Bluff Diversion Dam appears to be a complete barrier to upstream movement (CDFG 1989). Splittail are believed to be present in the Sacramento River and its tributaries primarily during the adult spawning period. Juvenile splittail are not believed to use the Sacramento River or its tributaries for rearing to a great extent (USFWS 1994). However, recent studies in the Sutter Bypass have trapped large numbers of splittail, including fry through adult stages, with the yearling component suggesting that some splittail may reside and rear in the area (S. Cantrell 2003). Splittail emigration downstream into the Delta is believed to peak during the period April through August (Meng and Moyle 1995).

Delta Smelt. The USFWS listed delta smelt as a threatened species under the ESA in March 1993 (CFR 58 12854), and critical habitat for delta smelt has been designated within the area. Delta smelt also is listed as threatened under the CESA. In addition to the Delta, delta smelt have been found in the Sacramento River as far upstream as the confluence with the American River (USFWS 1994; Moyle 2002; CDFG unpublished data). This species also occurs in the San Joaquin River, downstream of Vernalis (EA Engineering, Science, and Technology 1999).

Delta smelt are a euryhaline fish, native to the Sacramento-San Joaquin estuary. As a euryhaline species, delta smelt tolerate wide-ranging salinities, but rarely occur in waters with salinities greater than 10-14 ppt (Baxter et al. 1999). Similarly, delta smelt tolerate a wide-range of water temperature, as they have been found at water temperatures ranging from 42.8-82.4°F (Moyle 2002). Delta smelt are typically found within Suisun Bay and the lower reaches of the Sacramento and San Joaquin rivers, although they are occasionally collected within the Carquinez Strait and San Pablo Bay. The delta smelt is a small slender bodied fish, with a typical adult size of 2-3 inches, although some individuals may reach lengths of 5 inches.

During the late winter and spring, delta smelt migrate upstream into freshwater areas to spawn. Shortly before spawning, adults migrate upstream from the brackish-water estuarine areas into river channels and tidally influenced backwater sloughs. Delta smelt are thought to spawn in shallow fresh or slightly brackish waters in tidally influenced backwater sloughs and channel edgewaters (Wang 1986). While most delta smelt spawning seems to take place at 44.6-59°F, gravid delta smelt and recently hatched larvae have been collected at 59-71.6°F. Thus, it is likely that spawning can take place over the entire range of 44.6-71.6°F (Moyle 2002). Females produce between 1,000 and 2,600 eggs (CDFG unpublished data), which adhere to vegetation and other hard substrate. Although spawning has not been observed in the wild, the eggs are thought to attach to substrates such as cattails, tules, tree roots, submerged branches, and other hard substrate. Larvae hatch between 10-14 days (Wang 1986) and are planktonic (float with water currents) as they are transported and dispersed downstream into the low-salinity areas within the western delta and Suisun Bay (Moyle 2002). Delta smelt grow rapidly, with the majority of smelt living only one year. Most adult smelt die after spawning in the early spring; although approximately 3-8 percent survive to age 2, it is not known if they previously spawned at age 1 or if they contribute disproportionately to delta smelt abundance (CDFG unpublished data; Moyle 2002; Brown and Kimmerer 2001). Delta smelt feed entirely on zooplankton. For the majority of their one-year life span, delta smelt inhabit areas within the western Delta and Suisun Bay characterized by salinities of approximately 2 ppt. Historically, they have been abundant in low (around 2 ppt) salinity habitats. Delta smelt occur in open surface waters and shoal areas (USFWS 1994). Critical habitat for delta smelt is defined (USFWS 1994) as:

> *"Areas and all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma Sloughs; and the existing contiguous waters contained within the Delta."*

Because delta smelt typically have a one-year life span, their abundance and distribution have been observed to fluctuate substantially within and among years. Delta smelt abundance appears to be reduced during years characterized by either unusually dry years with exceptionally low outflows (1987 through 1991) and unusually wet years with exceptionally high outflows (1982 and 1986). Other factors thought to affect the abundance and distribution of delta smelt within the Bay-Delta estuary include entrainment in water diversions, changes in the zooplankton community resulting from introductions of non-native species, and potential effects of toxins. As a result of declines in abundance coincident with the 1987 through 1991 drought period, delta smelt were listed as a threatened species under both the State and Federal Endangered Species Acts. In recent years, the abundance of delta smelt and their geographic distribution has improved, as reflected in monitoring conducted by CDFG including summer tow-net surveys, 20 mm larval surveys, and the fall mid-water trawl surveys.

Other Fish Species. The species selected for species-specific assessments include those sensitive to changes in both river flow and water temperature throughout the year. An evaluation of effects on the above species is believed to reasonably encompass the range of potential effects upon other fish resources (specifically, those listed below) that could occur with the Flexible Purchase Alternative relative to the Baseline Condition. Furthermore, there is not sufficient information available regarding the species listed below to develop rigorous impact indicators and significance criteria similar to those developed for the above species. Therefore, because the life history requirements (e.g., spawning temperature ranges) for these species are similar to or less stringent than those for Chinook salmon, the life history and species criteria (water temperature and flow) used for Chinook salmon is thought to be more conservative and will apply to the analysis for these species. Therefore, the following species are not further evaluated in the analysis, although brief narratives are included to provide support for the above assumptions:

- Hardhead. Hardhead is a large (occasionally exceeding 600 mm standard length [SL]), native cyprinid species that generally occurs in large, undisturbed low- to mid-elevation rivers and streams of the region (Moyle 2002). The species is widely distributed throughout the Sacramento-San Joaquin River system, though it is absent from the valley reaches of the San Joaquin River. Hardhead mature following their second year. Spawning migrations, which occur in the spring, into smaller tributary streams are common. The spawning season may extend into August in the foothill streams of the Sacramento and San Joaquin river basins. Spawning behavior has not been documented, but hardhead are believed to elicit mass spawning in gravel riffles (Moyle 2002). Little is known about lifestage-specific temperature requirements of hardhead; however, temperatures ranging from approximately 65°F to 75°F are believed to be suitable (Cech et al. 1990). Hence, this species has greater thermal tolerance compared to that of the anadromous salmonids discussed above. Given hardhead's thermal tolerance, spawning and rearing preferences, and a general lack of information on spawning behavior and early life history, assessing impacts on Chinook salmon, stripped bass, and American shad are anticipated to provide a reasonable estimate of potential impacts on hardhead.

- Green sturgeon. Green sturgeon is an anadromous species, migrating from the ocean to freshwater to spawn. Adults of this species tend to be more marine-oriented than the more common white sturgeon. Nevertheless, spawning populations have been identified in the Sacramento River (Beak Consultants 1993), and most spawning is believed to occur in the upper reaches of the Sacramento River as far north as Red Bluff (Moyle et al. 1992; 1995). Adults begin their inland migration in late-February (Moyle et al. 1995), and enter the Sacramento River between February and late-July (CDFG 2001). Spawning activities occur from March through July, with peak activity believed to occur between April and June (Moyle et al. 1995). In the Sacramento River, green sturgeon presumably spawn at temperatures ranging from 46°F to 57°F (Beak Consultants 1993). Small numbers of juvenile green sturgeon have been captured and identified each year from 1993 through 1996 in the Sacramento River at the Hamilton City Pumping Plant (RM 206) (Brown 1996). Lower American River fish surveys conducted by the CDFG have not collected green sturgeon (Snider 1997). Although a green sturgeon sport fishery exists on the lower Feather River, the extent to which green sturgeon use of the Feather River is still to be determined. Green sturgeon larvae are occasionally captured in salmon outmigrant traps, suggesting the lower Feather River may be a spawning area (Moyle 2002). However, NOAA Fisheries (2002) reports that green sturgeon spawning in the Feather River is unsubstantiated. Riverine conditions (water temperature) suitable for the various life history stages of Chinook salmon are also suitable for green sturgeon, thus conservation measures targeting Chinook salmon should also benefit green sturgeon. Given the similarities between riverine conditions suitable for adult green sturgeon migration and spawning and juvenile green sturgeon rearing and those of Chinook salmon, and a general lack of definitive information on green sturgeon life history requirements in Central Valley rivers, assessing impacts on Chinook salmon are anticipated to provide a reasonable estimate of potential impacts on green sturgeon.

- White sturgeon. The species account information presented for white sturgeon is taken largely from the Draft EIR/EIS for the Interim South Delta Program (ISDP). White sturgeon generally complete their life cycle within the Delta and its major tributaries, although a few fish enter the ocean and make extensive coastal migrations (Moyle 2002). During most of the year, adults are concentrated in San Pablo and Suisun bays, where they feed principally on bottom-dwelling invertebrates. Mature adults ascend the Sacramento River and probably the San Joaquin River to spawn between February and June. Spawning peaks in March and April. Most spawning occurs between Ord Bend and Knights Landing in the Sacramento River (Kohlhorst 1976). About 10 percent of the adult population (Kohlhorst et al. 1991) migrates into the San Joaquin River between Mossdale and the mouth of the Merced River. Spawning migration may begin several months prior to the spawning period (Kohlhorst 1976; Moyle 2002). Spawning occurs at water temperatures between approximately 46°F and 66°F (Moyle 2002). Spawning occurs over rock and gravel in deep riffles or holes with swift currents.

- Longfin smelt. Longfin smelt is a euryhaline species, meaning they can tolerate a wide range of salinities. This is particularly evident in the Delta where they are found in areas ranging from almost pure seawater upstream to areas of pure freshwater. In this system, they are most abundant in San Pablo and Suisun bays (Moyle 2002). They tend to inhabit the middle to lower portion of the water column. The longfin smelt spends the early summer in San Pablo and San Francisco bays, generally moving into Suisun Bay in August. Most spawning is from February to April at water temperatures of 44.6-58.1°F (Moyle 2002). The majority of adults perish following spawning. Longfin smelt eggs have adhesive properties and are probably deposited on rocks or aquatic plants upon fertilization. Newly hatched longfin smelt are swept downstream into more brackish parts of the estuary. Strong Delta outflow is thought to correspond with longfin smelt survival, as higher flows transport longfin smelt young to more suitable rearing habitat in Suisun and San Pablo bays (Moyle 2002). Longfin smelt are rarely observed upstream of Rio Vista in the Delta (Moyle et al. 1995). Due to similarities between longfin smelt spawning temperature requirements and Chinook salmon migration, spawning, and rearing temperature requirements, longfin smelt impacts are assessed indirectly through analysis of Chinook salmon.

- Pacific lamprey. Adult Pacific lamprey likely spend their oceanic phase in nearshore coastal areas adjacent to their natal rivers (Moyle 2002). Spawning adult Pacific lamprey can be found inland to the upper reaches of most rivers draining into the Pacific Ocean. Pacific lamprey are believed to enter freshwater in the late winter and further ascend into spawning streams between early March and late June (Moyle 2002). Most upstream movement takes place at night and tends to occur in surges, although small numbers may move upstream more or less continuously over a two- to four-month period. Lampreys can move considerable distances, stopped only by major barriers such as the Friant Dam. Both sexes construct a crude nest by removing the larger stones from a gravelly area where the current is fairly swift and depths are 30-150 cm. Water temperatures are typically 53.6-64.4°F (Moyle 2002). Usually, both sexes die shortly after spawning. After hatching, ammocoetes spend a short time in the nest gravel. Eventually they swim up into the current and are washed downstream to a suitable area of soft sand and mud, where they become filter feeders. Downstream migration begins when transformation is completed, seemingly during high-outflow events in winter and spring. Juvenile Pacific lamprey freshwater residency presumably last 5-7 years (Moyle 2002).

- River lamprey. The anadromous river lamprey is found in coastal streams from San Francisco Bay to Alaska (Moyle 2002). Adults migrate back into fresh water in the fall and spawn from April to June in small tributary streams (Wang 1986). Presumably, the adults need clean, gravelly riffles in permanent streams for spawning, while the ammocoetes require sandy backwaters or stream edges in which to bury themselves, where water quality is continuously high and temperatures do not exceed 77°F. Adults die after spawning. Ammocoetes begin their transformation into adults when they are about 12 cm TL, during the summer. The process of metamorphosis may take nine to 10 months, the longest known for any lamprey. Lampreys in the final stages of metamorphosis congregate immediately upriver from salt water and enter the ocean in late spring. Adults apparently only spend three to four months in salt water, where they grow rapidly, reaching 25-31 cm TL (Moyle 2002).

- Kern brook lamprey. The Kern brook lamprey was first discovered in the Friant-Kern Canal, but it has since been found in the lower reaches of the Merced River, Kaweah River, Kings River, and San Joaquin River. Since this species was first discovered in 1976, attempts to fully document its range have been only partially successful. Isolated populations of Kern brook lamprey seem thinly distributed throughout the San Joaquin drainage, and their abundances are probably much reduced. Ammocoetes thrive in the dark siphons of the Friant-Kern Canal, but it is unlikely that there is suitable spawning habitat in the canal, so those individuals probably do not contribute to the persistence of the species. Judged from ammocoetes taken, the spawning season is estimated to be from July to September (Wang 1986).

- Sacramento perch. Sacramento perch are deep-bodied laterally compressed centrarchids. Historically, Sacramento perch were found throughout the Central

Valley, the Pajaro and Salinas rivers, and Clear Lake. The only populations today that represent continuous habitation within their native range are those in Clear Lake and Alameda Creek. Within their native range, Sacramento perch exist primarily in farm ponds, reservoirs, and lakes into which they have been introduced (Moyle 2002). Sacramento perch are often associated with beds of rooted, submerged, and emergent vegetation and other submerged objects. Sacramento perch are able to tolerate a wide range of physicochemical water conditions. This tolerance is thought to be an adaptation to fluctuating environmental conditions resulting from floods and droughts. Thus, they do well in highly alkaline water (McCarraher and Gregory 1970; Moyle 1976). Most populations today are established in warm, turbid, moderately alkaline reservoirs or farm ponds. Spawning occurs during spring and early summer and usually begins by the end of March, continuing through the first week of August (Mathews 1965; Moyle 2002). Introductions of non-native species, not necessarily habitat alterations, are foremost in the cause of Sacramento perch declines (Moyle 2002). The ability of Sacramento perch to tolerate a wide range of environmental conditions justifies using Chinook salmon analyses as an alternative.

- San Joaquin roach. The San Joaquin roach, a native freshwater minnow, is found throughout the Sacramento-San Joaquin drainage system (Moyle 2002). California roach, for which the San Joaquin roach is a subspecies, are generally found in small, warm intermittent streams, and dense populations are frequently found in isolated pools (Moyle 2002; Moyle et al. 1982). They are most abundant in mid-elevation streams in the Sierra foothills and in the lower reaches of some coastal streams (Moyle 2002). Roach are tolerant of relatively high temperatures (86-95°F) and low oxygen levels (1-2 ppm) (Taylor et al. 1982). Roach reach sexual maturity by about the second year (approximately 45 mm SL). Reproduction generally occurs from March to June, usually when temperatures exceed 60.8°F, but may be extended through late July (Moyle 2002). EWA actions are not anticipated to affect the primary habitats of the California Roach, which are generally small warm streams.

9.1.1 Upstream from the Delta Region

The following narratives describe specific conditions (e.g., species composition, distribution, time of year when the species is present) for each of the major water bodies that are evaluated in the Upstream from the Delta Region of the area of analysis. Life histories and lifestage-specific environmental requirements for several species may differ slightly among the water bodies. Any differences are noted in the discussions of the individual water bodies. If there are not any noted differences, the species life history and environmental requirements are assumed to be identical to the general discussions above.

9.1.1.1 Sacramento River Area of Analysis

The Sacramento River area of analysis includes Lake Shasta, the Sacramento River from Keswick Dam (the upstream extent of anadromous fish migration and spawning) to the Delta (at approximately Chipps Island near Pittsburg), and Butte Creek from Centerville Head Dam to the confluence with the Sacramento River. Details regarding the water bodies within the Sacramento River area of analysis and the fisheries resources they support are provided below.

9.1.1.1.1 Lake Shasta

Lake Shasta was formed when Shasta Reservoir was constructed in 1935 through 1945, and its filling in 1948 impounded the Pit, McCloud, and Sacramento rivers. Lake Shasta has a storage capacity of 4.5 million acre-feet, a capacity equal to Folsom and Oroville reservoirs combined. It has 365 miles of shoreline and a surface area of 30,000 acres. When full, the surface water elevation is 1,067 feet above mean sea level (msl) and its' maximum depth is 517 feet.

Thermal stratification, which occurs in Lake Shasta annually between April and November, establishes a warm surface water layer (epilimnion), a middle water layer characterized by decreasing temperature with increasing depth (metalimnion or thermocline), and a bottom, coldwater layer (hypolimnion) within the reservoir. In terms of aquatic habitat, the warm epilimnion of Lake Shasta provides habitat for warmwater fishes, whereas the reservoir's lower metalimnion and hypolimnion form a "coldwater pool" that provides habitat for coldwater fish species throughout the summer and fall portions of the year. Hence, Lake Shasta supports a "two-story" fishery during the stratified portion of the year (April through November), with warm-water species using the upper, warm-water layer and coldwater species using the deeper, colder portion of the reservoir.

Coldwater species include rainbow trout, brown trout, landlocked white sturgeon, and landlocked Coho salmon; and warmwater species include smallmouth bass, largemouth bass, spotted bass, black crappie, bluegill, green sunfish, channel catfish, white catfish, and brown bullhead. Other, nongame species in Lake Shasta include hardhead, golden shiner, threadfin shad, common carp, Sacramento sucker, and Sacramento pikeminnow.

Although developed primarily for irrigation, the multiple-purpose Shasta Reservoir project also provides flood control, improves Sacramento River navigation, supplies domestic and industrial water, generates electric power, conserves fish and wildlife, creates opportunities for recreation, and enhances water quality. Since construction, Shasta Dam plays a major role in maintaining ecosystem values since such a large demand exists on the water resource, meeting Bay-Delta water quality standards, and meeting requirements for the endangered winter-run Chinook salmon (USBR 1999). These regulating and other uses cause water surface elevations to fluctuate by approximately 55 feet over the course of a year, which disturb the reservoir's littoral (shallow, nearshore) habitats. Disruptions to littoral habitat also occur from shoreline wave action caused by wind and boating activity.

9.1.1.1.2 Sacramento River

The upper Sacramento River is often defined as the portion of the river from Princeton (RM 163) (the downstream extent of salmonid spawning in the Sacramento River

(Burmester 1996)) to Keswick Dam (the upstream extent of anadromous fish migration and spawning). The Sacramento River serves as an important migration corridor for anadromous fishes moving between the ocean and/or Delta and upper river/tributary spawning and rearing habitats. The upper Sacramento River is differentiated from the river's "headwaters" which lie upstream of Lake Shasta. The upper Sacramento River provides a diversity of aquatic habitats, including fast-water riffles and shallow glides, slow-water deep glides and pools, and off-channel backwater habitats.

In excess of 30 species of fish are known to use the Sacramento River. Of these, a number of both native and introduced species are anadromous. Anadromous species include Chinook salmon, steelhead, green and white sturgeon, striped bass and American shad. The upper Sacramento River is of primary importance to native anadromous species, and is presently utilized for spawning and early-life-stage rearing, to some degree, by all four runs of Chinook salmon (fall, late-fall, winter, and spring runs) and steelhead. Consequently, various life stages of the four races of Chinook salmon and steelhead can be found in the upper Sacramento River throughout the year. Other Sacramento River fishes are considered resident species, which complete their lifecycle entirely within freshwater, often in a localized area. Resident species include rainbow and brown trout, largemouth and smallmouth bass, channel catfish, sculpin, Sacramento pikeminnow, Sacramento sucker, hardhead, and common carp (USBR 1991).

The lower Sacramento River is generally defined as that portion of the river from Princeton to the Delta, at approximately Chipps Island (near Pittsburg). The lower Sacramento River is predominantly channelized, leveed and bordered by agricultural lands. Aquatic habitat in the lower Sacramento River is characterized primarily by slow-water glides and pools, is depositional in nature, and has reduced water clarity and habitat diversity, relative to the upper portion of the river.

Many of the fish species utilizing the upper Sacramento River also use the lower river to some degree, even if only as a migratory pathway to and from upstream spawning and rearing grounds. For example, adult Chinook salmon and steelhead primarily use the lower Sacramento River as an immigration route to upstream spawning habitats and an emigration route to the Delta. The lower river is also used by other fish species (e.g., Sacramento splittail and striped bass) that make little to no use of the upper river (upstream of RM 163). Overall, fish species composition in the lower portion of the Sacramento River is quite similar to that of the upper Sacramento River and includes resident and anadromous cold- and warmwater species. Many fish species that spawn in the Sacramento River and its tributaries depend on river flows to carry their larval and juvenile life stages to downstream nursery habitats. Native and introduced warmwater fish species primarily use the lower river for spawning and rearing, with juvenile anadromous fish species also using the lower river and non-natal tributaries, to some degree, for rearing.

An important component of aquatic habitat throughout the Sacramento River is referred to as Shaded Riverine Aquatic Cover. Shaded Riverine Aquatic consists of the portion of the riparian community that directly overhangs or is submerged in the river. Shaded Riverine Aquatic provides high-value feeding and resting areas and escape cover for juvenile anadromous and resident fishes. Shaded Riverine Aquatic also can provide some degree of local temperature moderation during summer months due to the shading it provides to nearshore habitats (USFWS 1980). The importance of Shaded Riverine Aquatic to Chinook salmon was demonstrated in studies conducted by the USFWS (DeHaven 1989). In early summer, juvenile Chinook salmon were found exclusively in areas of Shaded Riverine Aquatic, and none were found in nearby rip-rapped areas (DeHaven 1989).

9.1.1.1.3 Butte Creek

Butte Creek is a perennial river that originates on the western slope of the Sierra Nevada at an elevation of approximately 7,000 feet msl and flows into the Sacramento River via two separate means. Under high flow conditions Butte Creek enters the Sacramento River through Butte Slough southeast of the City of Colusa. During normal flow conditions, water is not diverted through the Butte Slough Outfall gates, but instead flows through the Sutter Bypass, which enters the Sacramento River via the Sacramento Slough southeast of the community of Knights Landing (Butte Creek Watershed Conservancy 2003).

The upper portion of Butte Creek flows from its headwaters in the Sierra Nevada through Butte Meadows to the Centerville Head Dam via Butte Creek Canyon. This portion of the creek contains several power generating dams and receives flows from numerous small tributaries as well as water diverted from the West Branch of the Feather River via the Toadtown/Hendricks Canal (Butte Creek Watershed Conservancy 2003). The various natural waterfalls in this reach historically precluded anadromous fishes from migrating higher than the vicinity of Centerville Head Dam (CDFG 1998).

Several species of fish occur in upper Butte Creek and its tributaries. The reach extending from the Centerville Head Dam, through Butte Meadows, and up to the creek's headwaters sustains a popular trout fishery maintained by the CDFG. Rainbow, brown and brook trout are common in this reach and fishing pressure is relatively high due to easy access (Butte Creek Watershed Conservancy 2003).

Below Centerville Head Dam, Butte Creek continues through Butte Creek Canyon for approximately 15 miles until its gradient shallows as it enters the Sacramento Valley southeast of the City of Chico. Numerous dams and diversions in the valley section of the river divert water for agricultural, flood protection, and wildlife uses including the Parrot-Phelan diversion, Adams Dam, Gorrill Dam, Sanborn Slough Bifurcation, Mallard Dam, and the Butte Slough outfall. The Western Canal Siphon (Butte Creek Siphon) lies in this reach between Gorrill Dam and Nelson Road. Under normal flow conditions, Butte Creek water passes through this reach and continues through the Sutter Bypass before joining the Sacramento River. It is within this reach that Butte

Creek gains flow through the return of irrigation water (Butte Creek Watershed Conservancy 2003).

The reach of Butte Creek between Centerville Head Dam and Highway 99 contains habitat for and supports spring-run, fall-run, and late- fall-run Chinook salmon, Sacramento sucker, largemouth bass, smallmouth bass, bluegill, green sunfish, redear sunfish, riffle sculpin, hardhead, roach, golden shiner, speckled dace, Sacramento pikeminnow, tule perch, brown bullhead, Pacific lamprey, rainbow trout, steelhead, brown trout, and bigscale logperch (Butte Creek Watershed Conservancy 2003). All spring-run Chinook salmon spawning and holding in Butte Creek occurs within this reach (CDFG 1998). Additional species observed in the reach between Highway 99 and the Sutter Bypass include black crappie, white crappie, golden shiner, hitch, Sacramento splittail, and wakasagi (Butte Creek Watershed Conservancy 2003).

In most years the majority of fall-run Chinook salmon spawning in Butte Creek reportedly occurs between Durham Mutual Dam near Highway 99 and the Western Canal Siphon. In some years, however, it has been observed that some fall-run Chinook spawning occurs as far upstream as the Parrot-Phelan Diversion (USFWS 2000; Butte Creek Watershed Conservancy 2003). Little evidence is available on the spawning locations of late fall-run Chinook salmon in Butte Creek. However, it has been reported that late fall-run Chinook spawning occurs upstream of the Parrot-Phelan Diversion (USFWS 2000; Butte Creek Watershed Conservancy 2003). Steelhead have also been reported to spawn upstream of the Parrot Phelan Diversion to the Centerville Head Dam (Butte Creek Watershed Conservancy 2003). The Sutter Bypass reportedly contains spawning Sacramento splittail during the months of February through April (USFWS 1995b; USFWS 2000).

<u>Spring-run Chinook Salmon</u>
Adult spring-run Chinook salmon enter their natal streams from mid-February through July, with peak migration occurring during May. Once in their spawning reaches, adult salmon seek deep pools with bedrock or boulder substrate in which to hold over the summer (CDFG 1998). Holding occurs in Butte Creek from the time of upstream migration until the onset of spawning (generally from mid-February through October). Adult spring-run Chinook salmon have been observed holding between the Parrot-Phelan Diversion and the Centerville Head Dam (CDFG 1998). Generally, however, most fish are found holding between the confluence of Little Butte Creek and a pool known as Quartz Bowl, located approximately one mile downstream from the Centerville Head Dam (Butte Creek Watershed Conservancy 2003).

Holding pools often have a large bubble curtain at the head with moderate water velocities (0.5 to 1.3 feet per second) throughout the remainder of the pool. The upper limit of suitable water temperatures for holding adult Chinook salmon is believed to be between 59ºF and 60ºF (CDFG 1998). During the over-summer holding period, physiological changes in the fish, including gonadal maturation, take place in preparation for spawning which generally occurs near holding pools (CDFG 1998).

Spring-run Chinook salmon spawning in Butte Creek reportedly occurs between late August and early November, with peak spawning activity occurring between late September and early October (DWR and USBR 2000). Spawning activity and redds have been observed in Butte Creek up to the Centerville Head Dam, although the Centerville Head Dam upstream limit was likely the result of unusually high river flows combined with record spring-run Chinook salmon escapement in 1998 (Butte Creek Watershed Conservancy 2003; CDFG 1998; M. Gard 2003). During most years, the documented upstream limit of migration is Quartz Bowl. During some years, such as 1998, CDFG has documented spring-run Chinook salmon spawning as far downstream as Parrott-Phelan Diversion Dam (CDFG 2002b). Unpublished data from the USFWS, however, suggests that spawning does not occur below the confluence of Butte Creek and Little Butte Creek because of unsuitable temperature regimes during peak spawning months (M. Gard 2003).

Water velocity is generally considered the most important parameter in redd selection (CDFG 1998; DWR 2000c; Butte Creek Watershed Conservancy 2003). According to CDFG (1998), suitable water velocities range from 1.2 to 3.5 feet per second, with water temperatures ranging from 40ºF to 57ºF. Suitable substrate composition is reportedly a mixture of gravel and cobble with a mean diameter of one to four inches with less than five percent fines (Butte Creek Watershed Conservancy 2003; CDFG 1998).

The incubation period for spring-run Chinook salmon eggs in Butte Creek is approximately three months (90 days), with fry emergence beginning in November and continuing through January (CDFG 1998). Because of highly variable water temperatures in different drainages, egg incubation times can differ significantly. Salmon eggs hatch in 50 days when incubated at 50ºF but require over 110 days when incubated at 40ºF (CDFG 1998). Suitable temperatures for fry emergence are slightly higher than for egg incubation. Fifty to 55ºF has been reported to be the suitable range for fry emergence (CDFG 1998).

Upon emergence, spring-run Chinook salmon fry congregate in shallow, low velocity edgewater where food supply and cover are adequate for rapid growth and rearing (CDFG 1998; Butte Creek Watershed Conservancy 2003). Rearing times for spring-run Chinook in general are highly variable, and for salmon spawning in Butte Creek, the bulk of emigration is reported to occur between December and January, with some emigration continuing through May (CDFG 1998). Some juveniles continue to rear in Butte Creek through the summer and emigrate as yearlings from October to February, with peak yearling emigration occurring in November and December (CDFG 1998). The suitable water temperature range for rearing and emigration is reported to be between 55ºF and 60ºF (CDFG 1998). The theoretical upper temperature limit for rearing and emigrating juveniles has been reported as 78.5ºF (DWR and USBR 2000).

9.1.1.2 Feather River Area of Analysis

The Feather River area of analysis includes Little Grass Valley and Sly Creek reservoirs on the South Fork Feather River; the Oroville Facilities, including Lake Oroville, the Thermalito Forebay, the Thermalito Afterbay, and the Feather River Fish Hatchery; and the lower Feather River extending from the Fish Barrier Dam to the confluence with the Sacramento River. Water assets purchased from Little Grass Valley and Sly Creek reservoirs would be transferred via a series of conveyance and storage facilities prior to release directly into Oroville Reservoir. The South Fork Feather River would not be affected by EWA actions and therefore is not included in the Feather River area of analysis. Details regarding the facilities and water bodies within the Feather River area of analysis and the fisheries resources they support are provided below.

9.1.1.2.1 Little Grass Valley and Sly Creek Reservoirs

Oroville-Wyandotte Irrigation District (ID) owns and operates Little Grass Valley and Sly Creek Reservoirs as storage facilities on the South Fork Feather River. The district uses the reservoirs mainly for water regulating purposes, though both reservoirs support coldwater fisheries. Little Grass Valley Reservoir is located on the South Fork Feather River in Plumas County, at an elevation of 5,047 feet above msl, and has a storage capacity of 94,700 acre-feet. It has a surface area of 1,615 acres and 16 miles of shoreline. Fish species present in Little Grass Valley Reservoir include rainbow, brook, and brown trout and catfish. CDFG stocks Little Grass Valley with rainbow trout monthly from June through August. Brook and brown trout are planted annually. Sly Creek Reservoir is in eastern Butte County at an elevation of 3,536 feet and has a storage capacity of 65,700 acre-feet. CDFG regularly plants the reservoir with fish, including rainbow trout, brown trout, brook trout, and kokanee salmon (DWR 2002).

9.1.1.2.2 Lake Oroville and Associated Facilities

Lake Oroville is located at the confluence of the West Branch and the North, Middle, and South Forks of the Feather River, upstream from the Yuba and Bear River tributaries, at an elevation of 900 feet above msl. Lake Oroville is the second largest reservoir in California, with a storage capacity of 3.5 million acre-feet. Like many other California foothill reservoirs, Lake Oroville is steep-sided, with large surface fluctuations and a low surface-to-volume ratio. It is a warm, monomictic reservoir that thermally stratifies in the spring, destratifies in the fall, and remains destratified throughout the winter. Due to the stratification, Lake Oroville has been said to contain a "two-story" fishery, supporting both coldwater and warmwater fisheries that are thermally segregated for most of the year. The coldwater fish use the deeper, cooler, well-oxygenated hypolimnion, whereas the warmwater fish are found in the warmer, shallower, epilimnetic, and littoral zones. Once Lake Oroville destratifies in the fall, the two fishery components mix in their habitat utilization.

Lake Oroville's coldwater fishery is primarily composed of Coho salmon and brown trout, although rainbow trout and lake trout are periodically caught. The coldwater fisheries for Coho salmon and brown trout are sustained by hatchery stocking because natural recruitment to the Lake Oroville coldwater fishery is very low. A "put-and-grow" hatchery program is currently in use, where salmonids are raised at CDFG hatcheries and stocked in the reservoir as juveniles, with the intent that these fish will grow in the reservoir before being caught by anglers (DWR 2001a).

The Lake Oroville warm water fishery is a regionally important self-reproduction fishery. The black bass fishery is the most significant, both in terms of angler effort and economic impact on the area. Spotted bass are the most abundant bass species in Lake Oroville, followed by largemouth, redeye and smallmouth bass, respectively. Catfish are the next most popular warmwater fish at Lake Oroville, with both channel and white catfish present in the lake. White and black crappie are also found in Lake Oroville, though populations fluctuate widely from year to year. Bluegill and green sunfish are the two primary sunfish species in Lake Oroville, though red ear sunfish and warmouth are also present in very low numbers. Although common carp are considered by many to be a nuisance species, they are also abundant in Lake Oroville (DWR 2001a). The primary forage fish in Lake Oroville are wakasagi and threadfin shad. Threadfin shad were intentionally introduced in 1967 to provide forage for gamefish, whereas the wakasagi migrated down from an upstream reservoir in the mid-1970s (DWR 2001a).

The Thermalito Forebay is a cold, shallow, open reservoir with minor fluctuations in surface elevations and a high surface-to-volume ratio. It remains cold throughout the year because it is supplied with water from the Diversion Pool, although pump-back operations from the Thermalito Afterbay warm the Forebay somewhat. The CDFG manages the Forebay as a put-and-take trout fishery, where catchable (about 1/2 lb.) trout are stocked biweekly. Rainbow and brook trout are the primary fish planted, although surplus Chinook yearlings reared in the Feather River Fish Hatchery were stocked in the Forebay in February 2000. The Forebay coldwater fishery is the second most popular reservoir fishery at the Oroville Facilities (DWR 2001a). Warmwater fish species found in Lake Oroville are believed to exist in the Forebay in low numbers (DWR 2001a).

The Thermalito Afterbay is a large, shallow, open reservoir with frequent water level fluctuations and a high surface-to-volume ratio. The shallow nature of the Afterbay results in very noticeable fluctuation effects with only a few feet of surface level changes. Mudflats can be exposed and a significant amount of the littoral zone can be dewatered. Water temperatures can vary widely around the Afterbay in the summer, with water in the low 60s near the tailrace channel that feeds the Afterbay, and water in the mid 80s in the backwater areas that do not readily circulate (DWR 2001a).

The diverse temperature structure of the Afterbay has provided suitable habitat for both coldwater and warmwater fish. A popular largemouth bass fishery currently exists, and large trout are sometimes caught near the inlet. No salmonid stocking currently occurs at the Afterbay, so these fish most likely passed through the Thermalito Pumping-Generating Plant from the Forebay. Though limited fish sampling has been conducted at the Afterbay, smallmouth bass, rainbow trout, brown trout, red ear sunfish, bluegill, black crappie, channel catfish, and carp have all been observed. Most of the Lake Oroville sportfish probably occur in the Afterbay to some degree (DWR 2001a).

DWR constructed the Feather River Fish Hatchery in 1967 to mitigate for salmonid spawning habitat lost due to the construction and operation of Oroville Dam/Reservoir complex. Since the late 1960s, the Feather River Fish Hatchery, operated by the CDFG, has released millions of spring and fall Chinook salmon fry, fingerlings, smolts and yearlings, and yearling steelhead. The hatchery water supply is diverted directly from the Thermalito Diversion Pool, which receives cold, hypolimnetic water (which rarely exceeds mid to high fifties (ºF)) from Lake Oroville. Because the hatchery's water supply comes from stored water in the Thermalito Diversion Pool and does not come directly from the Feather River, it is not subject to the thermal warming effects associated with downstream in-channel transport.

9.1.1.2.3 Lower Feather River

The lower Feather River commences at the Low Flow Channel, which extends eight miles from the Fish Barrier Dam (RM 67) to the Thermalito Afterbay Outlet (RM 59). (See Figure 9-2.) Under an agreement with the CDFG, flows in this reach of the river are regulated at 600 cfs, except during flood events when flows have reached as high as 150,000 cfs (DWR 1983). Average monthly water temperatures typically range from about 47°F in winter to about 65°F in summer. The majority of the Low Flow Channel flows through a single channel contained by stabilized levees. Side-channel or secondary channel habitat is extremely limited, occurring primarily in the Steep Riffle and Eye Riffle areas between RM 60-61. The channel banks and streambed consist of armored cobble as a result of periodic flood flows and the absence of gravel

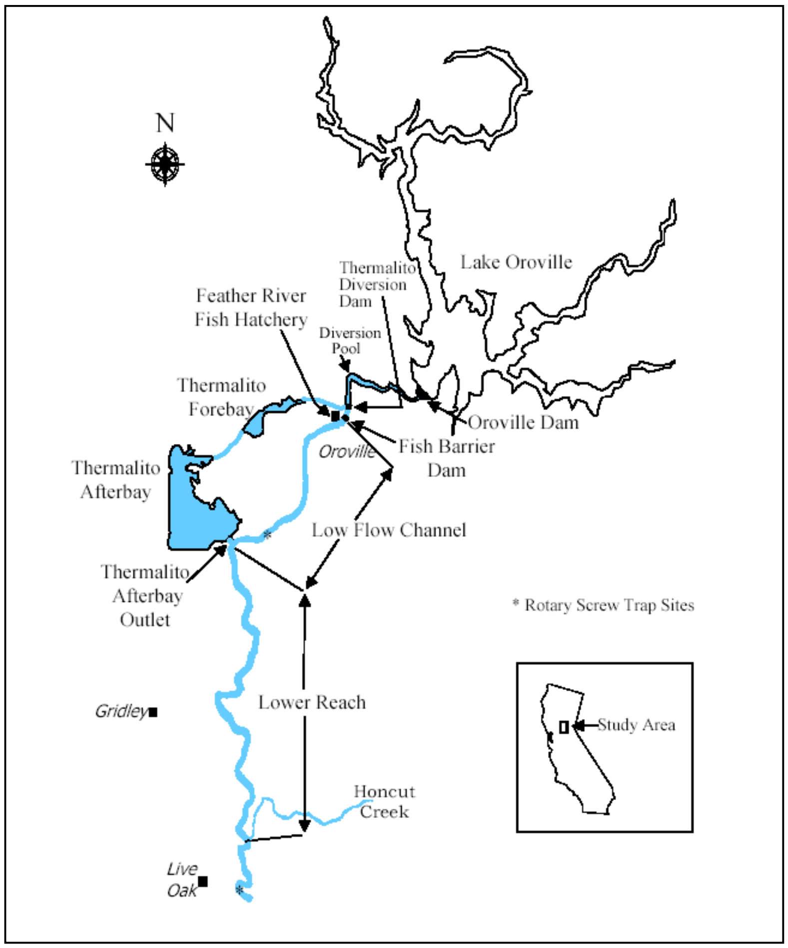

Figure 9-2
Lower Feather River

recruitment. However, there are nine major riffles with suitable spawning size gravel, and approximately 75 percent of the Chinook salmon spawning takes place in this upper reach (Sommer et al. 2001). Releases are made from the coldwater pool in Lake Oroville and this cold water generally provides suitable water temperatures for spawning in the Low Flow Channel (DWR 2001a).

The lower reach extends 15 miles from the Thermalito Afterbay Outlet (RM 59) to Honcut Creek (RM 44). Releases from the outlet vary according to operational requirements. In a normal year, total flow in the lower reach ranges from 1,750 cfs in fall to 5,000-8,000 cfs in spring. Water temperature in winter is similar to the Low Flow Channel but increases to 74°F in summer. Higher flows dramatically increase the channel width in this reach. Numerous mid-channel bars and islands braid the river channel, creating side-channel and backwater habitat. The channel is not as heavily armored, and long sections of riverbanks are actively eroding. In comparison to the Low Flow Channel, there is a greater amount of available spawning areas, which are isolated by longer and deeper pools (DWR 2001a).

The lower Feather River from the Fish Barrier Dam to Honcut Creek supports a variety of anadromous and resident fish species. The most important fish species in terms of sport fishing is the fall-run Chinook salmon, although striped bass and American shad are also common targets for anglers. Approximately 75 percent of the natural spawning for fall-run Chinook salmon currently occurs between the Fish Barrier Dam and the Thermalito Afterbay Outlet (RM 67-59), with approximately 25 percent of the spawning occurring between the Afterbay outlet and Honcut Creek (RM 59-44) (Sommer et al. 2001). The fall-run may enter the river as early as August and begin spawning in September. Spawning typically continues through December, with October and November constituting the peak spawning months.

In addition to the sportfish mentioned above, several other native and exotic fish species are found in the Feather River. The Feather River maintains spawning, rearing, and migration habitat for three special-status species: spring-run Chinook salmon, Central Valley steelhead, and Sacramento splittail (DWR 2001a). The occasional capture of larval green sturgeon in outmigrant traps suggests that green sturgeon spawn in the Feather River (Moyle 2002). However, NOAA Fisheries (2002) reports that evidence of green sturgeon spawning in the Feather River is unsubstantiated. In the Feather River, the basic life history of spring-run Chinook salmon is very similar to fall-run Chinook salmon. Spawning may occur a few weeks earlier for spring-run (as compared to fall-run), but there is no clear distinction between the two due to the disruption of spatial segregation by Oroville Dam. Fish exhibiting the typical life history of the spring-run are found holding at the Thermalito Afterbay Outlet and the Fish Barrier Dam as early as March. At present, the genetic distinctness of Feather River spring-run is still officially undetermined, although additional analysis may be conducted prior to definitive determination of the genetic distinction of spring-run Chinook salmon and fall-run Chinook salmon.

Adult steelhead typically ascend the Feather River from September through January, where spawning takes place rather quickly. The residence time of adult steelhead in the Feather River after spawning and adult steelhead post-spawning mortality is currently unknown. It appears that most of the natural steelhead spawning in the Feather River occurs in the Low Flow Channel, particularly in the upper reaches near Hatchery Ditch. It is unknown whether steelhead spawn below the Thermalito Afterbay Outlet; though, based on the spawning habitat available it is very likely that at least some steelhead spawn below the Afterbay outlet. Soon after emerging from the gravel, a small percentage of the fry appears to emigrate. The remainder of the population rears in the river for at least six months to one year. Recent studies have confirmed that juvenile rearing (and probably adult spawning) is most concentrated in small secondary channels within the low flow channel. The smaller substrate size and greater amount of cover (compared to the main river channel) likely make these side channels more suitable for steelhead spawning. Currently, this type of habitat comprises less than 1 percent of the available habitat in the low flow channel (DWR 2001a).

9.1.1.3 Yuba River Area of Analysis

The Yuba River area of analysis includes New Bullards Bar and Englebright reservoirs and the lower Yuba River, extending from Englebright Dam to the confluence with the Feather River. Details regarding the facilities and water bodies within the Yuba River area of analysis and the fisheries resources they support are provided below.

9.1.1.3.1 New Bullards Bar and Englebright Reservoirs

New Bullards Bar Reservoir is located on the North Fork Yuba River and is the largest reservoir in the Yuba River watershed (DWR 2000a) with a storage capacity of 960,000 acre-feet. When full, the reservoir has a surface area of approximately 4,800 acres (at an elevation of 1,965 feet above msl) and regulates winter and spring drainage from approximately 489 square miles of watershed on the Yuba River. The reservoir has steeply sloped sides created from the flooding of a deep canyon. New Bullards Bar Reservoir supports both coldwater and warmwater fisheries consisting of the following species: rainbow trout, kokanee salmon, brown trout, largemouth bass, smallmouth bass, crappie, sunfish, and bullhead (DWR 2000a). Although warmwater fish species are known to occur in New Bullards Bar Reservoir (crappie, largemouth and smallmouth bass, and sunfish), limited recreational fisheries exist for these warmwater fish species. New Bullards Bar Reservoir supports a very significant salmonid fishery emphasizing kokanee salmon. In fact, New Bullards Bar Reservoir is known for having the best kokanee salmon fishing throughout the State of California (Jones and Pack 2002).

Englebright Reservoir is located downstream of New Bullards Bar Reservoir, and has a storage capacity of approximately 70TAF (DWR 2002). Englebright Reservoir supports warmwater and coldwater fish species, including rainbow and brown trout, large and smallmouth bass, kokanee salmon, catfish, and sunfish (USACE 2001). Transfer water that is released from New Bullards Bar Reservoir generally passes through Englebright Reservoir without modifying Englebright Reservoir elevations (EDAW 2001). Because Englebright Reservoir would serve as a flow-through facility for EWA acquisitions, warmwater and coldwater fishery resources at this facility would not be affected by EWA actions. Therefore, a discussion of potential effects on Englebright Reservoir fishery resources is not included in this analysis.

9.1.1.3.2 Yuba River

The Yuba River Basin drains approximately 1,350 square miles of the western Sierra Nevada slope, including portions of Sierra, Placer, Yuba, and Nevada counties (CALFED 1999). The primary watercourses of the upper watershed are the South, Middle, and North Yuba Rivers, which flow into Englebright Reservoir, which then releases water into the lower Yuba River. Both the upper and lower watersheds (above and below Englebright Dam, respectively) have been extensively developed for water supply, hydropower production, and flood control. Operators of upper watershed projects include Pacific Gas and Electric Company (PG&E), Nevada ID and Oroville-Wyandotte ID. The Yuba River Development Project (YRDP), which is operated by the Yuba County Water Agency (WA), includes water project operations in both the upper and the lower watershed. This project, completed in 1969, includes New Bullards Bar Dam and Reservoir, New Colgate Powerhouse, and Englebright Reservoir.

Based on general differences in hydraulic conditions, channel morphology, geology, water conditions, and fish species distribution, Beak (1989) divided the lower Yuba River into the following four reaches. (See Figure 9-3.)

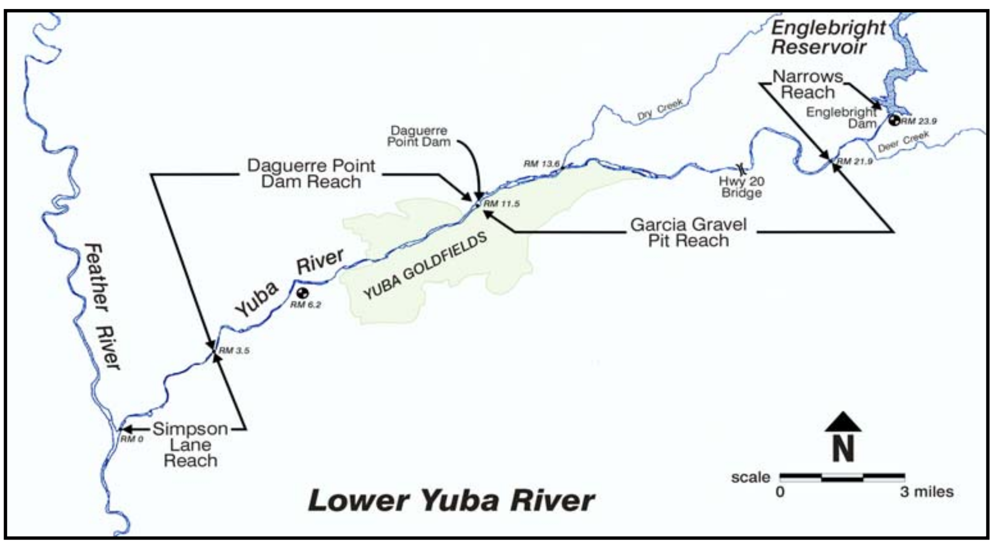

Figure 9-3
Lower Yuba River Study Reaches, Water Diversion Facilities, and USGS Gauging Stations

- **Narrows Reach** – extends from Englebright Dam to the downstream terminus of the Narrows (RM 23.9 to RM 21.9); topography is characterized by steep canyon walls;

- **Garcia Gravel Pit Reach** – extends from the Narrows downstream to Daguerre Point Dam (RM 21.9 to RM 11.5);
- **Daguerre Point Dam Reach** – extends from Daguerre Point Dam downstream to the upstream area of Feather River backwater influence (just east of Marysville; RM 11.5 to RM 3.5); and
- **Simpson Lane Reach** – begins at the upstream area of Feather River backwater influence and extends to the confluence with the Feather River (RM 3.5 to RM 0).

The lower Yuba River consists of the approximately 24-mile stretch of river extending from Englebright Dam, the first impassible fish barrier along the river, downstream to the confluence of the Feather River near Marysville. Water projects operated by PG&E, Nevada ID, and Oroville-Wyandotte ID export up to approximately 530 TAF of water per year into adjacent basins. Once exported, this water is not available to the lower Yuba River.

Fall-run Chinook Salmon

The fall-run Chinook salmon population in the Yuba River was substantially reduced before the 1950s by extensive mining, agriculture, urbanization, and commercial fishing. However, since 1950 natural production of fall-run Chinook salmon in the lower Yuba River has sustained or slightly increased the same average population levels despite continued and increasing out-of-basin stressors that have acted to further limit survival of Chinook salmon in the lower Sacramento River, Sacramento-San Joaquin Delta (Delta), and Pacific Ocean.

CDFG began making annual estimates of fall-run Chinook salmon spawning escapement (the number of salmon that "escape" the commercial and sport fisheries in the Pacific Ocean and return to spawn in the lower Yuba River) in 1953. From 1953 to 1971, these estimates ranged from 1,000 fish in 1957 to 37,000 fish in 1963, and averaged 12,906 fish. From 1972 to 2001, the annual average run of Chinook salmon was 15,361 fish. Assuming CDFG's traditional 15.5 percent estimated contribution to total escapement, the average for the 1972-2001 period is 14,560 fish.

The fall-run Chinook salmon population in the lower Yuba River is sustained largely by natural production. Trends in natural production can be masked by large numbers of returning hatchery spawners in rivers with major hatcheries or planting programs, or where significant straying of hatchery fish occurs. No hatchery or long-term planting program exists on the lower Yuba River. Analyses of straying of hatchery Chinook salmon in the Sacramento River Basin indicate a relatively low degree of straying hatchery spawners to the lower Yuba River (Cramer 1991; S. Cramer 2002).

Spring-run Chinook Salmon

Spring-run Chinook salmon had virtually disappeared from the Yuba River by 1959 (Fry 1961; Wooster and Wickwire 1970). Major in-basin factors contributing to the decline were migration barriers, hydraulic mining, and water diversions. Hydraulic mining in the Yuba River watershed from 1850 to 1885 caused extensive habitat destruction. Between 1900 and 1941, debris dams constructed by the California Debris Commission and now owned and operated by the Corps on the lower Yuba River to retain hydraulic mining debris, completely or partially blocked the migration of Chinook salmon and steelhead to historic spawning and rearing habitats (Wooster and Wickwire 1970; CDFG 1991; Yoshiyama et al. 1996). Spring-run Chinook salmon populations were probably severely affected because of inadequate flows and high water temperatures below the dams during the summer. It is likely that native spring-run Chinook salmon were extirpated during this period. Water diversions also contributed to poor habitat conditions below the dams, especially in dry years. Today, Englebright Dam, completed in 1941 by the California Debris Commission and now owned and operated by the Corps, completely blocks spawning runs of Chinook salmon and steelhead, and is the upstream limit of fish migration.

Since the completion of New Bullards Bar Dam in 1970 by Yuba County WA, higher, colder flows in the lower Yuba River have improved conditions for over-summering and spawning of spring-run Chinook salmon in the lower Yuba River. Small numbers of Chinook salmon that exhibit spring-run characteristics have been observed (CDFG 1998). Although precise escapement estimates are not available, the USFWS testified at the 1992 SWRCB lower Yuba River hearing *"…a population of about 1,000 adult spring-run Chinook salmon now exists in the lower Yuba River"* (SWRCB 1995). In 2001, 108 adult spring-run Chinook salmon were estimated passing the fish ladders at Daguerre Point Dam on the lower Yuba River during March 1 through July 31, possibly representing the early portion of the run. During the month of September 2001, 288 Chinook salmon redds were observed. Historically, September is the peak month of spring-run Chinook salmon spawning, although some temporal overlap with fall-run Chinook salmon exists (CDFG 2002). Neither of these estimates was used to attempt to estimate the total spring-run Chinook salmon escapement in the Yuba River. The origin of these fish and their genetic relationship with fall-run Chinook salmon are unknown. The run may have originated from plants of hatchery-reared spring-run in the lower Yuba River during the 1970s. Limited observations of tagged adults during annual carcass surveys indicate that hatchery strays from the Feather River also may contribute to the run. The USFWS estimates are the best currently available estimates for spring-run Chinook salmon escapement in the Yuba River.

<u>Steelhead</u>

Historical information on Central Valley steelhead populations is limited. Steelhead ranged throughout accessible tributaries and headwaters of the Sacramento and San Joaquin Rivers before major dam construction, water development, and other watershed disturbances. Many of the freshwater habitat factors cited for declines in spring-run Chinook salmon runs generally apply to steelhead as well, because of their need for tributaries and headwater streams where cool, well-oxygenated water is available year round. Historical declines in steelhead abundance have been attributed largely to dams that eliminated access to most of their historic spawning and rearing habitat, and restricted steelhead to unsuitable habitat below the dams. Other factors that have contributed to the decline of steelhead and other salmonids include habitat modification, over-fishing, disease and predation, inadequate regulatory mechanisms, climate variation, and artificial propagation (NMFS 1996).

CDFG estimated that only approximately 200 steelhead spawned in the lower Yuba River annually before New Bullards Bar Reservoir was completed in 1969. From 1970 to 1979, CDFG annually stocked 27,270–217,378 fingerlings, yearlings, and sub-catchables from Coleman National Fish Hatchery into the lower Yuba River (CDFG 1991). Based on angling data, CDFG estimated a run size of 2,000 steelhead in the lower Yuba River in 1975. The current status of this population is unknown, but it appears to be stable and able to support a significant sport fishery (McEwan and Jackson 1996). The Yuba River is currently managed for natural steelhead production (CDFG 1991).

9.1.1.4 American River Area of Analysis

The American River area of analysis includes French Meadows Reservoir on the Middle Fork American River and Hell Hole Reservoir on the Rubicon River; the Middle Fork American River from Ralston Afterbay to the confluence with the North Fork American River; Folsom Reservoir, Lake Natoma, and the Nimbus Fish Hatchery; and the lower American River, extending from Nimbus Dam to the confluence with the Sacramento River. Water assets purchased from Hell Hole Reservoir would be transferred via a series of conveyance and storage facilities prior to release into the Middle Fork American River. The Rubicon River below Hell Hole Reservoir would not be affected by EWA actions and therefore is not included in the American River area of analysis. Details regarding the facilities and water bodies within the American River area of analysis and the fisheries resources they support are provided below.

9.1.1.4.1 French Meadows and Hell Hole Reservoirs on the Middle Fork American and Rubicon Rivers

Placer County WA owns and operates the Middle Fork Project (MFP) on the upper American River. The principal project features consist of French Meadows and Hell Hole reservoirs. French Meadows Reservoir is located on the Middle Fork American River and has a storage capacity of 133,700 acre-feet. Hell Hole Reservoir is located on the Rubicon River, the main tributary to the Middle Fork American River, and has a storage capacity of 208,400 acre-feet. French Meadows and Hell Hole reservoirs are mid-elevation Sierra Nevada reservoirs (having elevations of approximately 5,000 feet above msl) that support coldwater recreational fisheries for resident rainbow and brown trout. CDFG stocks French Meadows with rainbows and browns in June and July and Hell Hole once a year. Warmwater fisheries also exist including smallmouth bass, catfish, and sunfish. Fish production in these reservoirs is limited by large seasonal fluctuations in water levels and low productivity compared to natural lakes. French Meadows Reservoir supports a self-sustaining population of brown trout that migrates from the reservoir to spawning areas in the Middle Fork American River above the reservoir during the fall. No physical barriers to brown trout migration are present in the Middle Fork American River within two miles above the reservoir during the fall (Jones and Stokes 2001).

9.1.1.4.2 Middle Fork American River

The Middle Fork American River originates above 7,500 feet msl, west of Squaw Peak in Placer County. The Middle Fork American River supports both warm and coldwater fish species year-round. Operation of Placer County Water Agency's Middle Fork Project, constructed in 1962 (including Ralston Afterbay), results in cooler summer and fall water temperatures, thereby improving habitat suitability for rainbow trout and brown trout for a portion of the river below Ralston Afterbay (USACE 1991; USBR 1996). Brown trout are resident stream fish, meaning they spend their entire lifecycle in fresh water. Spawning generally occurs during November and December (Moyle 1976). Brown trout fry typically hatch in seven to eight weeks, depending on water temperature, with emergence of young three to six weeks later.

Optimal riverine habitat for brown trout reportedly consists of cool to coldwater, silt-free rocky substrate, an approximate 1:1 pool-to-riffle ratio, and relatively stable water flow and temperature regimes (Raleigh et al. 1986). Moyle (1976) reported that while brown trout will survive for short periods at temperatures in excess of 80.6°F, optimum temperatures for growth range from 44.6°F to 66.2°F, with a preference for temperatures in the upper half of this range. Brown trout tend to utilize lower reaches of low to moderate gradient areas (less than one percent) in suitable, high gradient rivers (Raleigh et al. 1986).

Rainbow trout are the non-anadromous form of steelhead. As with brown trout, rainbow trout also are resident stream fish whose optimal riverine habitat reportedly consists of coldwater, silt-free rocky substrate, a 1:1 pool-to-riffle ratio, and relatively stable water flow and temperature regimes (Raleigh and Duff 1980 *in* Raleigh et al. 1984). Moyle (1976) reported that while rainbow trout will survive temperatures up to 82.4°F, optimum temperatures for growth and completion of most lifestages reportedly range from 55.4°F to 69.8°F. Rainbow trout spawning generally occurs from February to June (Moyle 1976). Rainbow trout fry emerge from spawning nests approximately 45 to 75 days after spawning, depending on water temperatures.

In addition to rainbow and brown trout, fish sampling surveys of the Middle Fork American River conducted by the USFWS in 1989 from Ralston Afterbay, downstream to the confluence with the North Fork American River, documented the presence of hitch (*Lavinia exilicauda*), Sacramento sucker (*Catostomus occidentalis*), pikeminnow (*Ptychocheilus grandis*), and riffle sculpin (*Cottus gulosus*) (USACE 1991). No Federal- or State-listed species or species proposed for listing under the Federal ESA and CESA are reported in the Middle Fork American River.

9.1.1.4.3 Folsom Reservoir

Folsom Reservoir has a maximum storage capacity of approximately 977 TAF, and has a maximum depth of approximately 266 feet. Folsom Reservoir is the most upstream CVP facility on the American River, and is located at an elevation of 466 feet above msl. Strong thermal stratification occurs within Folsom Reservoir annually between

April and November. Thermal stratification establishes a warm surface water layer (epilimnion), a middle water layer characterized by decreasing temperature with increasing depth (metalimnion or thermocline), and a bottom, coldwater layer (hypolimnion) within the reservoir. In terms of aquatic habitat, the warm epilimnion of Folsom Reservoir provides habitat for warmwater fishes, whereas the reservoir's lower metalimnion and hypolimnion form a "coldwater pool" that provides habitat for coldwater fish species throughout the summer and fall portions of the year. Hence, Folsom Reservoir supports a “two-story” fishery during the stratified portion of the year (April through November), with warm-water species using the upper, warm-water layer and coldwater species using the deeper, colder portion of the reservoir.

Native species that occur in the reservoir include hardhead and Sacramento pikeminnow. However, introduced largemouth bass, smallmouth bass, spotted bass, bluegill, crappie, and catfish constitute the primary warm-water sport fisheries of Folsom Reservoir. The reservoir’s coldwater sport species include rainbow and brown trout, kokanee salmon and Chinook salmon, all of which are currently or have been stocked by CDFG. Although brown trout are no longer stocked, a population still remains in the reservoir. These species are stream spawners and, therefore, do not reproduce within the reservoir. However, some spawning by one or more of these species may occur in the American River upstream of Folsom Reservoir.

Species-specific spawning times for those fish species that do spawn in Folsom Reservoir define the months of concern during which additional surface water diversions under the preferred program alternative could impact fish spawning and young-of-the-year rearing success. For example, largemouth and smallmouth bass spawn primarily in April and May, whereas peak spawning for sunfish and catfish generally occurs in late-May and June.

Folsom Reservoir’s coldwater pool is important not only to the reservoir’s coldwater fish species identified above, but also is important to lower American River fall-run Chinook salmon and steelhead. Seasonal releases from the reservoir’s coldwater pool provide thermal conditions in the lower American River that support annual in-river production of these salmonid species. Folsom Reservoir’s coldwater pool is not large enough to allow for coldwater releases during the warmest months (July through September) to provide maximum thermal benefits to lower American River steelhead, and coldwater releases during October and November that would maximally benefit fall-run Chinook salmon immigration, spawning, and incubation. Consequently, management of the reservoir’s coldwater pool on an annual basis is essential to providing thermal benefits to both fall-run Chinook salmon and steelhead, within the constraints of coldwater pool availability.

9.1.1.4.4 Lake Natoma

Lake Natoma was constructed to serve as a regulating afterbay for Folsom Reservoir and is located at an elevation of 132 feet above msl. Consequently, water surface elevations in Lake Natoma fluctuate from three to seven feet on a daily and weekly basis (USFWS 1991). Lake Natoma receives controlled releases from Folsom Reservoir and has a storage capacity of 9 TAF. Despite its size (an operating range of 2,800 acre-feet), Lake Natoma can influence the temperature of water flowing through it. Residence time in the lake, particularly during summer months, has a warming effect on water released from Folsom Reservoir. Water is released from Lake Natoma into the lower American River below Nimbus Dam.

Lake Natoma supports many of the same fisheries found in Folsom Reservoir (rainbow trout, bass, sunfish, and catfish). Some recruitment of warm-water and coldwater fishes likely comes from Folsom Reservoir. In addition, CDFG stocks catchable-size rainbow trout into Lake Natoma annually. Although supporting many of the same fish species found in Folsom Reservoir, Lake Natomas' limited primary and secondary production, colder epilimnetic water temperatures (relative to Folsom Reservoir), and daily elevation fluctuations are believed to reduce the size and annual production (USFWS 1991) of many of its fish populations, relative to Folsom Reservoir.

9.1.1.4.5 Nimbus Hatchery

CDFG operates the Nimbus Salmon and Steelhead Hatchery and the American River Trout Hatchery, which are at the same facility immediately downstream from Nimbus Dam. The Nimbus Salmon and Steelhead Hatchery is devoted to producing anadromous fall-run Chinook salmon and steelhead. The hatchery's fish ladder is opened to fall-run Chinook salmon annually when the average daily river temperature declines to approximately 60°F (West 2000), which generally occurs in October or early November. The fall-run Chinook salmon produced by the Nimbus Hatchery are released directly into the Delta. Immigrating adult steelhead typically begin arriving at the hatchery fish ladder in December. Peak steelhead egg collection generally occurs during January and February, but sometimes continues through March. Steelhead produced by the Nimbus Hatchery are released into the Sacramento River at either Miller Park or Garcia Bend (West 1999).

The Nimbus Hatchery receives water for its operations directly from Lake Natoma via a 60-inch-diameter pipeline. Water temperatures in the hatchery are dictated by the temperature of water diverted from Lake Natoma, which, in turn, is primarily dependent upon the temperature of water released from Folsom Reservoir, air temperature, and retention time in Lake Natoma. The temperature of water diverted from Lake Natoma for hatchery operations is frequently higher than that which is desired for hatchery production of rainbow trout, steelhead, and Chinook salmon. Under such conditions, increasing releases at Folsom Dam and/or releasing colder water from a lower elevation within Folsom Reservoir may achieve more suitable temperatures. However, seasonal releases from Folsom Reservoir's limited coldwater pool to benefit hatchery operations must be considered in conjunction with seasonal in-river benefits from such releases.

9.1.1.4.6 Lower American River

The American River drains a watershed of approximately 1,895 square miles (USBR 1996), and is a major tributary to the Sacramento River. The American River has provided over 125 miles of riverine habitat to anadromous and resident fishes. Presently, use of the American River by anadromous fish is limited to the 23 miles of river below Nimbus Dam (the lower American River).

The lower American River provides a diversity of aquatic habitats, including shallow, fast-water riffles, glides, runs, pools, and off-channel backwater habitats. The lower American River from Nimbus Dam (river mile [RM] 23) to approximately Goethe Park (RM 14) is primarily unrestricted by levees, but is bordered by some developed areas. Natural bluffs contain this reach of the river and terraces cut into the side of the channel. The river reach downstream of Goethe Park, and extending to its confluence with the Sacramento River (RM 0), is bordered by levees. The construction of levees changed the channel geomorphology and has reduced river meanders and increased depth.

At least 43 species of fish have been reported to occur in the lower American River system, including numerous resident native and introduced species, as well as several anadromous species. Although each fish species fulfills an ecological niche, several species are of primary management concern either as a result of their declining status or their importance to recreational and/or commercial fisheries. Both steelhead, listed as "threatened" under the Federal ESA, and Sacramento splittail, treated as a Federally listed threatened species, occur in the lower American River. Current recreationally and/or commercially important anadromous species include fall-run Chinook salmon, steelhead, striped bass, and American shad.

With over 125 miles of available upstream salmonid spawning habitat, the American River historically served as a regionally vital component for the reproduction and survival of fall- and spring-run Chinook salmon (Water Forum 2001). While development and dam construction extirpated the spring-run fishery, the lower American River continues to function as spawning and rearing habitat for large numbers of fall-run Chinook salmon. Today the river supports a mixed run of hatchery and naturally produced fish. During the period of 1967 through 1991 (AFRP restoration goal baseline period), lower American River fall-run Chinook salmon spawning comprised approximately 21 percent (41,040 fish) of total fall-run Chinook salmon spawning (197,740 fish) in the Sacramento Valley river system, including the Sacramento River and its tributary rivers and creeks (SWRI 2002, unpublished data). Recent escapement estimates (1992-2002) in the Central Valley, suggest the American River fall-run Chinook salmon comprise approximately 22 percent of the total fall-run Chinook salmon escapement in the Sacramento and its major tributaries (68,373 of 311,746, respectively, fall-run Chinook salmon) (PFMC 2003)

Historically, the majority of anadromous salmonid spawning and rearing habitat within the American River was located in the watershed above Folsom Dam. The lower American River currently provides spawning and rearing habitat for fall-run Chinook salmon and steelhead below Nimbus Dam. The majority of the steelhead run is believed to be of hatchery origin. However, with the exception of an emergency release during January of 1997 resulting from poor water quality caused by flooding, no steelhead have been stocked directly into the lower American River since 1990 (Barngrover 1997).

The primary factor potentially limiting fall-run Chinook salmon and steelhead production within the lower American River is believed to be high water temperatures during portions of their freshwater residency in the river. High water temperatures during the fall can delay the onset of spawning by Chinook salmon, and river water temperatures can become unsuitably high for juvenile salmon rearing during spring and steelhead rearing during summer. In addition, relatively low October and November flows, when they occur, tend to increase the amount of fall-run Chinook salmon redd superimposition, thereby potentially limiting initial year-class strength.

9.1.1.5 San Joaquin River Area of Analysis

The San Joaquin River Area of analysis includes Lake McClure and Lake McSwain on the Merced River; the Merced River from Crocker-Huffman Dam to the confluence with the San Joaquin River, and the San Joaquin River from the mouth of the Merced River to Mossdale/Vernalis. Details regarding the facilities and water bodies within the San Joaquin River Area of analysis and the fisheries resources they support are provided below.

9.1.1.5.1 Lake McClure

The Merced Irrigation District operates Lake McClure and Lake McSwain in Mariposa County. The Merced River flows from the Sierra Nevada into Lake McClure, which is formed by New Exchequer Dam. Lake McClure has a storage capacity of 1,024,500 acre-feet and is located at an elevation of 867 feet above msl. Smaller Lake McSwain has 9,730 acre-feet of storage capacity and is located just downstream of Lake McClure at an elevation of 425 feet above msl. Lake McSwain is fed from the larger McClure's cool depths. The lower water temperature of Lake McSwain provides suitable habitat for coldwater fish species.

Lake McClure supports both coldwater and warmwater fisheries. CDFG stocks Chinook salmon annually. In addition, rainbow trout and brown trout are stocked in the lake by local hatcheries. Warmwater fish present in Lake McClure include several centrarchid species, including largemouth bass, spotted bass, crappie, bluegill, catfish and shad.

9.1.1.5.2 Merced River

The Merced River 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. It is one of the main tributaries to the San Joaquin River on the east side of the drainage. The Merced River is the southernmost Central Valley stream presently inhabited by anadromous salmonids. Chinook salmon are restricted during all of their freshwater life stages to utilize the lower Merced River up to Crocker-Huffman Dam, which is the upstream barrier for fish migration and the location of the Merced River Hatchery. Crocker-Huffman Dam along with three upstream dams (Merced

Falls Dam, McSwain Dam, and New Exchequer Dam, proceeding in an upstream direction) regulates flows in the lower Merced River.

Fall-run Chinook salmon is the anadromous fish species present in the Merced River. Central Valley steelhead habitat potentially exists on the Merced River below Crocker-Huffman Dam, however, there is no conclusive evidence that steelhead are present in the Merced River. Fall-run Chinook salmon, Central Valley steelhead, striped bass, American shad, and white sturgeon are the anadromous fish species present in the San Joaquin River from the Merced River confluence to Mossdale (USBR 2000).

Within the Merced River, juvenile salmon can be found between mid-January through May, depending on environmental conditions. 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 abundance of fall-run Chinook salmon is affected by flows, water temperature and water quality. Higher flows and lower water temperatures (51-67ºF) 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. For many years the 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 are now installed along the San Joaquin River above and below the confluence of the Merced River to prevent Chinook salmon migration into the wrong water streams and to help guide them to the Merced.

Minimum instream flow requirements in the river are defined under Merced Irrigation District's current licenses and agreements and are intended to provide adequate flows for Chinook salmon and for the Merced River Riparian Water Users Association diversions. In addition, Merced Irrigation District is coordinating with CDFG to implement studies to assess the effects of flows on Chinook salmon in the river (Stillwater Sciences 2002).

9.1.1.5.3 San Joaquin River

The portion of the San Joaquin River from Mossdale/Vernalis to the mouth of the Merced River is the most significant for anadromous fish that use the San Joaquin River for migration and spawning. This 43-mile reach includes the confluences of the Merced, Tuolumne, and Stanislaus Rivers, the main tributaries to the San Joaquin River, entering on the east side of the drainage. Little water is contributed from the upper San Joaquin River, except during flood events (EA Engineering, Science, and Technology 1999). Flows in the San Joaquin River at Vernalis are controlled by operations of the New Exchequer, New Don Pedro, and New Melones dams resulting in average monthly flows that are uniform throughout the year, with maximum flows less than historical levels (Interior 1999).

Fall-run Chinook salmon, Central Valley steelhead, striped bass, American shad, and white sturgeon are the anadromous fish species present in the San Joaquin River from the Merced River confluence to Mossdale. Shad and striped bass migrate from the Pacific Ocean via the Delta into the San Joaquin River to spawn in the spring. Splittail, pikeminnow, and other native species are also found in the San Joaquin River. However, this portion of the San Joaquin is dominated by introduced species such as largemouth bass, silversides, green sunfish and brown bullhead. Introduced species dominate in terms of numbers and biomass.

Adult fall-run Chinook salmon enter the San Joaquin River system in October and spawn through January, with peak spawning period in November (Moyle 2002). Although timing of Chinook salmon maturation is typically variable, many San Joaquin River female fall-run Chinook salmon mature after only two years (NMFS 1999). Typically eggs are buried in the spawning gravels for parts of November, December, and January, with occasional occurrences in October and February. Hatching begins in January, and fry remain in the gravel for up to 30 days, before emerging to feed and grow in shallow, slow moving water at the edge of the river. The majority of juveniles leave the tributaries from March to the end of June, although some over-summer and emigrate October and November (EA Engineering, Science, and Technology 1999; Baker and Morhardt 2001). San Joaquin River fall-run Chinook salmon abundance is typically small and more variable than Sacramento River fall-run Chinook salmon. Annual escapement estimates range from 1,100-77,500, with half being fewer than 10,000 fish (Moyle 2002). Although the run and spawn timing of fall-run Chinook salmon in the San Joaquin River system may not reflect historical timing, environmental conditions in the San Joaquin River system represent the extreme of Chinook salmon tolerance (NMFS 1999).

Steelhead use the San Joaquin River in much the same way the fall-run Chinook salmon, although several differences between steelhead and fall-run Chinook occur. First, adult steelhead begin their spawning migration slightly later than Chinook and, therefore, stages of development for the eggs and juveniles will be approximately one month later than Chinook. Adult steelhead will not necessarily die after spawning, resulting in some adults remaining in the rivers through June. Lastly, young steelhead likely remain in the rivers throughout their first summer (EA Engineering, Science, and Technology 1999).

9.1.2 Sacramento-San Joaquin Delta Region

San Francisco Bay and the Sacramento-San Joaquin Delta (Figure 9-4) make up the largest estuary on the west coast (USEPA 1993). The Bay-Delta estuary provides habitat for a diverse assemblage of fish and macroinvertebrates. Many of the fish and macroinvertebrate species inhabit the estuary year-round, while other species inhabit the system on a seasonal basis as a migratory corridor between upstream freshwater riverine habitat and coastal marine waters, as seasonal foraging habitat, or for reproduction and juvenile rearing.

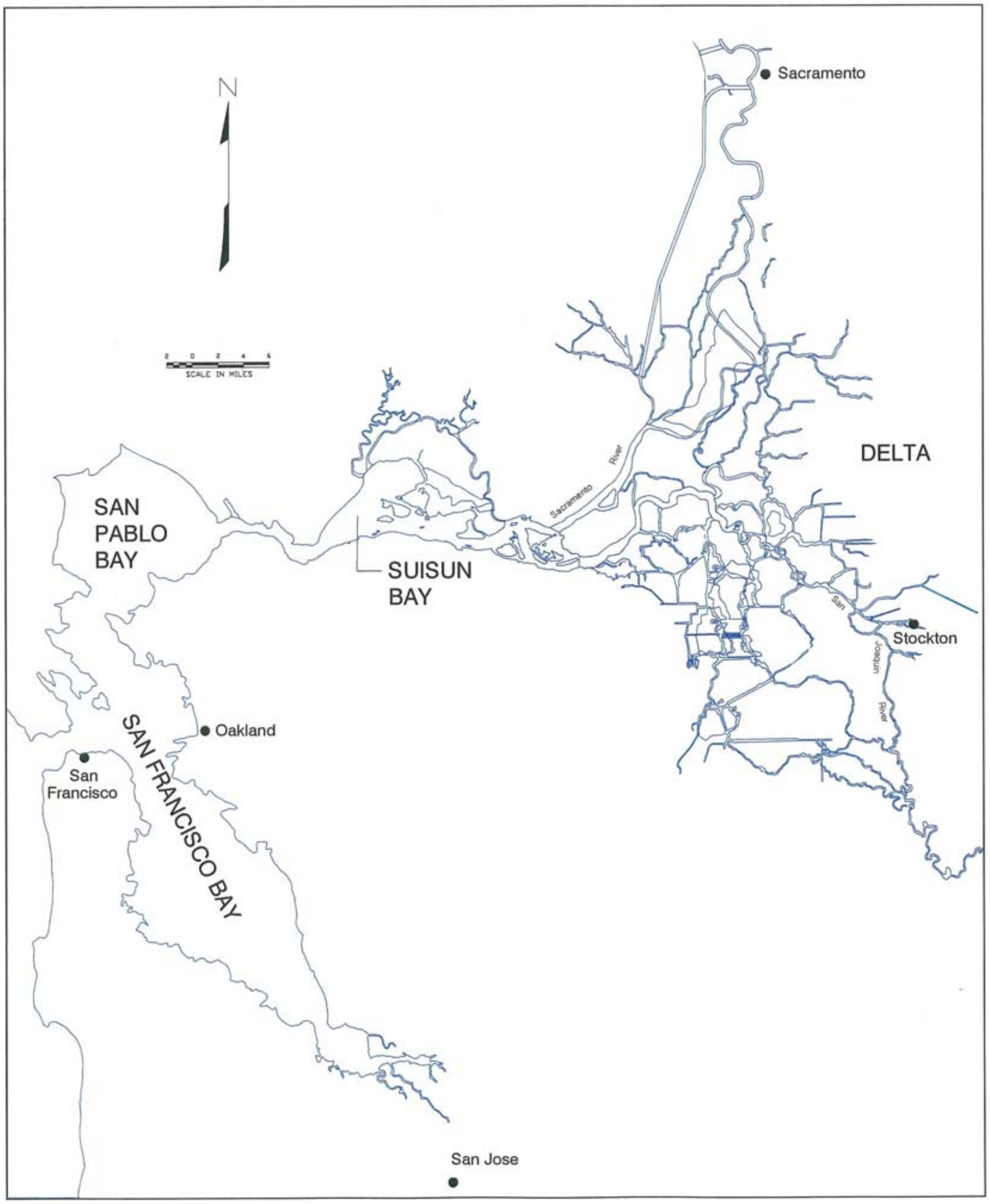

Figure 9-4
San Francisco Bay and the Sacramento-San Joaquin River Delta

Migratory (e.g., anadromous) fish species which inhabit the Bay-Delta system and its tributaries include, but are not limited to, white sturgeon, green sturgeon, Chinook salmon (including fall-run, spring-run, winter-run, and late-fall-run Chinook salmon), steelhead, American shad, Pacific lamprey and river lamprey (Moyle 2002). The Bay-Delta estuary and tributaries also support a diverse community of resident fish which includes, but is not limited to, Sacramento sucker, prickly and riffle sculpin, California roach, hardhead, hitch, Sacramento blackfish, Sacramento pikeminnow, speckled dace, Sacramento splittail, tule perch, inland silverside, black crappie, bluegill, green sunfish, largemouth bass, smallmouth bass, white crappie, threadfin shad, carp, golden shiner, black and brown bullhead, channel catfish, white catfish, and a variety of other species which inhabit the more estuarine and freshwater portions of the Bay-Delta system (Moyle 2002).

The geographic distribution of species within the estuary is determined, in part, based on salinity gradients, which range from freshwater within the Sacramento and San Joaquin River systems, to marine conditions near the Golden Gate Bridge. The abundance, distribution, and habitat use by these fish and macroinvertebrates has been monitored over a number of years through investigations conducted by CDFG, NOAA Fisheries, USFWS, DWR, and a number of other investigators. Results of these monitoring programs have shown changes in species composition and abundance within the system over the past several decades. Many of the fish and macroinvertebrate species have experienced a generally declining trend in abundance (Moyle et al. 1995) with several native species, including winter-run and spring-run Chinook salmon, steelhead, delta smelt, and Sacramento splittail (currently treated as a Federally listed threatened species) either listed or being considered for protection under the Federal or California Endangered Species Acts. Portions of the estuary have been identified as critical habitat for species such as winter-run Chinook salmon and delta smelt. A number of fish and macroinvertebrate species inhabiting the estuary also support recreational and commercial fisheries, such as fall-run Chinook salmon, Bay shrimp, Pacific herring, northern anchovy, starry flounder, striped bass, largemouth bass, sturgeon, and many others, and hence the estuary also has been identified as EFH for these species.

Many factors have contributed to the decline of fish species within the Delta (Moyle et al. 1995), including changes in hydrologic patterns resulting from water project operations, loss of habitat, contaminant input, entrainment in diversions, and introduction of non-native species. The Delta is a network of channels through which water, nutrients, and aquatic food resources are moved and mixed by tidal action. Pumps and siphons divert water for Delta irrigation and municipal and industrial use or into CVP and SWP canals. River inflow, Delta Cross Channel operations, and diversions (including agricultural and municipal diversions and export pumping) affect Delta species through changes in habitat conditions (e.g., salinity intrusion), and mortality attributable to entrainment in diversions.

The majority of land in the Delta, which covers approximately 678,200 acres, is irrigated cropland (CALFED 2000). Other terrestrial habitats include *"riparian vegetation, wetlands, and other forms of 'idle land'"* (CALFED 2000). The CALFED PEIS/EIR describes the Delta aquatic environment as comprised of *"…channels, sloughs, and other open water. Under existing conditions, most of the open water is deep-channel habitat that has been modified to provide passage for ocean-going vessels as well as efficient conveyance of fresh water from the Sacramento River through the Delta. Vegetation is removed from levees, primarily to facilitate inspection, repair, and flood fighting when necessary. Although current flood protection programs may allow for properly managed vegetation, the amount of shallow water and shaded riverine habitat throughout the Delta is* *much lower now than it was historically, largely having been replaced by a patchwork of agricultural islands and revetted levees"* (CALFED, 2000).

Seasonal and interannual variability in hydrologic conditions, including the magnitude of flows into the Bay-Delta estuary from the Sacramento and San Joaquin rivers and other tributaries and the outflow from the Delta into San Francisco Bay, have been identified as important factors affecting habitat quality and availability, and abundance for a number of fish and invertebrate species within the Bay-Delta estuary. Flows within the Bay-Delta system may affect larval and juvenile transport and dispersal, water temperatures (primarily within the upstream tributaries), dissolved oxygen concentrations (e.g., during the fall within the lower San Joaquin River), and salinity gradients within the estuary. The seasonal timing and geographic location of salinity gradients are thought to be important factors affecting habitat quality and availability for a number of species (Baxter et al. 1999). Operation of upstream storage impoundments, in combination with natural hydrologic conditions, affect seasonal patterns in the distribution of salinity within the system. Water project operations, for example, may result in a reduction in Delta inflows during the late winter and spring with an increase in Delta inflows, when compared to historical conditions, during the summer months. Objectives have been established for the location of salinity gradients during the late winter and spring to support estuarine habitat for a number of species (X_2 location), in addition to other salinity criteria for municipal, agricultural, and wetland benefits. Although a number of studies have focused on the effects of variation in salinity gradients as a factor affecting estuarine habitat during the late winter and spring (Kimmerer 2002), very little information exists on the effects of increased inflows into the Delta during summer months and the resulting changes in salinity conditions (e.g., reduced salinity when compared to historical conditions) on the abundance, growth, survival, and distribution of various fish and macroinvertebrates inhabiting the Bay-Delta system.

Despite the high degree of habitat modification that has occurred in the Delta, Delta habitats are of key importance to fisheries, as illustrated by the more than 120 fish species that rely on its unique habitat characteristics for one or more of their lifestages (USEPA 1993). Fish species found in the Delta include anadromous species, as well as freshwater, brackish water, and saltwater species. The Delta provides spawning and nursery habitat for more than 40 resident and anadromous fish species, including delta smelt, Sacramento splittail, American shad, and striped bass. The Delta also is a migration corridor and seasonal rearing habitat for Chinook salmon and steelhead. All anadromous fish of the Central Valley either migrate through the Delta to spawn and rear upstream or are dependent on the Delta to support some critical part of their life cycle. Delta smelt, which have been listed under both the State and Federal Endangered Species Acts, and Sacramento splittail, treated as a Federally listed threatened species under the Federal Endangered Species Act, reside year-round within the Delta. Species such as green sturgeon utilize the Delta as a migratory corridor, juvenile nursery, and adult foraging habitat, with spawning occurring further upstream within the mainstem Sacramento River. Longfin smelt, which have been identified as a species of special concern, inhabit the Delta estuary year-round. Other species which have been listed for protection under the State and/or Federal Endangered Species Acts, including winter-run and spring-run Chinook salmon and steelhead, utilize the estuary as a migratory corridor and as juvenile foraging habitat with spawning and egg incubation occurring further upstream within the Sacramento and San Joaquin River systems.

Delta inflow and outflow are important for species residing primarily in the Delta (e.g., delta smelt and longfin smelt) (USFWS 1994), as well as juveniles of anadromous species (e.g., Chinook salmon) that rear in the Delta prior to ocean entry. Seasonal Delta inflows affect several key ecological processes, including: 1) the migration and transport of various lifestages of resident and anadromous fishes using the Delta (USEPA, 1992); 2) salinity levels at various locations within the Delta as measured by the location of X_2; and 3) the Delta's primary (phytoplankton) and secondary (zooplankton) production.

The analysis of Delta fish species focuses on the following Federal or State listed or recreationally or commercially important fish species:

- American shad (*Alosa sapidissima*);
- Delta smelt (*Hypomesus transpacificus*);
- Fall-run and late-fall-run Chinook salmon (*Oncorhynchus tshawytscha*);
- Northern anchovy (*Engraulis mordax*);
- Sacramento splittail (*Pogonichthys macrolepidotus*);
- Spring-run Chinook salmon (*Oncorhynchus tshawytscha*);
- Starry flounder (*Platichthys stellatus*);
- Steelhead (*Oncorhynchus mykiss*);
- Striped bass (*Morone saxatilis*); and
- Winter-run Chinook salmon (*Oncorhynchus tshawytscha*).

The habitat requirements and distribution for Chinook salmon, striped bass, American shad, delta smelt, and Sacramento splittail are largely representative of the habitat requirements and distribution of other Delta fish species (Jones and Stokes 2001). Therefore, the analysis of EWA effects on the above species encompasses the range of potential effects on other Delta fishery resources.

The following section describes the aquatic habitats and fish populations within the Delta, and borrows heavily from the Interim South Delta Program (ISDP) Draft EIS/EIR (DWR and USBR 1996). This section is organized into the following components: 1) a description of the Bay-Delta estuary; 2) a description of the principle hydraulic features of the Sacramento and San Joaquin rivers and the Delta that affect aquatic resources, including components of the CVP and SWP; and 3) descriptions of the status, life history, and factors affecting abundances of selected fish and invertebrate species, focusing on those species having economic importance or those identified as species of concern by the Federal or State government.

9.1.2.1 Sacramento-San Joaquin Delta Area of Analysis

The Sacramento-San Joaquin Delta, the most upstream portion of the Bay-Delta estuary, is a triangle-shaped area composed of islands, river channels, and sloughs at the confluence of the Sacramento and San Joaquin rivers (Figure 9-4). The northern Delta is dominated by the waters of the Sacramento River, which are of relatively low salinity, whereas the relatively higher salinity waters of the San Joaquin River dominate the southern Delta. The central Delta includes many channels where waters from the Sacramento and San Joaquin rivers and their tributaries converge. The Delta Area of analysis includes the river channels and sloughs at the confluence of the Sacramento and San Joaquin rivers. Details regarding the facilities and water bodies within the Delta Area of analysis and the fisheries resources they support are provided below.

The Delta's tidally influenced channels and sloughs cover a surface area of approximately 75 square miles. These waters support a number of resident freshwater fish and invertebrate species. The waters are also used as migration corridors and rearing areas for anadromous fish species and as spawning and rearing grounds for many estuarine species. Shallow-water habitats, defined as waters less than three meters in depth (mean low water), are considered particularly important forage, reproduction, rearing, and refuge areas for numerous fish and invertebrate species.

There have been over 100 documented introductions of exotic species to the Bay-Delta estuary. These include intentionally introduced game fishes such as striped bass and American shad, as well as inadvertent introductions of undesirable organisms such as the Asian and Asiatic clams. Table 9-2 gives common and scientific names for all known native and exotic fish species found in the Delta, including species no longer present.

Table 9-2
Fishes of the Sacramento-San Joaquin Delta

Common Name	***Scientific Name***	***Life History***	***Status***
Pacific lamprey*	*Lampetra tridentata*	A	declining
River lamprey*	*Lampetra ayersi*	A	SC
White sturgeon*	*Acipenser transmontanus*	A	declining; fishery
Green sturgeon*	*Acipenser medirostris*	A	SC; FP
American shad	*Alosa sapidissima*	A	fishery
Threadfin shad	*Dorosoma petenense*	A	common
Steelhead*	*Oncorhynchus mykiss*	A	SC; FT; fishery
Pink salmon*	*Oncorhynchus gorbuscha*	A	SC; rare
Chum salmon*	*Oncorhynchus keta*	A	SC; rare
Coho salmon*	*Oncorhynchus kisutch*	A	SC, FT

Table 9-2
Fishes of the Sacramento-San Joaquin Delta

Common Name	*Scientific Name*	*Life History*	*Status*
Chinook salmon*	*Oncorhynchus tshawytscha*	A	fishery:
Sacramento fall-run			fishery
late-fall-run			SC
winter-run			FE, SE
spring-run			ST; FT
San Joaquin fall-run			fishery
spring-run			extinct
Longfin smelt*	*Spirinchus thaleichthys*	A-R	SC
Delta smelt*	*Hypomesus transpacificus*	R	FT, ST
Wakasagi	*Hypomesus nipponensis*	R?	invading
Thicktail chub*	*Gila crassicauda*	R	extinct
Hitch*	*Lavinia exilicauda*	R	unknown
Sacramento blackfish*	*Orthodon microlepidotus*	R	unknown
Sacramento splittail*	*Pogonichthys macrolepidotus*	R	SC, FT
Hardhead*	*Mylopharodon conocephalus*	N	SC
Sacramento pikeminnow*	*Ptychocheilus grandis*	R	common
Fathead minnow	*Pimephales promelas*	N	rare
Golden shiner	*Notemigonus chrysoleucas*	R?	uncommon
Common carp	*Cyprinus carpio*	R	common
Goldfish	*Carassius auratus*	R	uncommon
Sacramento sucker*	*Catostomus occidentalis*	R	common
Black bullhead	*Ameiurus melas*	R	common
Brown bullhead	*Ameiurus nebulosus*	R	uncommon
Yellow bullhead	*Ameiurus natalis*	R	rare?
White catfish	*Ameiurus catus*	R	abundant
Channel catfish	*Ictalurus punctatus*	R	common
Blue catfish	*Ictalurus furcatus*	R?	rare
Western mosquitofish	*Gambusia affinis*	R	abundant
Rainwater killifish	*Lucania parva*	R?	rare
Striped bass	*Morone saxatilis*	R-A	abundant
Inland silverside	*Menidia beryllina*	R	abundant
Sacramento perch*	*Archoplites interruptus*	N	SC
Bluegill	*Lepomis macrochirus*	R	common
Redear sunfish	*Lepomis microlophus*	R	uncommon
Green sunfish	*Lepomis cyanellus*	R	uncommon
Warmouth	*Lepomis gulosus*	R	uncommon
White crappie	*Pomoxis annularis*	R	common
Black crappie	*Pomoxis nigromaculatus*	R	uncommon
Largemouth bass	*Micropterus salmoides*	R	common
Smallmouth bass	*Micropterus dolomieui*	R	uncommon
Bigscale logperch	*Percina macrolepida*	R	common
Yellow perch	*Perca flavescens*	N	rare
Tule perch*	*Hysterocarpus traski*	R	common
Threespine stickleback*	*Gasterosteus aculeatus*	R	common
Yellowfin goby	*Acanthogobius flavimanus*	R	common
Chameleon goby	*Tridentiger trigonocephalus*	R	invading
Staghorn sculpin*	*Leptocottus armatus*	M	common
Prickly sculpin*	*Cottus asper*	R	abundant
Starry flounder*	*Platichthys stellatus*	M	common

Modified from USFWS 1994 *as cited in* DWR and USBR 1996.

An asterisk (*) indicates a native species; A = anadromous; R = resident; N = non-resident visitor; M = marine; SC = species of special concern; FT = Federal threatened; ST = State threatened; FE = Federal endangered; SE = State endangered; FP = Federal proposed.

9.1.2.1.1 Water Project Development

California's water resources have been developed through a lengthy and complex process involving private, local, State, and Federal agencies and individuals. This development has provided water supply, flood control, and hydropower as well as improvements to navigable waters. Adverse impacts of water resources development include blocked access of anadromous fish to habitats upstream of dams, alteration or destruction of fish and wildlife habitats, changes in the seasonal timing and magnitude of streamflow, entrainment of young fish at diversions, and changes in water quality and sediment transport regimes.

The development of water storage and delivery systems affecting the Bay-Delta began in the early 1900s in response to flooding problems in the Delta and the Sacramento River basin, summer salinity problems and associated damages to Delta farm crops, and the need for water in other parts of California. In 2002, approximately 59 major reservoirs with a total storage capacity of about 27 million acre-feet of water are in operation in the Central Valley watershed. Most of these reservoirs are operated for local water supply or for flood control.

Reservoir operations have altered the timing and magnitude of river flows in the Central Valley. Before water was diverted from the Delta, annual runoff into the Estuary ranged from 19 to 29 million acre-feet (SFEP 1992 *as cited in* DWR and USBR 1996). Now, upstream users, Bay Area cities, Delta farmers, and water projects divert about half of the historical flow. The water projects store water during the winter and spring months for release later in the year, which reduces the natural flow in April, May, and June and increases the flow in late summer and fall.

9.1.2.1.2 Salinity

Historically during summer months, especially in dry years, salt water intruded far into the Delta (DWR 1987 *as cited in* DWR and USBR 1996). After the State and Federal water projects were built, freshwater releases from upstream reservoirs helped reduce saltwater intrusion into the Delta. However, salinity intrusion from the ocean remains a problem, and salts accumulated in agricultural drainage have increased salinities in the San Joaquin River and south Delta.

While freshwater inflows to the Delta during summer are generally higher than historical flows, winter and spring flows are typically lower because of reservoir storage and flood control. The lower inflows during the winter and spring lead to high salinities in areas such as Suisun Bay and the western Delta, which are important nursery areas for many estuarine fish species during spring. Elevated salinities reduce growth and survival of young stages of Delta fish. Salinity intrusion is often particularly severe during spring, when agricultural demand is high.

Agricultural drainage discharged from Delta islands contains dissolved minerals that increase salinities in Delta channels. The salt content of drainage water flowing down the San Joaquin River is relatively high. Use of this water by Delta farmers dramatically increases the salinity of the irrigation return flows and further increases the concentration of salts flowing into the Estuary.

Current and future efforts to control the level of salinity in the Estuary focus on fresh water flow adjustments to maintain salinity standards, use of tidal flow barriers, and reductions in agricultural drainage.

9.1.2.1.3 Flood Control Operations

Operating storage facilities for flood control changes the timing and magnitude of flows in an effort to minimize property damage and loss of life. However, dams and other structures built for flood control can block fish migration pathways and access to spawning and rearing habitat. Such structures can also prevent replenishment of spawning gravels and reduce the frequency of flushing flows that remove silt from existing gravels. Flood control has diminished fish habitat by removing woody debris and riparian vegetation and by riprapping riverbanks.

9.1.2.1.4 Unscreened Diversions

Unscreened diversions may be responsible for entraining significant numbers of juvenile fish. As of April 1997, 3,356 diversions in California's Central Valley have been identified, approximately 98 percent of which are unscreened or screened insufficiently to protect fish (Herren and Kawasaki 2001). These diversions primarily provide irrigation water for agriculture; in the summer growing season, they can divert roughly one-quarter of the freshwater inflow into the Delta. Many of these diversions are known to entrain larval and juvenile fish. Estimates of fish losses to unscreened Delta diversions range upwards of several hundred million striped bass less than one inch long and tens of thousands of juvenile Chinook salmon (Spaar 1994 *as cited in* DWR and USBR 1996).

In recent years, efforts to screen many of these diversions have been undertaken, frequently as a result of actions taken under State and Federal Endangered Species Acts. California law requires fish screens on all new diversions and existing diversions that are relocated. Requirements are being proposed by various agencies to screen existing diversions, especially those diversions known to entrain the most fish. Other agencies propose to allow relocating diversion intakes and restricting diversion times as alternatives to expensive screening retrofits.

Fish losses also occur at the SWP and CVP export facilities in the south Delta. These losses are discussed in Section 9.1.2.2, Facilities and Operations of the SWP and CVP and their Effects on Aquatic Resources.

9.1.2.2 Facilities and Operations of the SWP and CVP and Their Effects on Aquatic Resources

9.1.2.2.1 State Water Project Facilities

State Water Project (SWP) facilities in the Delta include the North Bay Aqueduct, Clifton Court Forebay, John E. Skinner Delta Fish Protection Facility, Harvey O. Banks Delta Pumping Plant, and the intake channel to the pumping plant (Figure 9-5). The North Bay Aqueduct would be unaffected by the EWA Program alternatives and, therefore, is not discussed further. Banks Pumping Plant lifts water 244 feet to the beginning of the California Aqueduct. An open intake channel conveys water to Banks Pumping Plant from Clifton Court Forebay. The forebay provides storage for off-peak pumping and permits regulation of flows into the pumping plant. All water arriving at Banks Pumping Plant flows first through the primary intake channel of the John E. Skinner Delta Fish Protective Facility. Fish screens (louvers) across the intake channel direct fish into bypass openings leading into the salvage facilities. The main purpose of the fish facility is to reduce the number of fish adversely impacted by entrainment at the export facility and to reduce the amount of floating debris conveyed to the pumps.

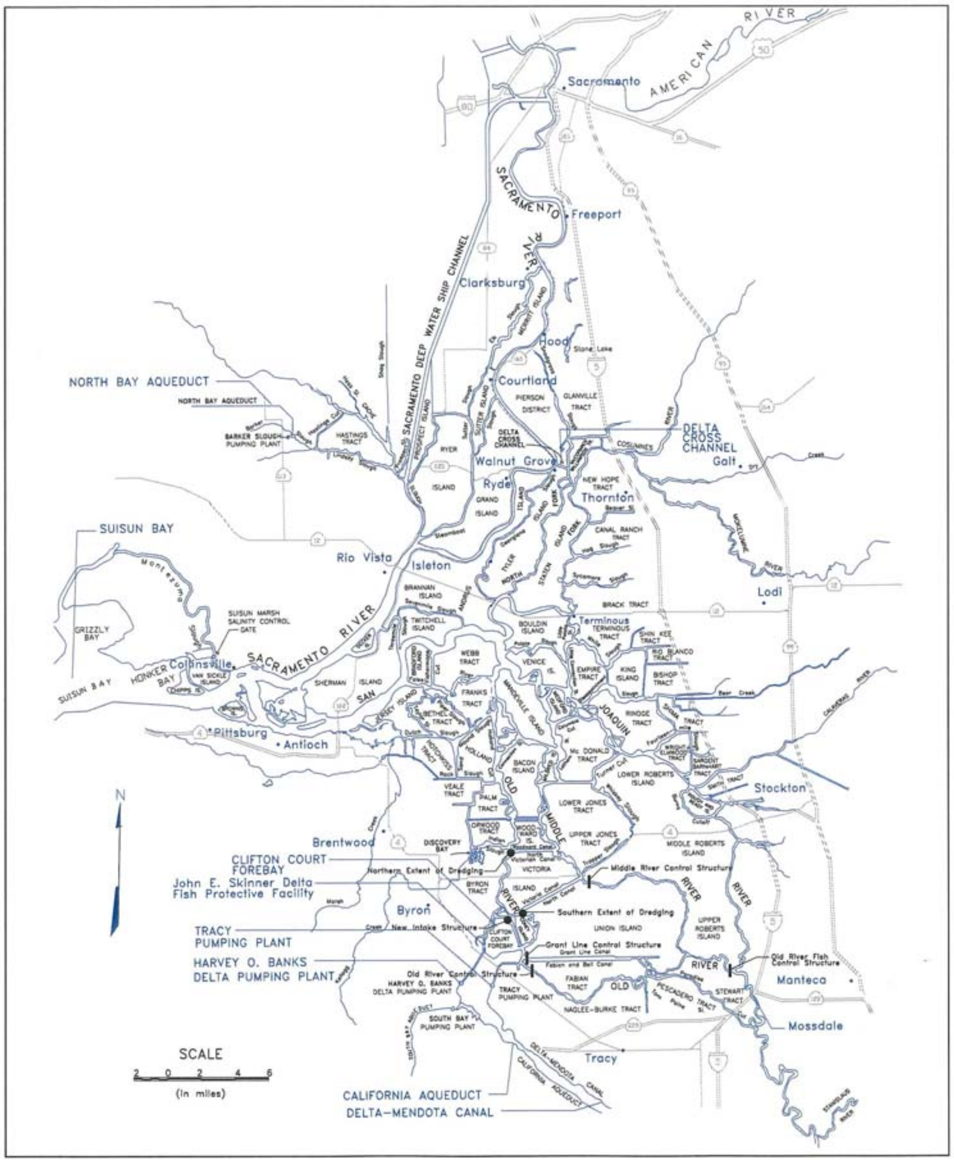

Figure 9-5
Delta Facilities

Clifton Court Forebay. Clifton Court Forebay serves as a regulating reservoir providing reliability and flexibility for the water pumping operations at the Banks Pumping Plant (DWR and USBR 1994 *as cited in* DWR and USBR 1996). The forebay has a maximum total capacity of 31 thousand acre-feet (TAF). Five radial gates are opened during a high tide to allow the forebay reservoir to fill, and are closed during a low tide to retain water that supplies the pumps.

When the gates are open at high tide, inflow can be as high as 12,000 cubic feet per second (cfs) for a short time, decreasing as water levels inside and outside the forebay reach equilibrium. This flow, at times, reaches velocities of 6-10 feet per second (fps) in the primary intake channel. Velocities decrease as water levels in the intake channel and forebay approach equilibrium. Starting in May 1994, gate operation patterns were adjusted to reduce entrainment of delta smelt into the forebay.

Fish that enter Clifton Court Forebay may take up residence in the forebay. Once in the forebay, fish may be eaten by other fish or taken by anglers (pre-screening losses); entrained by the pumps at the Banks Pumping Plant (direct losses); impinged on the fish screens at the Skinner Fish Protection Facility (direct loss); or bypassed and salvaged at the Skinner Fish Protection Facility (salvage). The California Department of Fish and Game views predation on fish entrained into the forebay as a concern insofar as it may exceed natural predation rates in Delta Channels.

Juvenile salmon, juvenile striped bass, and other species entrained into the forebay are exposed to high levels of predation before they can be salvaged at the Skinner Fish Protection Facility (DWR and USBR 1994 *as cited in* DWR and USBR 1996). CDFG has conducted studies to assess the loss rate of juvenile salmon and striped bass that cross the forebay (Schaffter 1978; Hall 1980; CDFG 1985a, 1985b, 1992a, 1993; Brown and Greene 1992 *as cited in* DWR and USBR 1996). The operation of the existing radial gates admits fish, along with water, into Clifton Court Forebay, where predation, salvage handling, and transport to another location in the Delta, entrainment, and other fates await them. The existing intake structure and gates are believed to provide cover and a feeding station for predators. Predation losses are believed to be very high. Based on studies of marked juvenile salmon released at the radial gates, mortality estimates of juvenile fall-run Chinook salmon traversing the forebay range from 63 to 98 percent.

Survival of young striped bass in Clifton Court Forebay is also low. Six percent of young-of-the-year (YOY) striped bass released at the radial gates survived passage across the forebay (CDFG 1985a *as cited in* DWR and USBR 1996).

The losses for both striped bass and salmon are attributed to predation. CDFG (1992a *as cited in* DWR and USBR 1996) identified sub-adult striped bass as the major predatory fish in Clifton Court Forebay. These fish were most abundant near the radial gates during winter and spring, when small fish may be particularly vulnerable. Predators have been periodically removed from the forebay and released in the Delta. In 1993, striped bass made up 96 percent of the predators removed, followed by white catfish and channel catfish (Liston et al. 1994 *as cited in* DWR and USBR 1996).

Loss rates of other fish species of concern, such as delta smelt, cannot be assessed accurately at this time. However, estimated salvage rates are discussed below.

John E. Skinner Fish Facility. The John E. Skinner Fish Facility includes primary and secondary louvers (screens) designed to guide fish to bypass and salvage facilities before they are drawn into the Banks Pumping Plant (Brown and Greene 1992 *as cited in* DWR and USBR 1996). The primary fish screens are composed of a series of V-shaped bays containing louver systems resembling Venetian blinds that act as a behavioral barrier to fish. The secondary fish screen is a perforated plate, positive-pressure screen, which removes fish greater than about 20 mm in length. Salvaged fish are transported in trucks to one of several Delta release sites. Despite recent improvements in salvage operations, survival of species that are more sensitive to handling, such as delta smelt, is believed to be low (DWR and USBR 1994 *as cited in* DWR and USBR 1996).

The fish screening and salvage facilities began operating in 1968 (Brown and Greene 1992 *as cited in* DWR and USBR 1996). In the early 1970s, CDFG and DWR initiated extensive evaluations of the facility that have led to improved performance and reduced fish losses. Most of this effort focused on fall-run Chinook salmon, striped bass, and American shad. Screening efficiency studies have been proposed for delta smelt, but difficulties have arisen because the fish are susceptible to losses during handling and survive poorly in captivity. Alternative approaches are being investigated. A direct loss model has been developed by DWR and CDFG to estimate losses based on operations at the SWP south Delta facilities. This model can be used to estimate the effect of changes in operations on salmon and striped bass.

DWR conducts daily fish monitoring and fish salvage operations at the SWP Skinner Fish Facility. As part of the monitoring program at the Skinner Fish Facility, operations are monitored and information recorded on water velocities that affect louver guidance efficiency for various species and lifestages of fish, species composition, the occurrence of coded-wire tag (CWT) and other marked fish released as part of experimental investigations, the length-frequency distribution for various species, and other information used to evaluate and monitor fish salvage operations. Fish entering the salvage facilities are subsampled, identified and measured, and subsequently returned to the Delta through a trucking and release operation. Using data on the species composition and numbers of fish collected in each subsample, in combination with information on estimated louver guidance efficiency, the percentage of time and volume subsampled, and estimates of pre-salvage predation mortality and losses, an expanded estimate of fish salvage is then derived and reported on both a daily and monthly basis.

Examination of the numbers of various fish species salvaged at the SWP Skinner Fish Facility and CVP Tracy Fish Facility shows high variability on a seasonal basis and between years, reflecting variation in both the life history characteristics of many of the species and their vulnerability to salvage at the facility. Information on the seasonal and interannual variability in salvage for various species, in combination with results of daily operations and monitoring, serve as one of the important focuses for application of EWA assets in an effort to help reduce loss of various fish species at the export facilities.

In general, the majority of juvenile Chinook salmon (primarily fall-run Chinook salmon) are observed in salvage operations during the late winter and early spring (February through May), although juvenile salmonids are also observed during the late fall and winter (November through January), which may include yearling spring-run and fall-run salmon, late-fall-run salmon smolts, and pre-smolt winter-run juvenile salmon. Steelhead are primarily observed in salvage during the spring months (March and April), which is consistent with the general seasonal timing for steelhead smolt out migration. Striped bass are observed in salvage operations throughout the year, with the majority of juvenile striped bass occurring during the summer months (May through July). Similarly, delta smelt are observed in the salvage operations throughout the year, with the majority of juvenile delta smelt occurring during the late spring and early summer (May through July). Larger sub-adult and adult delta smelt are typically observed in the salvage operation more predominantly during the fall, winter, and early spring. Longfin smelt are primarily observed in the salvage operations during the spring (March through May) as juveniles, although larger sub-adult longfin smelt are also observed in the salvage operations during the fall. Sacramento splittail are also observed in salvage operations throughout the year, although the majority of splittail (young-of-the-year) occur during the spring and early summer (March through July). A variety of other resident and migratory fish species are also collected as part of both SWP and CVP salvage operations.

Fish that are not bypassed by the salvage facility may survive passage through the pumps and enter the aqueduct. Fish, including striped bass and resident species, may rear in the canals and downstream reservoirs. These fish support recreational fisheries both in the aqueduct and in downstream reservoirs.

Harvey O. Banks Pumping Plant. The initial Banks Pumping Plant facilities, including seven pumps, were constructed in 1962. The pumping plant was completed in 1992 with the addition of four pumps. The total capacity of these eleven pumps is 10, 668 cfs, with two pumps rated at 375 cfs, five at 1,130 cfs, and four at 1,067 cfs. Water is pumped into the California Aqueduct, which extends 444 miles into southern California.

Total annual exports at the Banks Pumping Plant have greatly increased since construction of the initial facilities. Operation of the SWP, in combination with CVP export operations, influences the hydrologic conditions within south-Delta channels. For example, export operations have an effect on water surface elevations within the south-Delta and subsequently operations of a number of siphons and irrigation pump diversions, which is being addressed, in part, through seasonal construction and operations of temporary barriers within the south-Delta channels. Export operations also influence water currents (both the direction and velocity) within various south-

Delta channels, with the primary hydrologic effects occurring within Old and Middle rivers. Export operation effects on hydrologic conditions, and associated effects on habitat quality and availability for various fish and macroinvertebrates and the risk of entrainment and salvage at the SWP and CVP export facilities have been the subject of a number of programs. The Department of Water Resources (e.g., ISDP), State Water Resources Control Board, USFWS, NOAA Fisheries, and various experimental investigations including, but not limited to, the Vernalis Adaptive Management Plan (VAMP; San Joaquin River Group Authority 2002, 2003) and others have conducted investigations on operational effects in the south Delta. As a result of these various proceedings, a number of management actions, including seasonal reductions in SWP and CVP export rates relative to Delta inflow (export/inflow ratio) and other actions such as short-term reductions in export operations based on actual observed salvage of sensitive fish species as part of EWA actions and/or in response to biological opinions, have been implemented to reduce and/or avoid adverse effects of changes in hydrologic conditions and the vulnerability of species to salvage operations.

Currently, average daily diversions are limited during most of the year to 6,680 cfs, as set forth by U.S. Army Corps of Engineers criteria dated October 13, 1981. Diversions may be increased by one-third of San Joaquin River flow at Vernalis during mid-December to mid-March if that flow exceeds 1,000 cfs. The maximum diversion rate during this period would be 10,300 cfs, the nominal capacity of the California Aqueduct. In 2000 through 2002, the U.S. Army Corps of Engineers has authorized use of an additional 500 cfs of Banks Pumping Plant capacity in July through September, which has been used to make up export supply lost during pumping curtailments undertaken for fish protection. Permission to continue using the 500 cfs for this purpose for two more years has been requested by the EWA agencies, which would be used exclusively to divert water being transferred for the EWA Program.

Additional limitations on export pumping are imposed by the State Water Resources Control Board, under its authority to issue water rights permits for the SWP. From 1991 to 1994, exports were also restricted under the biological opinions for winter-run Chinook salmon and delta smelt. The May 1995 "Water Quality Control Plan" established further restrictions on exports (SWRCB 1995a *as cited in* DWR and USBR 1996).

South Delta Temporary Barriers. The Temporary Barriers Project, operated by DWR since 1991, has involved seasonally installing, operating, and removing temporary barriers in channels of the south Delta. The purpose of these barriers is to benefit local agricultural diversions by increasing water levels and circulation and to improve fishery conditions for up-migrating adult salmon and out-migrating smolts (DWR 1995a *as cited in* DWR and USBR 1996). A program was initiated in 1991 to assess the effects of temporary barriers on water quality, fisheries, and vegetation as a basis for predicting the effects of installing permanent barriers in the southern Delta.

The locations and periods of operation of the temporary barriers are as follows: Middle River near Victoria Canal, installed and operated from April 15 through September 30; Head of Old River, installed and operated from September 15 through November 30[3]; Grant Line Canal 1/4 mile east of Old River, installed and operated from April 15 through September 30; and Old River near Tracy, installed and operated from April 15 through September 30 (DWR 2000c). Some barriers have not been installed in some years because of varying hydrologic and hydrodynamic conditions, and concerns about endangered species.

The temporary barriers are constructed of rock and sand stockpiled for reuse when the barriers are removed. During the fall (and periodically the spring), the barrier on Old River at the confluence with the San Joaquin River (Head of Old River Barrier) is designed to impede flow from the San Joaquin River into Old River. The additional flow in the San Joaquin River helps maintain adequate dissolved oxygen concentrations for adult salmon migrating upstream (Hayes 1995 *as cited in* DWR and USBR 1996). The barrier is notched at the top in the fall to allow passage of salmon migrating up Old River to enter the San Joaquin River. During spring, the barrier remains fully closed to prevent downstream migrating salmon smolts in the San Joaquin River from entering Old River, with subsequent exposure to SWP, CVP, and agricultural diversions. In recent years, however, culverts have been installed in the barrier to improve water levels in the south Delta that allow some fish movement from the San Joaquin River into Old River. The other three temporary barriers are traversed by several buried 48-inch pipes, with flap gates on one end that allow unidirectional flow. These barriers operate by allowing water to flow through the pipes and flap gates during flood tides to fill the upstream channels. During ebb tides, the flap gates close to retain water in the channels. This operation maintains water levels and facilitates agricultural diversion of higher quality water.

The presence of the temporary barriers alters the patterns and volume of flow in south Delta channels. In particular, installation of the Old River barrier prevents San Joaquin River inflow to Old River, causing the SWP and CVP pumps to pull more water from the central Delta via Columbia Cut and Turner Cut (Resource Management International, Inc. [RMI] 1995 *as cited in* DWR and USBR 1996). Changes in the south Delta flow patterns affect the distribution and abundance of fishes in the south Delta as well as direct losses to the export facilities. The barriers may also alter survival of fall-run Chinook salmon smolts emigrating from the San Joaquin River (USBR and SJRGA 2001) and spawning migrations of adult salmon. Since the barriers provide additional cover for fish predators, predation loss of juvenile fish at the barriers is probably increased.

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[3] The Head of Old River barrier also has been installed periodically from April 15 through May 30 (in 1992, 1994, 1996, 1997, 2000, and 2003).

9.1.2.2.2 Central Valley Project Facilities

The USBR operates Central Valley Project (CVP) facilities in the Delta, including the Tracy Pumping Plant, Tracy Fish Collection Facility, and Delta Cross Channel.

Tracy Pumping Plant. The Tracy Pumping Plant is located adjacent to Clifton Court Forebay. (See Figure 9-4.) The plant pumps directly from the Old and Middle rivers. Its pumping capacity is 4,600 cfs, which is supplied to the Delta-Mendota Canal.

Tracy Fish Collection Facility. Fish salvage facilities at the Tracy Pumping Plant are composed of a system of primary and secondary louvers (Brown and Greene 1992 *as cited in* DWR and USBR 1996). Four bypasses placed equidistantly along the screen face direct fish from the primary louvers to a secondary set of louvers, where they are concentrated and bypassed to holding tanks. Salvaged fish are periodically transferred by truck to a release point in the Delta.

The Tracy pumps are usually operated continuously, and because water is drawn directly from the Delta, pumping is subject to tidal influence, causing variation in channel velocity and approach velocities to fish screens (Brown and Greene 1992 *as cited in* DWR and USBR 1996). There has never been a complete field evaluation of the efficiency of the fish protection facility, although fish loss and salvage are monitored closely. CDFG conducted efficiency tests on the primary louver system, which revealed that striped bass longer than 24 mm were effectively screened and bypassed. However, planktonic eggs, larvae, and juveniles less than 24 mm in length received no protection from entrainment (Hallock et al. 1968 *as cited in* DWR and USBR 1996). The tests also indicated that juvenile Chinook salmon would be effectively screened because they would be greater than 24 mm in length by the time they were exposed to the screens and pumps. Screening efficiency for delta smelt has yet to be determined.

Delta Cross Channel and Georgiana Slough. The Delta Cross Channel near Walnut Grove (Figure 9-5) was constructed in 1951. It conveys Sacramento River water into eastern Delta channels (including the north and south forks of the Mokelumne River) to supply the southern Delta with water for export via CVP and SWP pumps. Two radial gates near the Sacramento River entrance to the channel regulate flow through the Cross Channel. The gates can be closed to provide flood control protection to interior Delta channels.

Georgiana Slough, a natural, unregulated channel about one mile downstream of the Delta Cross Channel, can convey Sacramento River water to the San Joaquin River. Georgiana Slough is not a component of the CVP, but because of the similarities between Georgiana Slough and the Delta Cross Channel in their effects on flows and on fish, it is logical to discuss these two features together.

Approximately 25 to 40 percent of Sacramento River flow enters the central Delta through the Cross Channel when both gates are open. During moderate Sacramento River flows, about 16.5 percent of its flow is diverted through Georgiana Slough. The rate of diversion in Georgiana Slough increases when the Delta Cross Channel gates are closed. Thus, roughly 15 to 50 percent of the Sacramento River flow is diverted into the central Delta, based on mean monthly DWR estimates (DWR and USBR 1996). The hydraulic capacities of the Delta Cross Channel and Georgiana Slough physically limit the amount of flow of Sacramento River water that can be conveyed toward the pumping plants in the south Delta. This limitation can result in insufficient flows to meet pumping demand, which results in water being drawn from the San Joaquin River. When this "reverse flow" condition occurs, water is drawn from downstream areas upstream toward the pumps from the lower rivers.

The principal fisheries concern with respect to the Delta Cross Channel and Georgiana Slough is that many emigrating juvenile anadromous fish produced in the Sacramento River drainage are shunted into the central and southern Delta. A number of studies have been conducted to evaluate the effects of Delta cross-channel gate operations and the movement of juvenile salmonids from the Sacramento River into Georgiana Slough, and resulting changes in juvenile salmonid survival rates. Juvenile Chinook salmon survival investigations begun in the 1980s by USFWS using coded-wire tag mark-recapture techniques to evaluate the effects of Delta cross-channel gate operations on juvenile Chinook salmon survival (Kjelson et al. 1989 *as cited in* DWR and USBR 1996). These mark-recapture studies are continuing to date by USFWS to further investigate the effects of cross-channel gate operations and the movement of juvenile salmonids from the Sacramento River into Georgiana Slough under various export conditions during both the spring and winter periods of salmonid emigration. Additional studies have been recently conducted to examine the effects of Delta cross-channel gate operations on local hydraulic conditions and juvenile salmonid behavior using a multi-disciplinary approach involving extensive water velocity monitoring, drogue studies (studies to define water current patterns), hydroacoustic surveys, and experiments with coded wire tagged and radio tagged salmon to monitor juvenile salmonid behavior (Herbold et al. unpublished data). Other investigations, such as the application of an underwater acoustic barrier for reducing the movement of juvenile salmonids from the Sacramento River into Georgiana Slough (San Luis and Delta-Mendota Water Authority and Hanson 1996), have also been investigated in an effort to better identify management actions that would reduce potential adverse affects on juvenile salmonids and other fish species within the area. Many of these studies have demonstrated that juvenile Chinook salmon, and other species, are diverted from the Sacramento River through either the Delta cross-channel or Georgiana Slough. The migration routes through the central Delta to the ocean are longer and less direct than the Sacramento River route, exposing out migrating fish to greater predation and diversion risks. There are a large number of small, unscreened diversions in the central Delta and in other areas that entrain small fish. Fish that avoid entrainment in the small agricultural diversions may pass into the southern Delta, where they are vulnerable to mortality at the SWP or CVP export facilities. Nearly all the species of special concern are affected by Cross Channel operations, including all races of Chinook salmon, steelhead, American shad, striped bass, and green and white sturgeon. Delta smelt are potentially affected by Cross Channel operations both during upstream migrations by spawning adults and during downstream transport of larvae.

Initial studies on adult Chinook salmon movement in relation to DCC gate operations have also been conducted. Using both sonic tags and acoustic tracking, adult salmon were shown to utilize the DCC as a migration route to the Sacramento River and were not found to congregate behind DCC gates when they were closed. Further investigations designed to elucidate the relationship between adult Chinook salmon movement and DCC gate operations are forthcoming (CALFED 2001).

The Delta Cross Channel is not screened. However, the gates of the Delta Cross Channel can be operated to reduce flow from the Sacramento River into the central Delta. The Bay-Delta standards contained in SWRCB D-1641 require the gates be closed from February 1 through May 20. In addition, the Delta Cross Channel gates may be closed for up to a total of 45 days during the November 1 through January 31 period for fisheries protection as requested by USFWS, NOAA Fisheries, and CDFG. During the November through January period, the Delta Cross Channel gates may be closed on short notice and may be closed on weekends. The Delta Cross Channel gates also may be closed for a total of 14 days during the May 21 through June 15 period, per the direction of USFWS, NOAA Fisheries, and CDFG (USBR 2003). Additionally, USBR standing operation procedures call for gate closure when flow on the Sacramento River reaches the 20,000 to 25,000 cfs range.

Studies have been conducted to coordinate operation of the Delta Cross Channel gates with the abundance of vulnerable life stages of various fish species upstream (e.g., juvenile spring-run Chinook salmon) using near real-time monitoring information.

9.1.2.2.3 Other Facilities

Other major facilities in the Delta that may affect fish include the Contra Costa Canal, the North Bay Aqueduct, the Pittsburg and Antioch power plants, and the Montezuma Slough Salinity Control Structure. These projects would neither affect nor be affected by the EWA Program alternatives and therefore are not included in this discussion.

9.1.2.3 Combined Downstream Effects of the SWP and CVP Facilities

Local effects of the SWP and CVP facilities on fish, such as export losses and Cross Channel and Georgiana Slough diversions, were included in the above discussions of the facilities. In addition to these effects, however, the SWP and CVP facilities influence downstream habitat conditions. These conditions include Delta outflow, the salinity field in the western Delta and the bays, the location of X_2, and the level of flow reversals in the lower San Joaquin River.

Delta Outflow. Water development has changed the volume and timing of freshwater flows through the Estuary. Each year, diversions reduce the volume of fresh water that otherwise would flow through the Estuary. During this century, the volume of the Estuary's fresh water supply that has been depleted each year by upstream diversions, in-Delta use, and Delta exports has grown from about 1.5 million acre-feet (MAF) to nearly 16 MAF. As a result, the proportion of Delta outflow depleted by upstream and Delta diversions has grown substantially.

Water development has also greatly altered seasonal flows into and through the Estuary. Flows have decreased substantially in April, May, and June and have increased slightly during the summer and fall (SFEP 1992). Seasonal flows influence the transport of eggs and young organisms through the Delta and into San Francisco Bay. Flows during the months of April, May, and June play an especially important role in determining the reproductive success and survival of many estuarine species including salmon, striped bass, American shad, delta smelt, longfin smelt, splittail, and others (Stevens and Miller 1983; Stevens et al. 1985; Herbold 1994; Meng and Moyle 1995 *as cited in* DWR and USBR 1996).

Salinity. In many segments of the Estuary, but particularly in Suisun Bay and the Delta, salinity is controlled primarily by freshwater flow. By altering the timing and volume of flows, water development has affected salinity patterns in the Delta and in parts of San Francisco Bay (SFEP 1992 *as cited in* DWR and USBR 1996).

Under natural conditions, the Carquinez Strait/Suisun Bay area marked the approximate boundary between salt and fresh water in the estuary during much of the year. In the late summer and fall of drier years, when Delta outflow was minimal, seawater moved into the Delta from San Francisco Bay. Beginning in the 1920s, following several dry years and because of increased upstream storage and diversions, salinity intrusions became more frequent and extensive.

Since the 1940s, releases of fresh water from upstream storage facilities have increased Delta outflows during summer and fall. These flows have correspondingly limited the extent of salinity intrusion into the Delta. Reservoir releases have helped to ensure that the salinity of water diverted from the Delta is acceptable during the summer and late fall for farming, municipal, and industrial uses (SFEP 1992 *as cited in* DWR and USBR 1996).

Salinity is an important habitat factor in the Estuary. Estuarine species characteristically have optimal salinity ranges, and their survival may be affected by the amount of habitat available within the species' optimal salinity range. Because the salinity field in the Estuary is largely controlled by freshwater outflows, the level of outflow may determine the surface area of optimal salinity habitat that is available to the species (Hieb and Baxter 1993; Unger 1994 *as cited in* DWR and USBR 1996).

Entrapment Zone Location and X_2. The entrapment zone is an area of the Estuary characterized by higher levels of particulates, higher abundances of several types of organisms, and maximal turbidity. It is commonly associated with the position of the 2 ppt salinity isopleth (X_2), but actually occurs over a broader range of salinities (Kimmerer 1992 *as cited in* DWR and USBR 1996). Originally, the primary mechanism responsible for this area was thought to be gravitational circulation, a circulation pattern formed when freshwater flows seaward over a dense, landward-flowing marine tidal current. However, recent studies have shown that gravitational circulation does not occur in the entrapment zone in all years, nor is it always associated with X_2 (Burau et al. 1995 *as cited in* DWR and USBR 1996). Lateral circulation within the Estuary or chemical flocculation may play a role in the formation of the turbidity maximum of the entrapment zone.

As a consequence of higher levels of particulates, the entrapment zone may be biologically significant to some species. Mixing and circulation in this zone concentrates plankton and other organic material, thus increasing food biomass and production. Larval fish such as striped bass, delta smelt, and longfin smelt may benefit from enhanced food resources. Since about 1987, however, the introduced Asian clam population has reduced much of the primary production in the Estuary and there has been virtually no enhancement of phytoplankton production or biomass in the entrapment zone (CUWA 1994 *as cited in* DWR and USBR 1996).

Although little to no enhancement of the base of the food chain in the entrapment zone may have occurred during the past decade, this area continues to have relatively high levels of invertebrates and larval fish. Vertical migration of these organisms through the water column at different parts of the tidal cycle has been proposed as a possible mechanism to maintain high abundance in this area, but recent evidence suggests that vertical migration does not provide a complete explanation (Kimmerer *as cited in* DWR and USBR 1996).

Although recent evidence indicates that X_2 and the entrapment zone are not as closely related as previously believed (Burau et al. 1995 *as cited in* DWR and USBR 1996), X_2 continues to be used as an index of the location of the entrapment zone or area of increased biological productivity. Historically, X_2 has varied between San Pablo Bay (River km 50) during high Delta outflow and Rio Vista (River km 100) during low Delta outflow. In recent years, it has typically been located between approximately Honker Bay and Sherman Island (River km 70 to 85). X_2 is controlled directly by the volume of Delta outflow, although changes in X_2 lag behind changes in outflow. Minor modifications in outflow do not greatly alter the X_2 location. The location of X_2 during the late winter through spring (February through June) is included as a regulatory requirement in the 1995 Water Quality Control Plan.

Jassby et al. (1994 *as cited in* DWR and USBR 1996) showed that when X_2 is in the vicinity of Suisun Bay, several estuarine organisms tend to show increased abundance. However, it is by no means certain that X_2 has a direct effect on any of the species. The observed correlations may result from a close relationship between X_2 and other factors that affect these species. More information is needed to better understand these relationships.

Reverse Flows. Reverse flows (also referred to as QWEST) occur when Delta exports and agricultural demands exceed San Joaquin River inflow plus Sacramento River inflow through the Delta Cross Channel, Georgiana Slough, and Threemile Slough. The capacities of the Cross Channel, Georgiana Slough, and Threemile Slough are fixed, so if pumping rates exceed that total capacity plus flows in Old River and Eastside streams, the pumping causes Sacramento River water to flow around the west end of Sherman Island and then eastward up the San Joaquin River. This condition occurs frequently during dry years with low Delta inflows and high levels of export at the SWP and CVP pumps. Reverse flows are particularly common during summer and fall when nearly all exported water is drawn across the Delta from the Sacramento River (DWR and USBR 1994 *as cited in* DWR and USBR 1996).

There have been concerns regarding the effects of reverse flows on fish populations and their food supply (DWR and USBR 1994 *as cited in* DWR and USBR 1996). These concerns have focused mainly on planktonic egg and larval stages of species such as striped bass, delta smelt, splittail, and American shad. Even when these species do not spawn to a significant extent in the southern Delta, eggs and larvae may be transported into the area by reversed flows in the Middle and Old rivers. As discussed previously, these early life stages are generally entrained, since they are too small to be effectively screened from export waters. The effects of reverse flows on downstream migrating juvenile Chinook salmon and steelhead have also been identified as an area of concern by resource agencies. Pilot studies on the effect of Delta Cross Channel operations on the movement of juvenile Chinook salmon in the Delta indicated that yearlings will move into the Delta Cross Channel during flood tides, and can be drawn into the channel after initially migrating past the channel gates (CALFED 2001). The closure of the gates as required by D-1644 occurs during this period of Chinook salmon juvenile migration. Additional discussion regarding local effects of the SWP and CVP pumping facilities on fish associated with the Delta Cross Channel and Georgiana Slough is provided in Section 9.1.2.2.2, Central Valley Project Facilities.

9.1.3 Export Service Area

The Area of analysis for the Export Service Area consists of San Luis Reservoir, Anderson Reservoir, Castaic Lake, Lake Perris, Diamond Valley Lake, and Lake Mathews. Details regarding the facilities and water bodies within the Area of analysis for the Export Service Area and the fisheries resources they support are provided below.

9.1.3.1 San Luis Reservoir

San Luis Reservoir is located in Merced County at an elevation of 543 feet above msl and has a storage capacity of 2,039 TAF. It was constructed as a storage reservoir for the Federal CVP and the California SWP and stores runoff water via the California Aqueduct and the Delta-Mendota Canal. Water is pumped from the O'Neil Forebay into the main reservoir during the winter and spring. San Luis Reservoir provides habitat for both coldwater and warmwater fisheries. The game fish found in San Luis Reservoir include largemouth bass, crappie, sunfish, striped bass, and bullhead catfish. Fish production in San Luis Reservoir is generally limited by changes in water elevations during critical spawning periods, overall reservoir levels, and the availability of shallow near-shore rearing habitat. Los Banos Creek Reservoir was built to prevent storm runoff from flooding the canals and is known in the area for its' excellent fishing. Stocking by CDFG keep the reservoir well supplied with trout. Bass fishing derbies are often held here, and crappie and bluegill are also caught.

9.1.3.2 Anderson Reservoir

Anderson Reservoir is located in the Coyote Creek watershed of central Santa Clara County. Coyote Creek is a south-to-north trending drainage that discharges into the southern end of South San Francisco Bay. Anderson Reservoir is managed by the Santa Clara Valley Water District for water supply and flood control purposes. Anderson Reservoir is filled in the winter and spring using runoff collected from within the watershed, and from San Luis Reservoir. When full, the reservoir holds 111,198 acre-feet. At present, the District maintains a minimum pool amount of 20,000 acre-feet for summer recreation and emergency storage.

The fishery in Anderson Reservoir is self-propagating; the reservoir is not stocked and currently there are no plans for stocking it. The fish population is game fish, including trout, bass, and other predatory fish. The minimum pool size to maintain the fish population is 4,000 acre-feet.

Coyote Creek below Anderson Reservoir is habitat for fall-run Chinook salmon and steelhead trout. The Anderson Reservoir dam is a barrier to fish migration into the remaining portion of the watershed. Salmon and trout are known to spawn in the stretch of Coyote Creek near the base of the dam. Currently less than 100 salmon and trout are observed in Coyote Creek each year[4]. The District has entered into a cooperative agreement with fish management agencies (CDFG, USFWS, and NOAA Fisheries) and conservation groups to alter releases from Anderson Reservoir in a manner to benefit spawning salmon and trout.

9.1.3.3 Castaic Lake

Castaic Lake is located in Los Angeles County approximately 45 miles northwest of the City of Los Angeles, at an elevation of 1,515 feet above msl. It is the terminal reservoir on the West Branch of the State Water Project. It was designed and built by the DWR and has 323,700 acre-feet of storage capacity, 2,240 acres of surface area, and about 29 miles of shoreline. Castaic Lagoon located immediately downstream of Castaic Lake, provides a recreation pool with a constant water surface elevation and functions as a recharge facility for the downstream groundwater basin. Castaic Lake supports largemouth bass, striped bass, bluegill, rainbow trout, crappie and catfish. Castaic Lagoon supports similar species as Castaic Lake, excluding striped bass. CDFG stocks rainbow trout every other week from October through June.

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[4] Coyote Creek, Stevens Creek, and Guadalupe River Watersheds – Fisheries and Aquatic Habitat Collaborative Effort: Summary Report. February 26, 2003. (Akin, et al.)

9.1.3.4 Lake Perris

Lake Perris is located in Riverside County, approximately 65 miles southeast of downtown Los Angeles at an elevation of 1,590 feet above msl. It is the southern terminus of the State Water Project's East Branch of the California Aqueduct. The lake has ten miles of shoreline and its gross storage capacity is approximately 131,500 acre-feet. Lake Perris has 2,320 acres of surface area, with a mean depth of only 57 feet, and becomes thermally stratified during the summer months. It has a slightly larger surface area than Castaic Lake and yet has only half the capacity. Lake Perris was the first lake in Southern California to be stocked with Alabama spotted bass. Other fish include rainbow trout, channel catfish, largemouth and spotted bass, and bluegill. CDFG stocks the rainbow trout twice per month fall through spring.

9.1.3.5 Diamond Valley Lake

Diamond Valley Lake is located between Temecula and Hemet in Riverside County at an elevation of 1,756 feet above msl. The reservoir is 4.5 miles long, over two miles wide, and has a maximum depth of 260 feet. It is owned and operated by the Metropolitan WD. The reservoir is supplied by water diverted from the Delta and from the Colorado River and conveyed to the reservoir site. The reservoir completed filling in December 2002 and became operational in January 2003. Total storage capacity for Diamond Valley Lake is 800 TAF and surface area is 4,500 acres.

9.1.3.6 Lake Mathews

Lake Mathews Reservoir was completed in 1939 by the Metropolitan Water District of Southern California as the western terminus for the Colorado River Aqueduct. Lake Mathews is located within Riverside County approximately five miles southeast of Corona and three miles south of Riverside. Before the construction of Diamond Valley Reservoir, Lake Mathews was the largest reservoir operated by Metropolitan WD, and it remains the oldest. Lake Mathews holds up to 182,000 acre-feet.

The lands immediately surrounding the lake have been held by the Metropolitan WD, and human intrusions have been few. As Riverside continued to grow during the latter part of the century, surrounding areas began to be developed primarily as custom-built homes on small ranchettes. Additionally, since the 1930s, many of the surrounding lands were and continue to be used for citrus agriculture. In July 1997, the SWRCB approved a resolution project for the Drainage Water Quality Management Plan (DWQMP) for the Lake Mathews Watershed Project. As part of a mitigation plan for its water projects, and recognizing the value to wildlife of such a large, open source of water, the Metropolitan WD lands (approximately 4,000 acres) surrounding the lake were formally designated as a State Ecological Reserve in 1982.

Public access on the Reserve is limited to non-Metropolitan WD lands only, and the lake is not open for public recreation. The Reserve is open daily from dawn to dusk, but since motorized vehicles are not allowed on Reserve lands, access to these non-Metropolitan WD lands is by foot or horse travel only (CNLM 2003). Lake Mathews is not currently stocked with fish and there are no plans for stocking it in the future. The reservoir is also not open for fishing (CNLM 2003). Due to the lack of stocking and fishing activity at Lake Mathews, there is limited information available regarding the fisheries resources within this reservoir.

9.2 Environmental Consequences/Environmental Impacts

9.2.1 Assessment Methods/Hydrologic Model Summary

Extensive hydrologic, water temperature, and early lifestage salmon mortality modeling was performed to provide a quantitative basis from which to assess potential diversion-related effects of the EWA Flexible Purchase Alternative on fisheries resources and aquatic habitats within the Area of analysis. The Fixed Purchase Alternative would involve the same actions as the Flexible Purchase Alternative, but to a lesser degree. Hydrologic modeling was not completed for the Fixed Purchase Alternative because the quantity of water that could be purchased from the Upstream from the Delta Region is small (35 TAF) and differences (if any) in the modeling output would not represent meaningful changes from the Baseline Condition. Instead, potential impacts associated with implementation of the Fixed Purchase Alternative were analyzed on a qualitative basis, in relation to the hydrologic modeling results for the maximum amount of water that could be purchased under the Flexible Purchase Alternative. Data generated as part of the Flexible Purchase Alternative analysis is also used to approximate the in-Delta fishery impacts that could occur under the Flexible Purchase Alternative. Detailed information regarding the alternatives considered for analysis is provided in Chapter 2, Alternatives, Including the Proposed Action/Proposed Project. The analysis of the Flexible Purchase Alternative incorporates implementation of the variable operational assets of the EWA, including relaxation of the export/inflow (E/I) ratio, and SWP pumping of instream improvement flows upstream from the Delta utilizing CVPIA b(2) and Ecosystem Restoration Program water, as described in Attachment 1, Modeling Description.

Modeling output provided monthly values for each year of the 72-year period of record modeled for river flows, reservoir storage and elevation, and for each year of the 69-year hydrologic simulation period modeled for river water temperatures. The period of record for water temperature modeling is shorter because it is based on records through 1990, whereas the period of record for CALSIM II extends through 1993. River water temperature output was then used in Reclamation's Chinook salmon mortality models to characterize water temperature-induced losses of early lifestages of Chinook salmon under each simulated condition. Output from the salmon mortality models provided estimates of annual (rather than monthly mean) losses of emergent fry from egg potential (all eggs brought to the river by spawning adults), which is presented in terms of survival. Diversion-related resource assessments are based on comparisons made between computer model simulations that represent baseline and Flexible Purchase Alternative hydrologic conditions.

The models used in this analysis (CALSIM II, a Yuba River basin model, post-processing tool, reservoir temperature models, American and Sacramento river water temperature models, and the lower American and Sacramento river Chinook salmon early lifestage mortality models) are tools that have been developed for comparative planning purposes, rather than for predicting actual river conditions at specific locations and times. The 72-year and 69-year periods of record for CALSIM II and water temperature modeling, respectively, provide an index of the kinds of changes that would be expected to occur with implementation of a specified set of operational conditions. Reservoir storage, river flows, water temperature, and salmon survival output for the period modeled should not be interpreted or used as definitive absolutes depicting actual river conditions that will occur in the future. Rather, output for the Flexible Purchase Alternative can be compared to that for the Baseline Condition simulation to determine:

- Whether reservoir storage or river flows and water temperatures would be expected to change with implementation of the Flexible Purchase Alternative;
- The months in which potential reservoir storage and river flow and water temperature changes could occur; and,
- A relative index of the magnitude of change that could occur during specific months of particular water year types, and whether the relative magnitude anticipated would be expected to result in effects on fish resources within the regional area.

The models used, although mathematically precise, should be viewed as having "reasonable detection limits." Establishing reasonable detection limits is useful to those using the modeling output for impact assessment purposes, and prevents making inferences: 1) beyond the capabilities of the models; and 2) beyond an ability to actually measure changes. Although data from the models are reported to the nearest 1,000 acre-feet (AF), foot in elevation, cubic foot per second (cfs), tenth of a degree Fahrenheit (°F), and tenth of a percent (%) in salmon mortality, these values were rounded when interpreting differences for a given parameter between two modeling simulations. For example, two simulations having river flows at a given location within one percent of each other were considered to be essentially equivalent. Because the models also provide reservoir storage data on a monthly time step, measurable differences in reservoir storage were evaluated similarly. Similar rounding of modeled output was performed for other output parameters in order to assure the reasonableness of the impact assessments.

In-situ temperature loggers were used to collect water temperature data used for the model. These loggers typically have a precision of ±0.36°F, yielding a potential total error of 0.72°F (Sacramento River Temperature Modeling Project 1997). Therefore, modeled differences in water temperature of 0.36°F or less could not be consistently detected in the river by actual monitoring of water temperatures. In addition, as mentioned above, output from Reclamation's water temperature models provides a "relative index" of water temperatures under the various operational conditions modeled. Output values indicate whether the water temperatures would be expected to increase, remain unchanged, or decrease, and provide insight regarding the relative magnitude of potential changes under one operational condition compared to another. For the purposes of this impact assessment, modeled water temperature changes that were within 0.3°F between modeled simulations were considered to represent no measurable change (were considered to be "essentially equivalent"). A level of detection of measurable change of 0.3°F was used because: 1) model output is reported to the one-tenth degree Fahrenheit; 2) rounding the level of error associated with in-situ temperature loggers used for model temperature data up to 0.4°F would eliminate the possibility of detecting measurable change between 0.36°F and 0.4°F; and 3) rounding the level of detection down to 0.3°F is the more conservative approach in detecting a change in temperature between the modeling results. Temperature differences between modeling results of more than 0.3°F were assessed for their biological significance. This approach is considered very rigorous, because it utilizes a more conservative threshold of detection for potential water temperature changes than used in other fisheries impact assessments. For example, USFWS and Reclamation, in the Trinity River Mainstem Fishery Restoration Draft EIS/EIR (USFWS et al. 1999), used a change in long-term average water temperature of 0.5°F as a threshold of significance, and the Central Valley Regional Water Quality Control Board (RWQCB) generally uses a change of 1.0°F or more as a threshold of significance.

Attachment 1, Modeling Description, provides a more detailed discussion of the modeling process and its application to the EWA Program analysis, including: a) the primary assumptions and model inputs used to represent hydrologic, regulatory, structural and operational conditions; and b) the simulations performed from which effects were estimated.

EWA assets may be managed or purchased from facilities that are not part of the State or Federal water projects. These facilities, referred to throughout the document as "non-Project" facilities, are not included in the CALSIM II model of CVP/SWP operations. Therefore CALSIM II hydrologic modeling output is not available for these facilities. The methodologies used to predict comparative operational scenarios under Flexible Purchase Alternative and Baseline Condition is included in the discussions that follow. Organizationally, methods for the determination of potential impacts on reservoir fish species are presented first (Section 9.2.1.1), followed by discussions of riverine and Delta impact assessment methodologies (Sections 9.2.1.2 and 9.2.1.3, respectively).

9.2.1.1 Reservoir Fish Species

EWA acquisitions could result in alterations to storage and water surface elevations for CVP/SWP and non-Project reservoirs within the Area of analysis. The following reservoirs potentially could be affected by EWA acquisitions:

- Shasta
- French Meadows
- Anderson

- Little Grass Valley
- Sly Creek
- Oroville
- New Bullards Bar
- Hell Hole
- Folsom
- McClure
- San Luis
- Castaic
- Perris
- Mathews
- Diamond Valley

Fluctuations in these reservoirs, in response to day-to-day operations and changes in runoff patterns, can potentially affect reservoir fish species due to alterations in the timing and magnitude of reservoir drawdowns. Methods used to determine potential effects on reservoir fish species within CVP/SWP reservoirs are discussed below in Section 9.2.1.1.1. Methods used to determine potential impacts on reservoir fish species within non-Project reservoirs upstream from the Delta are discussed in Section 9.2.1.1.2, and reservoirs in the Export Service Area are discussed in Section 9.2.1.1.3.

9.2.1.1.1 CVP/SWP Reservoirs (Shasta, Oroville, and Folsom reservoirs)

The methodologies used to analyze potential impacts on reservoir warmwater and coldwater fish species in Project reservoirs are discussed below.

Warmwater Fisheries

Because warmwater fish species of Shasta, Oroville, and Folsom reservoirs (including largemouth bass, smallmouth bass, spotted bass, green sunfish, crappie, and catfish) use the warm upper layer of the reservoir and nearshore littoral habitats throughout most of the year, seasonal changes in reservoir storage, as it affects reservoir water surface elevation (feet msl), and the rates at which water surface elevation change during specific periods of the year, can directly affect the reservoir's warmwater fish resources. Reduced water surface elevations can reduce the availability of nearshore littoral habitats used by warmwater fish for spawning and rearing, thereby reducing spawning and rearing success and subsequent year-class strength. In addition, decreases in reservoir water surface elevation during the primary spawning period for nest building, warmwater fish may result in reduced initial year-class strength through warmwater fish nest "dewatering." Given the geographic and altitudinal differences among the reservoirs within the Area of analysis, warmwater fish spawning and rearing periods vary somewhat among reservoirs analyzed. For this analysis, the warmwater fish-spawning period is assumed to extend from March through June, and the warmwater fish-rearing period is assumed to extend from April through November.

Although black bass spawning may begin as early as February, or as late as May, in southern and northern California reservoirs, respectively, and may possibly extend to July in some waters, the majority of black bass spawning in California occurs from March through May (Lee 1999). However, given the geographical and altitudinal variation among the Project reservoirs, in order to examine the potential of nest dewatering events to occur, the warmwater fish spawning period is assumed to extend from March through June.

To encompass all reservoirs included in the EWA Program, the period of April through November is most appropriate for warmwater juvenile fish rearing.

To assess potential elevation-related effects on the warmwater fish of Shasta and Folsom reservoirs, the following two-phased approach was used. First, the magnitude of change (feet msl) in reservoir water surface elevation occurring each month of the primary spawning period for nest-building fish (March through June) under the Flexible Purchase Alternative was determined and compared to that modeled for the Baseline Condition. A recent study by CDFG, which examined the relationship between reservoir elevation fluctuation rates and nesting success for black bass, suggests that a reduction rate of 0.15, 0.18, and 0.39 meter per day (m/day) or greater would result in 100 percent nest mortality (or zero percent nest survival) for largemouth bass, smallmouth bass, and spotted bass, respectively (Lee et al. 1998). However, CDFG reservoir biologists suggest that, on the average, a nest survival rate of at least 20 percent is necessary to maintain the long-term population levels of high-fecundity, warmwater fish (D. Lee, pers. comm. 1998). Using nest survival curves developed by CDFG (Lee et al. 1998), reservoir fluctuation criteria were developed that would provide a minimum nest survival rate of approximately 20 percent for largemouth bass, the bass species found by CDFG to be most sensitive to reservoir elevation fluctuations.

A reduction rate of nine feet per month would represent an approximate water surface elevation decrease of 0.3 feet per day (ft/day) (0.09 m/day). If such a reduction would occur during a nesting event, it would correlate to an approximate nest survival rate of 20 percent for largemouth bass. Therefore, a decrease in Shasta, Oroville, or Folsom reservoirs water surface elevation of nine feet or more per month was selected as the threshold beyond which spawning success of nest-building, warmwater fish could potentially result in long-term population declines. To evaluate effects on largemouth bass, and ultimately warmwater fish in general, the number of times that reservoir reductions of nine feet or more per month could occur under the Flexible Purchase Alternative was compared to the number of occurrences that were modeled under the Baseline Condition.

Criteria for reservoir elevation increases (nest flooding events) have not been developed by CDFG. Because of overall reservoir fishery benefits (e.g., an increase in the availability of littoral habitat for warmwater fish rearing), greater reservoir elevations that would be associated with rising water levels would offset negative effects due to nest flooding (Lee 1999). Therefore, the likelihood of spawning-related effects from nest flooding is not addressed for reservoir fisheries.

Second, changes in the availability of nearshore littoral habitat were evaluated based on the relationship between reservoir water surface elevation and the quantity of nearshore littoral habitat containing submerged structure (submerged macrophytes and/or inundated terrestrial vegetation) (Water Forum 1999; PCWA and USBR 2002). Using this relationship, the mean number of acres of littoral habitat was estimated for each month of the primary rearing period (April through November) under the Flexible Purchase Alternative and compared to that modeled for the Baseline Condition. A relationship between water surface elevation and the quantity of submerged vegetation has not been established for Lake Oroville. Therefore, a qualitative assessment, more thoroughly described in Section 9.2.1.1.2, of the availability of littoral habitat was used for this location.

<u>Coldwater Fisheries</u>
During the period when Shasta, Oroville, and Folsom reservoirs are thermally stratified (April through November), coldwater fish within the reservoir reside primarily within the reservoir's metalimnion and hypolimnion where water temperatures remain suitable. Reduced reservoir storage (TAF) during this period could reduce the reservoir's coldwater pool volume, thereby reducing the quantity of habitat available to coldwater fish species during these months. Reservoir coldwater pool size generally decreases as reservoir storage decreases, although not always in direct proportion because of the influence of reservoir basin morphometry. Therefore, to assess potential storage-related effects on coldwater fish habitat availability in Shasta, Oroville, and Folsom reservoirs, end-of-month storage modeled for each year of the 72-year period of record under the Flexible Purchase Alternative was compared to end-of-month storage under the Baseline Condition for each month of the April through November period. Substantial reductions in reservoir storage were considered to result in substantial reductions in coldwater pool volume and, therefore, habitat availability for coldwater fish. Effects on the coldwater fisheries were further assessed by determining whether seasonal changes in reservoir storage, and associated changes in water-surface elevation, would be expected to indirectly affect coldwater fish species by adversely affecting the productivity of their primary prey species (threadfin shad (*Dorosoma petenense*) and wakasagi (*Hypomesis hipponensis*)).

<u>Lake Natoma</u>
No storage- or elevation-related impacts on fishery resources of Lake Natoma are expected to occur under the Flexible Purchase Alternative, relative to the basis of comparison. As a regulating afterbay of Folsom Reservoir, its monthly storage and elevation fluctuate significantly on a daily and hourly basis. Therefore, changes in releases from Folsom Reservoir would not significantly affect monthly mean storage or elevation, relative to the Baseline Condition. Consequently, no quantitative assessment of potential storage- or elevation-related impacts on fishery resources in this water body is warranted.

Because changes in CVP/SWP operations under the EWA alternatives could alter the temperature of water released from Folsom Dam (because of limited coldwater pool availability), and because Lake Natoma's temperature at any given time is largely dictated by the temperature of water released from Folsom Dam, these additional diversions could change seasonal water temperatures within Lake Natoma. The small changes in lake temperatures that could occur would not be expected to adversely affect the lake's warmwater fisheries. Conversely, increases in lake temperatures could adversely affect coldwater species such as rainbow trout stocked by CDFG. To assess the potential impacts of altered lake temperatures to fishery resources within the lake, monthly mean temperatures of water released from Nimbus Dam were determined for the Flexible Purchase Alternative and compared to monthly mean temperatures modeled under the Baseline Condition for each month of the year.

Temperatures of water released from Nimbus Dam were used as an "index" to represent the relative changes in Lake Natoma water temperatures that could occur under the Flexible Purchase Alternative, relative to the Baseline Condition.

9.2.1.1.2 Upstream from the Delta Region Non-Project Reservoirs

Several non-Project reservoirs upstream from the Delta could serve as potential water sources for the EWA. Because these non-Project reservoirs are not managed under the operations of either the CVP or SWP, they are not included in the CALSIM II hydrologic modeling simulations, and changes in monthly operations were evaluated using an alternate methodology. The methods used to evaluate potential impacts on fisheries resources are described in this section, and apply to the following reservoirs:

- Little Grass Valley
- Sly Creek
- New Bullards Bar
- Hell Hole
- French Meadows
- McClure

The range of fluctuation in surface water elevations for each non-Project reservoir is not expected to vary beyond annual operating ranges under the Baseline Condition, except in those facilities from which stored reservoir water would be purchased. Changes to the annual operational regimes of these reservoirs are not proposed under the EWA; however, the management of EWA assets within these facilities could result in seasonal changes in the timing of reservoir drawdown[5], which could affect rearing success and initial year-class strength of reservoir fisheries.

To evaluate the potential effects of EWA actions on reservoir fisheries, an analysis of seasonal changes in storage under baseline and Flexible Purchase Alternative conditions was performed. Median values for reservoir end-of-month storage under the Baseline Condition were obtained from historical records[6]. Estimates for reservoir storage levels under the Flexible Purchase Alternative were calculated by subtracting a portion of the acquisition quantity from the baseline median end-of-month storage levels, with the assumption that EWA acquisition amounts would be released evenly over a given period. Using reservoir specific area-capacity curves, estimates for storage changes were translated into relative changes in water surface elevations. The estimated values for changes in water surface elevations were used to conduct a qualitative analysis of the potential for increases in the frequency of nest dewatering

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[5] Limitations have been placed on the maximum volume of water potentially available to EWA from each non-Project reservoir, based upon reservoir size, operational constraints and the existing refill patterns within each basin. Additionally, EWA asset acquisitions must not result in a reduction of reservoir surface water elevation beyond the minimum reservoir drawdown levels as stated in the corresponding Federal Energy Regulatory Commission (FERC) license, where applicable. This documentation and any related material also was reviewed to ensure compliance with all appropriate regulatory requirements.

[6] Historical reservoir end-of-month storage was obtained from: DWR's California Data Exchange Center (DWR, 2002). Median values were computed because the historical period of record available for the non-Project reservoirs is substantially shorter than the period of record used for modeling simulations. Thus, mean estimates of change based on a shorter period of record are less likely to contain a representative frequency of water year types, and would be more likely to be skewed by extremely wet or dry water years.

events (decreases in water surface elevation of greater than nine feet per month during the spawning period), reductions in the availability of littoral habitat, and decreases in coldwater pool volume, to occur under the Flexible Purchase Alternative, relative to the Baseline Condition, as discussed in Section 9.2.1.1.1. Again, the time periods analyzed are March through June for spawning, and April through November for juvenile rearing.

Further discussion of using reservoir water surface elevation data to analyze impacts to warmwater fish juvenile rearing is warranted because of the assumptions that are necessary. A general relationship between mean water surface elevation and amount of littoral habitat is assumed to occur in the reservoirs for which this relationship has not been quantified (Oroville, New Bullards Bar, French Meadows, Hell Hole, Sly Creek, and McClure reservoirs). Specifically, higher mean water surface elevations are assumed to create more littoral habitat, therefore, more warmwater juvenile fish-rearing habitat. Usually, the optimum elevation for maximizing available littoral habitat for rearing is at or near the maximum reservoir elevation (Lee 1999). In most cases, the reservoir analyses are conducted when reservoir elevations are not at their maximum levels. Despite the necessary assumptions, analysis on impacts to warmwater fish rearing is conducted in order to identify potential impacts that may occur in reservoirs in which the relationship between reservoir surface elevation and amount (acres) of littoral habitat is not quantified.

9.2.1.1.3 Export Service Area Reservoirs

Several reservoirs within the Export Service Area could serve as potential water sources for the EWA, including San Luis Reservoir, Anderson Reservoir, Diamond Valley Lake, Castaic Lake, Lake Mathews, and Lake Perris, through source shifting. Changes in the seasonal timing of reservoir drawdown could affect existing fishery and aquatic resources in the reservoirs. Reduced water surface elevations could reduce the availability of nearshore littoral habitats used for warmwater fish for rearing and spawning, thereby reducing spawning and rearing success and subsequent year class strength. Reduced reservoir storage could also reduce the coldwater pool volume, thereby reducing the quantity of habitat available to coldwater fish in the reservoir.

Because reservoirs in the Export Service Area are not managed under the operations of either the CVP or SWP, they are not included in the CALSIM II hydrologic modeling simulations, and changes in monthly operations were evaluated using an alternate methodology. In order to assess whether implementation of the Flexible Purchase Alternative would affect reservoir fisheries at San Luis Reservoir, Anderson Reservoir, Diamond Valley Lake, Castaic Lake, Lake Mathews, and Lake Perris, a description of operational procedures under the Flexible Purchase Alternative and under the Baseline Condition were provided for each evaluated reservoir. Potential impacts on fisheries and aquatic resources were assessed by qualitatively comparing operations under the Flexible Purchase Alternative to operations under the Baseline Condition and assessing whether implementation of the Flexible Purchase Alternative would result in deviations from standard operating procedures.

9.2.1.2 Riverine Fish Species Hydrologic and Water Temperature Modeling

This section provides a description of the application of hydrologic and water temperature modeling output to identify potential effects on riverine fisheries and aquatic resources resulting from the implementation of the Flexible Purchase Alternative. Assessment methodologies are organized by river, from the Sacramento River south to the San Joaquin River, with further subdivisions based on species and lifestage, where appropriate. Specific impact assessment methodologies for salmonids are described in full for winter-run Chinook salmon in the Sacramento River. River-specific and run-specific differences in the application of the winter-run Chinook salmon assessment methodology are discussed for each river and/or run of Chinook salmon.

9.2.1.2.1 Sacramento River Area of Analysis

Changes in CVP/SWP operations under the EWA program could potentially alter seasonal Sacramento River flows and water temperatures, which could change the relative habitat availability for fish species that are present in the Sacramento River. The Sacramento River is utilized by a number of fish species of primary management concern, either as habitat during one or more of their life stages or as a migration corridor to upstream habitat in other river systems. For these reasons, species-specific impact assessments were warranted for this river system and were conducted for the following species of primary management concern:

- Winter-run Chinook salmon;
- Spring-run Chinook salmon;
- Fall-run Chinook salmon;
- Late-fall-run Chinook salmon
- Steelhead;
- Sacramento splittail;
- American shad; and
- Striped bass.

These species are of primary management concern due either to the importance of their commercial and/or recreational fisheries (fall-run Chinook salmon, steelhead, American shad, and striped bass) and/or because they are a species currently listed or proposed for listing under the Federal ESA and/or CESA (steelhead, winter-run and spring-run Chinook salmon, and Sacramento splittail). Because the species selected for species-specific assessments include those sensitive to changes in both river flow and water temperature throughout the year, an evaluation of effects on these species is believed to reasonably encompass the range of potential effects upon other Sacramento River fish species (e.g., green sturgeon) that could potentially be affected by EWA operations.

During some years, changes in CVP/SWP operations could potentially alter Sacramento River seasonal water temperatures. Changes in Sacramento River water temperatures that could occur as a result of the implementation of the Flexible Purchase Alternative would not be expected to be sufficiently large to adversely affect fish species present in the upper Sacramento River, with the possible exceptions of Chinook salmon and steelhead, which have low thermal tolerance. If implementation of the Flexible Purchase Alternative induced elevated water temperatures, then spawning and rearing success of these anadromous salmonids could be affected. Moreover, because: 1) thermal requirements of Chinook salmon and steelhead are generally similar; 2) the NOAA Fisheries Biological Opinion (BO) for Winter-run Chinook Salmon (NMFS 1993 as revised in 1995) has established quantitative temperature criteria for the upper Sacramento River to protect winter-run Chinook salmon; and 3) Reclamation has developed a Sacramento River Chinook Salmon Mortality Model applicable to all four runs of Chinook salmon, this assessment focused quantitatively on Chinook salmon. Impact findings for the four runs of Chinook salmon provide a technical basis from which to infer whether steelhead would be impacted by seasonal changes in water temperatures. For all runs of Chinook salmon in the Sacramento River, the time periods for the evaluation of potential effects on individual lifestages were based on life history descriptions from *Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest) – Chinook Salmon* (Allen and Hassler 1986).

EWA assets may be acquired from and/or stored in Lake Shasta on the Sacramento River. In addition, implementation of the Flexible Purchase Alternative could reduce agricultural return flows to Butte Creek, a tributary of the Sacramento River. Because of differences in management, fish passage, and species distribution, the Sacramento River and Butte Creek were evaluated separately.

Sacramento River

Winter-run Chinook Salmon

The analysis of potential impacts on winter-run Chinook salmon is based upon individual life-stages (adult immigration; spawning, incubation, and initial rearing; and juvenile rearing and emigration) because each lifestage exhibits preferences for different flow and temperature conditions.

Flow-related Effects

To assess flow-related effects on winter-run Chinook salmon, long-term average and monthly mean flows released from Keswick Dam (RM 302) and in the Sacramento River at Freeport (RM 46) simulated for the Flexible Purchase Alternative were compared to those simulated for the Baseline Condition. These comparisons were conducted for each of the following lifestages and time periods:

- Adult immigration (December through July);
- Spawning, incubation, and initial rearing (April through August); and
- Juvenile rearing and emigration (August through December).

In addition to the above assessment, the NOAA Fisheries BO for winter-run Chinook salmon provides flow criteria for the Sacramento River below Keswick Dam (NMFS 1993, as revised in 1995). NOAA Fisheries requires that Reclamation maintain a minimum release from Keswick Dam of 3,250 cfs from October 1 through March 31. To evaluate the potential for changes in CVP/SWP operations under the Flexible Purchase Alternative to result in changes in the frequency in which Sacramento River flow requirements are met, an assessment of flow levels below this threshold was conducted during the applicable lifestage. Thus, releases from Keswick Dam during December through March of the adult immigration period and during October through December of the juvenile emigration period were evaluated under the Flexible Purchase Alternative and compared to those simulated under the Baseline Condition to determine potential changes in the frequency of flows below the 3,250 cfs criterion.

No specific flow criteria have been identified for fish in the lower Sacramento River. Therefore, potential flow-related effects determinations for the lower Sacramento River were based on an evaluation of the frequency and magnitude of change in modeled monthly mean flow at Freeport, relative to the Baseline Condition.

Temperature-related Effects

Water temperature-related effects on Sacramento winter-run Chinook salmon were evaluated through three distinct assessments focusing on the distinct lifestages and periods, as described above. Temperature-related effects on individual winter-run Chinook salmon lifestages were based on water temperatures in the Sacramento River at Bend Bridge, Jelly's Ferry, and Freeport. The NOAA Fisheries BO for winter-run Chinook salmon typically manages for water temperature compliance at Bend Bridge and Jelly's Ferry based on runoff and storage conditions in Lake Shasta. Nearly all suitable spawning habitat for winter-run Chinook salmon is believed to be upstream of Red Bluff Diversion Dam (RM 243) (NMFS 1993; CDFG 2002) Freeport is provided as an additional location for passage (immigration and emigration) considerations.

Potential changes in the frequency of exceedance of temperature criteria, as established in the Winter-run Chinook Salmon BO, also were evaluated during each applicable lifestage. The BO specifies that:

- Daily average water temperatures not in excess of 56°F are required in the Sacramento River at Bend Bridge from April 15 through September 30; and

- Daily average water temperatures not in excess of 60°F are required in the Sacramento River at Bend Bridge from October 1 through October 31.

In dry water years, the location of the temperature compliance point is moved from Bend Bridge downstream to Jelly's Ferry. For all discussions that follow, if modeling output indicates that there would be instances in which either the 56°F or the 60°F water temperature criteria would be exceeded under the Flexible Purchase Alternative, relative to the Baseline Condition, a more detailed analysis of effects by individual water-year type and location were conducted. Although the NMFS (1993) water temperature criteria are stated as daily averages, the available hydrologic and water temperature models allow only for monthly mean temperature analyses and output. Consequently, this assessment was based on monthly mean water temperature data output from Reclamation's existing models.

<u>Adult Immigration (December through July)</u>

Long-term average and monthly mean water temperatures simulated for each month of the December through July period under the Flexible Purchase Alternative were compared to those under the basis of comparison at Bend Bridge, Jelly's Ferry, and Freeport in the Sacramento River. In addition, NOAA Fisheries temperature criteria are applicable from April through July of the adult winter-run Chinook salmon immigration period. For these months, the frequency of monthly mean water temperatures greater than 56°F was determined under the Flexible Purchase Alternative and compared to the frequency of index exceedance under the Baseline Condition.

<u>Spawning, Incubation, and Initial Rearing (April through August)</u>

Long-term average and monthly mean water temperatures simulated for each month of the April through August period under the Flexible Purchase Alternative were compared to those under the basis of comparison at Bend Bridge, Jelly's Ferry, and Freeport in the Sacramento River. In addition, NOAA Fisheries temperature criteria are applicable throughout the entire winter-run Chinook salmon spawning, incubation, and initial rearing period. For these months, the frequency of monthly mean water temperatures greater than 56°F was determined under the Flexible Purchase Alternative and compared to the frequency of index exceedance under the Baseline Condition.

Additionally, Reclamation's (1991) Sacramento River Chinook Salmon Mortality Model (LSALMON2) was used to assess potential temperature-related effects on the early lifestage survival of winter-run Chinook salmon, as well as the other runs of Chinook salmon in the Sacramento River. Model output represents the percentage of potential emergent fry produced, based on all eggs brought to the river by spawning adults, that would survive under the temperature regime that would occur under each model simulation. The LSALMON 2 model calculates temperature-induced mortality (the percentage of potential emergent fry lost as a result of temperature-induced mortality of pre-spawned eggs, fertilized eggs incubating in the gravel, and pre-emergent fry).

As discussed in the Trinity River Mainstem Fishery Restoration EIS/EIR (Trinity River EIS/EIR) (USFWS et al. 1999), the mortality model uses weekly average water temperatures obtained from the Sacramento River Water Temperature Model and tracks water temperature impacts on Chinook salmon egg and larval (sac-fry) development. Algorithms are used to compute the cumulative survival of eggs spawned in a particular week through fry emergence from the spawning gravel. Temperature mortality schedules (relationships) for Chinook salmon eggs and larvae were developed that establish temperature-related instantaneous daily mortality rates for modeling salmon losses. Recent (1990 through 1996) spawning distributions for winter-run Chinook salmon were used in the salmon mortality model (USFWS et al. 1999). The model uses spatial and temporal distribution information of spawning activity specific for each salmon run in the Sacramento River. Three river reaches, including Keswick to Balls Ferry (upper), Balls Ferry to Red Bluff (middle), and downstream of Red Bluff (lower) are used in the analysis of temperature-related mortality of Chinook salmon. Within each river reach, a specific temperature-related mortality estimate is calculated. From these three partial mortality estimates, a cumulative mortality estimate, for each run, is then calculated for each water year for the simulated period of record (69 years). The complement (survival = 100 - mortality) of these calculated percent losses are discussed for impact assessment purposes. For this analysis, annual early lifestage survival estimated for the Flexible Purchase Alternative was compared to that estimated for the Baseline Condition for each year of the 69-year period of record.

<u>Juvenile Rearing and Emigration (August through December)</u>

The same methodology described for adult winter-run Chinook salmon spawning, egg incubation, and initial rearing was used to evaluate potential water temperature-related effects on juvenile winter-run Chinook salmon rearing and emigration with the following modifications:

- The period of assessment was August through December;
- The number of years (of the 69 years modeled) that monthly mean water temperatures would exceed the index value of 65°F were determined at Bend Bridge, Jelly’s Ferry and in the Sacramento River at Freeport;
- Mean water temperatures for the years (of the 69 years modeled) during August through October that were shown to exceed the 56°F and 60°F index values identified in the NOAA Fisheries Biological Opinion were determined at Bend Bridge and Jelly’s Ferry; and

- Reclamation's Salmon Mortality Model was not used, because it does not assess mortality beyond the emergent fry lifestage.

The temperature index values for juvenile rearing and emigration are different from the indexes for spawning and incubation because adult and juvenile winter-run Chinook salmon are believed to tolerate water temperatures up to 65°F without substantial adverse effects, whereas incubating eggs and pre-emergent fry incur substantial reductions in survival when water temperatures exceed 56°F.

<u>Spring-run Chinook Salmon</u>

To assess flow- and temperature-related effects on spring-run Chinook salmon adult immigration, spawning, egg incubation and initial rearing, and juvenile rearing and emigration, the methodology described above for Sacramento River winter-run Chinook salmon was used with the following modifications:

- The adult immigration period was evaluated from March through September;
- The spawning/incubation and initial rearing was evaluated from August through January;
- The juvenile rearing and emigration period was evaluated from December through April;
- Although 56°F is used as an index temperature for spawning, egg incubation, and initial rearing, an analysis of the exceedance of NOAA Fisheries temperature criteria was not required, as no regulatory requirement exists for Sacramento River spring-run Chinook salmon; and
- Output for spring-run Chinook salmon from Reclamation's LSALMON2 Model was used to assess potential temperature-related effects on early lifestage survival for this salmon run.

<u>Fall-run Chinook Salmon</u>

To assess flow- and temperature-related effects on fall-run Chinook salmon adult immigration, spawning, egg incubation and initial rearing, and juvenile rearing and emigration, the methodology described above for Sacramento River winter-run Chinook salmon was used with the following modifications:

- The adult immigration period was evaluated from September through November;
- The spawning/incubation and initial rearing was evaluated from October through February;
- The juvenile rearing and emigration period was evaluated from February through June;

- Although 56°F is used as an index temperature for spawning, egg incubation, and initial rearing, an analysis of the exceedance of NOAA Fisheries temperature criteria was not required, as no regulatory requirement exists for Sacramento River fall-run Chinook salmon; and

- Output for fall-run Chinook salmon from Reclamation's LSALMON2 Model was used to assess potential temperature-related effects on early lifestage survival for this salmon run.

Late-fall-run Chinook Salmon

To assess flow- and temperature-related effects on late fall-run Chinook salmon adult immigration, spawning, egg incubation and initial rearing, and juvenile rearing and emigration, the methodology described above for Sacramento River winter-run Chinook salmon was used with the following modifications:

- The adult immigration period was evaluated from October through April;

- The spawning/incubation and initial rearing was evaluated from December through April;

- The juvenile rearing and emigration period was evaluated from April through October;

- Although 56°F is used as an index temperature for spawning, egg incubation, and initial rearing, an analysis of the exceedance of NOAA Fisheries temperature criteria was not required, as no regulatory requirement exists for Sacramento River fall-run Chinook salmon; and

- Output for late fall-run Chinook salmon from Reclamation's LSALMON2 was used to assess potential temperature-related effects on early lifestage survival for this salmon run.

Steelhead

Because environmental conditions required by steelhead are not significantly different from those required by fall-run Chinook salmon, impact indicators and significance criteria for steelhead are the same as for fall-run Chinook salmon. Flow- and temperature-related impact determinations for steelhead for the periods of September through November and February through June were based on the same modeling output used to assess effects on Sacramento River fall-run Chinook salmon during this period, and are discussed concurrently with potential impacts on fall-run Chinook salmon. However, because steelhead rear within the Sacramento River Basin year-round, additional flow and temperature impact assessments for over-summer and rearing juvenile steelhead were made for the months of the year not addressed by the fall-run Chinook salmon assessments (July through September and October through March). Flow- and temperature-related effects on steelhead rearing during the July through September and October through March periods were assessed via the same methods used to assess flow- and temperature-related effects on fall-run Chinook salmon during the February through June period.

For the temperature-related effects analysis, no steelhead mortality modeling could be performed as a part of the assessment for this species, because no steelhead mortality model has been developed for the Sacramento River. A fall-run Chinook salmon mortality model is available, however, as discussed in the Trinity River EIS/EIR, mortality estimates for late fall-run Chinook salmon can be used as a conservative surrogate for steelhead mortality estimates. Because it is likely that the actual number of steelhead spawning in the mainstem Sacramento River is likely to be much less than those spawning in tributaries to the Sacramento River (USFWS et al. 1999), potential adverse effects on steelhead populations, as a result of changes in water temperatures under the Flexible Purchase Alternative, would likely be less than that estimated via the late-fall run Chinook salmon mortality output (USFWS et al. 1999).

Splittail

Splittail move throughout the Sacramento-San Joaquin Delta, which serves as a migration corridor to spawning habitat within the Sacramento River and its tributaries. Splittail spawning and migration activities are limited to the portion of the Sacramento River below Red Bluff Diversion Dam, although occurrence in the upper reaches of the Sacramento River is coincident with wet water year types (Moyle 2002). The Sutter and Yolo Bypasses, along the Sacramento River, are apparently important spawning areas today (Moyle 2002). Water surface elevations in the Sacramento River have the potential to influence the amount of submerged vegetation available to splittail for spawning habitat along the shoreline of the Sacramento River. The frequency, magnitude, and duration of riparian vegetation flooding, and therefore the quality and quantity of potential splittail spawning habitat, has the potential to be affected by changes in releases from Lake Shasta under the Flexible Purchase Alternative. Consequently, if flows are reduced under the Flexible Purchase Alternative, then the availability of submerged vegetation available for spawning habitat could be reduced during the splittail spawning season (February through May). As discussed in Chapter 15, Flood Control, the EWA Program would not result in changes in the frequency of bypass flooding, therefore effects on Sacramento splittail within the Sutter and Yolo Bypasses are not analyzed further.

To assess potential flow-related effects on splittail spawning habitat availability within the Sacramento River during each month of the February through May period, the frequency and magnitude of potential flow-related changes under the Flexible Purchase Alternative were determined, relative to the Baseline Condition. Typically (as done in the lower American River analysis), a measure of the amount of submerged vegetation is regressed against flow to establish a relationship between flow and available habitat. However, such a relationship for flooded riparian habitat has not been determined for the Sacramento River. Therefore, the analysis of potential effects on splittail habitat in the Sacramento River focuses on the frequency and magnitude of monthly mean flow changes below Keswick Dam and at Freeport.

Splittail reportedly spawn at water temperatures from 48°F to 68°F (Wang 1986). To evaluate potential water temperature-related effects on splittail, the frequency in which monthly mean water temperatures in the Sacramento River below Keswick Dam and at Freeport would be within this range during the February through May period was determined under the Flexible Purchase Alternative and compared to that under the Baseline Condition.

American Shad

Because the majority of American shad spawning migrations into the Sacramento River are believed to occur during May and June, potential changes in river flows during these months were evaluated for this species. To evaluate potential flow-related effects on American shad attraction, migration, and spawning, the frequency and magnitude of flow changes in the Sacramento River below Keswick Dam and at Freeport under the Flexible Purchase Alternative were evaluated, relative to the Baseline Condition.

To evaluate potential water temperature-related effects on American shad spawning, monthly mean water temperatures under the Flexible Purchase Alternative were determined and compared to those under the Baseline Condition for the months of May and June both below Keswick Dam and at Freeport in the Sacramento River. Specifically, the frequency in which monthly mean May and June water temperatures in the Sacramento River below Keswick Dam and at Freeport would be within the reported preferred range for American shad spawning (60°F to 70°F) was determined under the Flexible Purchase Alternative and compared to that under the Baseline Condition.

Striped Bass

Potential flow-related effects on the striped bass sport fishery were assessed by determining the frequency and magnitude in which flows in the Sacramento River below Keswick Dam and at Freeport under the Flexible Purchase Alternative would change, relative to the Baseline Condition, during the May and June spawning and initial rearing period.

Optimal water temperatures for juvenile striped bass spawning and initial rearing are reported to range from approximately 59°F to 68°F (Moyle 2002). Therefore, to evaluate potential water temperature-related effects on striped bass spawning and initial rearing, the frequency in which monthly mean water temperatures in the Sacramento River below Keswick Dam and at Freeport during May and June would be within this range was calculated for the Flexible Purchase Alternative and compared to the frequency within this range under the Baseline Condition.

Butte Creek

Evaluation of potential impacts on fish species of primary management concern in Butte Creek associated with implementation of the Flexible Purchase Alternative was not based on flow or water temperature modeling output, because such output is not available for Butte Creek. Also, water asset acquisition from Butte Creek is not considered as part of the EWA program. Implementation of the Flexible Purchase Alternative, however, could reduce agricultural return flows to Butte Creek.

An evaluation of potential impacts was performed by comparing the characterization, timing, and location of potential changes in agricultural return flows with the lifestage periodicity and spatial distribution of spring-run, fall-run, and late-fall-run Chinook salmon, steelhead, and splittail in Butte Creek.

9.2.1.2.2 Feather River Area of Analysis

EWA acquisitions could potentially alter seasonal flows and water temperatures in the lower Feather River due to changes in releases from the Lake Oroville. The Feather River is utilized by fish species of primary management concern that are either Federally or State listed under ESA or considered in this category for other purposes, such as their recreational or commercial importance. For these reasons, species-specific impact assessments were warranted for this river system and were conducted for the following species of primary management concern:

- Spring-run Chinook salmon;
- Fall-run Chinook salmon;
- Steelhead;
- Sacramento splittail;
- American shad; and
- Striped bass.

Because the species selected for species-specific assessments include those sensitive to changes in both river flow and water temperature throughout the year, an evaluation of impacts on these species is believed to reasonably encompass the range of potential impacts upon other Feather River fish resources (e.g., green sturgeon) that could occur under the Flexible Purchase Alternative relative to the Baseline Condition.

During some years, additional water transfers could potentially alter Feather River seasonal water temperatures. Changes in Feather River water temperatures that could occur as a result of implementation of the Flexible Purchase Alternative would not be expected to be sufficiently large to adversely affect fish species present in the lower Feather River, with the possible exceptions of Chinook salmon and steelhead. Elevated water temperatures could reduce spawning and rearing success of these anadromous salmonids because of their low thermal tolerance. For this reason, an assessment of changes to lower Feather River water temperatures focused on these fish species. Moreover, because: 1) thermal requirements of Chinook salmon and steelhead are generally similar; and 2) the NOAA Fisheries Biological Opinion on interim operations of the Central Valley Project (CVP) and State Water Project (SWP) on Federally listed threatened Central Valley spring-run Chinook salmon and Central Valley steelhead (NMFS 2001) has established quantitative temperature criteria for the lower Feather River at the Feather River Fish Hatchery and for the Low Flow Channel (monitored near Robinson Riffle (below RM 62)) to protect spring-run Chinook salmon and steelhead, the assessment methodologies focus primarily on Chinook salmon and steelhead lifestages.

<u>Spring- and Fall-run Chinook Salmon</u>
Potential fisheries impacts in the two reaches of the lower Feather River were evaluated separately because of the importance of each reach to various lifestages of anadromous salmonids (adult immigration, spawning, incubation and initial rearing, and juvenile rearing and emigration). The majority (approximately 3/4) of Chinook salmon spawning in the lower Feather River occurs in the Low Flow Channel between the Fish Barrier Dam and the Thermalito Afterbay Outlet. A lesser extent (approximately 1/4) of spawning occurs in the lower Feather River in the High Flow Channel (below the Thermalito Afterbay Outlet). Further, this reach is also an important migration corridor for both juvenile and adult fish. Although the majority of Chinook salmon spawning occurs below the Fish Barrier Dam, flows were not evaluated at this location. Because of facility operations and minimum flow requirements (600 cfs) in the Low Flow Channel, the long-term average and monthly mean flows under the Flexible Purchase Alternative between the Fish Barrier Dam and the Thermalito Afterbay Outlet would not fall below the existing minimum of 600 cfs (DWR 2001a). Oroville facility operations, either with or without implementation of the EWA program, would not allow flow releases to deviate from the existing quantity and schedule of releases that are required to ensure that 600 cfs are released down the Low Flow Channel. Therefore, potential flow-related impacts were evaluated below the Thermalito Afterbay Outlet and at the mouth of the Feather River. Because changes in water surface elevations at Lake Oroville could affect the water temperature of releases from Oroville Dam, potential water-related effects were evaluated below the Fish Barrier Dam, in addition to below the Thermalito Afterbay Outlet and at the mouth of the Feather River.

Flow-related Effects

To thoroughly assess flow-related impacts on the discrete lifestages of spring- and fall-run Chinook salmon in the lower Feather River, long-term average and monthly mean flows below the Thermalito Afterbay Outlet and at the mouth of the Feather River were evaluated under the Flexible Purchase Alternative and compared to flows simulated at these locations under the Baseline Condition for each month of the relevant salmonid lifestage.

Flows in the Low Flow Channel of the Feather River, which extends from the Fish Barrier Dam to the Thermalito Afterbay Outlet, are governed by a 1983 agreement between DWR and CDFG (DWR 1983). The agreement specifies that DWR "*shall release into the Feather River from the Thermalito Diversion Dam for fishery purposes a flow of 600 cfs*" (DWR 1983). This is the total volume of flows from the Diversion Dam outlet, Diversion Dam power plant, and the Feather River Fish Hatchery pipeline (DWR 1983). With the exception of flood events, the reach of the Feather River extending from the Fish Barrier Dam to the Thermalito Afterbay Outlet is operated at a constant flow of 600 cfs year-round and in all water year types, with any water in excess of 600 cfs released from Oroville Dam being diverted through the Thermalito Forebay/Afterbay complex and returning to the Feather River at the Thermalito Afterbay Outlet (DWR 2001a). Because the flow in this reach of the river would not change from the Baseline Condition of 600 cfs under the EWA Program alternatives, implementation of the EWA Program would not result in any changes in flow in this section of the Feather River as compared to the Baseline Condition. Therefore, further analysis of the flow-related impacts on fisheries and aquatic resources in the reach of the Feather River extending from the Fish Barrier Dam to the Thermalito Afterbay Outlet is not warranted.

Temperature-related Effects

A three-phased water temperature assessment also was performed to evaluate potential water temperature-induced impacts on the anadromous salmonid resources of the lower Feather River. First, long-term average and monthly mean water temperatures in the Low Flow Channel below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River were evaluated under the Flexible Purchase Alternative were compared to monthly mean temperatures at these river locations under the Baseline Condition for each relevant salmonid lifestage.

Second, the number of years of the 69-year period modeled that water temperatures at each location would exceed the temperature criteria identified by NOAA Fisheries in its Biological Opinion for spring-run Chinook Salmon and steelhead (NMFS 2001) was determined for the Flexible Purchase Alternative and compared to the number of years that these criteria would be exceeded under the Baseline Condition. NOAA Fisheries criteria used for this component of the assessment are as follows:

- Daily average water temperatures less than or equal to 65°F are required in the Low Flow Channel of the lower Feather River from June 1 through September 30.

Additional water temperature criteria have been established through the 1983 agreement between CDFG and DWR, which stated: 1) water temperatures below the Afterbay river outlet must be suitable for fall-run Chinook salmon after September 15th; 2) water temperatures below the Afterbay river outlet must be suitable for shad, striped bass and other warmwater fish from May through August; and 3) set temperature objectives for water supplied to the Feather River Fish Hatchery as follows[7]:

- Daily average water temperatures not in excess of 60°F are required below the Thermalito Afterbay Outlet from June 16 through August 15;
- Daily average water temperatures not in excess of 58°F are required below the Thermalito Afterbay Outlet from August 16 through August 31;
- Daily average water temperatures not in excess of 56°F are required below the Thermalito Afterbay Outlet from June 1 through June 15;
- Daily average water temperatures not in excess of 55°F are required below the Thermalito Afterbay Outlet from December 1 through March 31, and May 16 through May 31;
- Daily average water temperatures not in excess of 52°F are required below the Thermalito Afterbay Outlet from September 1 through September 30; and
- Daily average water temperatures not in excess of 51°F are required below the Thermalito Afterbay Outlet from October 1 through November 30, and April 1 through May 15.

Because the hatchery's water supply comes from stored water in the Thermalito Diversion Pool and does not come directly from the Feather River, it is not subject to the thermal warming effects associated with downstream in-channel transport. Therefore, there would be no change to the source or quality of hatchery water supplies as a result of implementing the Flexible Purchase Alternative, relative to the Baseline Condition, and potential impacts on the DWR/CDFG temperature criteria will not be further evaluated in the impact analysis.

Although NMFS (2001) and other temperature criteria (DWR/CDFG 1983) are stated as daily averages, the available hydrologic and water temperature models allow only for monthly mean temperature analyses and output. Consequently, this assessment was based on monthly mean water temperature data output from Reclamation's existing models.

Third, the number of years in which monthly mean water temperatures during spring- would exceed 56°F or 65°F were evaluated under the Flexible Purchase Alternative and compared to the frequency in which water temperatures would exceed these index temperatures under the Baseline Condition. The 56°F and 65°F index temperatures were assessed to determine whether the upper end of the suitable range

7 A deviation of plus or minus 4°F is allowed between April 1 through November 30 (DWR 2001a).

of water temperatures for incubating eggs and juvenile salmonids, respectively, would be exceeded more frequently than under the Baseline Condition. The frequency in which water temperatures would exceed 56°F under Flexible Purchase Alternative were determined for each month of the relevant spring-run and fall-run Chinook salmon spawning and incubation periods and compared to the frequency of exceedance of this index temperature under the Baseline Condition. Similarly, the frequency in which water temperatures would exceed 65°F under Flexible Purchase Alternative were determined for each month of the relevant spring-run and fall-run Chinook salmon juvenile rearing periods and compared to the frequency of exceedance of this index temperature under the Baseline Condition. Although water temperatures are used to evaluate Chinook salmon mortality in the Sacramento and American rivers, no mortality modeling could be performed as a part of the assessments for spring- or fall-run Chinook salmon because no Chinook salmon mortality model has been developed for the Feather River.

Spring- and Fall-run Chinook Salmon Lifestages

The flow and temperature impact assessment methodologies described above were conducted for distinct time periods for each lifestage of spring- and fall-run Chinook salmon, as shown in Table 9-3.

Table 9-3
Feather River Chinook Salmon Lifestages

Species	***Lifestage***		
	Adult Immigration [1]	***Spawning, Incubation, and Initial Rearing***	***Juvenile Rearing and Emigration***
Spring-run Chinook Salmon	March through August	August through November	November through June
Fall-run Chinook Salmon	September through November	October through February	February through June

[1] The adult immigration period includes holding for spring-run Chinook salmon.

Steelhead

Because environmental conditions required by steelhead are not significantly different from those required by fall-run Chinook salmon, and because adult fall-run Chinook salmon and steelhead immigration and juvenile emigration periods in the Feather River occur during the same portions of the year, flow- and temperature-related impact determinations for these steelhead lifestages were evaluated concurrently with fall-run Chinook salmon. Additional flow and temperature analyses, using the same methodology described above, were conducted for steelhead spawning, incubation, and initial rearing (December through April). Further, additional flow and temperature impact assessments for over-summer and fall/winter juvenile steelhead rearing were made for the months of the year not addressed by the fall-run Chinook salmon assessments (July through September and October through January). Finally, because no steelhead mortality model has been developed for the Feather River, no steelhead mortality modeling could be performed as a part of the assessment for this species.

Splittail

Splittail may utilize the lower reaches of the Feather River for spawning. Water surface elevations in the lower Feather River have the potential to influence the amount of submerged vegetation available for splittail spawning. Consequently, changes in river flows that may result from the implementation of the Flexible Purchase Alternative could affect the availability of potential splittail spawning habitat within the lower Feather River by reducing the amount of riparian vegetation that would be submerged during the splittail spawning season (February through June). To assess flow-related impacts on potential splittail spawning habitat availability during each month of the February through May period, long-term average and monthly mean flows at the mouth of the Feather River were evaluated under the Flexible Purchase Alternative and compared to those under the Baseline Condition.

Splittail reportedly spawn at water temperatures from 48°F to 68°F (Wang 1986). To evaluate potential water temperature-related impacts on splittail, the frequency (of the 138 months simulated) that monthly mean water temperatures at the mouth of the lower Feather River would be within this preferred range during the period February through May was determined under the Flexible Purchase Alternative and compared to that under the basis of comparison. For the purposes of assessing temperature-related impacts on splittail in the Feather River, water temperatures at the mouth effectively represent the range of water temperatures that splittail would encounter when using the lower portion of the river for movement, spawning and initial rearing, and foraging activities.

American Shad

Attraction of American shad to the tributaries of the Sacramento River is believed to be related to the magnitude of flow from each river (Moyle 2002). As discussed in Section 9.1, spawning is influenced mostly by flow rather than other habitat characteristics. Consequently, the analysis of potential effects on American shad in the Feather River is based upon the potential for the Flexible Purchase Alternative to alter flows suitable to support American shad attraction and spawning. Because the majority of American shad spawning migrations into the lower Feather River are believed to occur during May and June, the analysis of potential flow-related effects on American shad focuses on these months. To assess flow-related impacts on American shad migration and spawning activities, the frequency and magnitude of flows at the mouth of the Feather River, below the Thermalito Afterbay Outlet, and below the Fish Barrier Dam under the Flexible Purchase Alternative were evaluated and compared to those under the Baseline Condition.

To evaluate potential water temperature-related impacts on American shad spawning, monthly mean water temperatures under the Flexible Purchase Alternative were determined and compared to those under the Baseline Condition for the months of May and June. A conservative approach for assessing potential water temperature impacts was to assume that American shad may spawn throughout the river and, therefore, to evaluate water temperature conditions at the Thermalito Afterbay Outlet and at the mouth of the Feather River. Specifically, the number of years in which monthly mean May and June water temperatures in the Feather River at the mouth and the Thermalito Afterbay Outlet would be within the reported preferred range for American shad spawning (60°F to 70°F) was determined under the Flexible Purchase Alternative and compared to that under the Baseline Condition.

<u>Striped Bass</u>
Potential flow-related effects on the striped bass sport fishery were assessed by determining the frequency and magnitude in which flows below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River under the Flexible Purchase Alternative would be reduced, relative to the Baseline Condition, during the May and June spawning and initial rearing period. As previously discussed, optimal water temperatures for juvenile striped bass spawning and initial rearing are reported to range from approximately 59°F to 68°F. Therefore, to evaluate potential water temperature-related effects on striped bass spawning and initial rearing, the frequency in which monthly mean water temperatures in the Feather River at the three locations identified above during May and June would be within this range was calculated for the Flexible Purchase Alternative and compared to the frequency within this range under the Baseline Condition.

9.2.1.2.3 Yuba River Area of Analysis
To assess potential flow-related effects on fishery resources, comparisons were made of "with" and "without" EWA Program-related transfer flows through all scenarios. Although limited modeling output was used to help determine the potential effects of the Flexible Purchase Alternative (for additional information, refer to Attachment 1, Modeling Description), monitoring results from water transfers that occurred during 2001 and 2002 were used to evaluate potential effects. The impact assessment discusses potential relationships between instream flows, water temperatures, and fish movement and distribution in the lower Yuba River. These potential relationships, with or without the implementation of the EWA program alternatives, may (or may not) affect the attraction of non-indigenous salmonids into the lower Yuba River, as well as the extent of rearing habitat that is available to juvenile steelhead, particularly below Daguerre Point Dam.

Monitoring associated with previous water transfers from the Yuba River suggests the possibility of relationships between water release patterns and downstream movement of juvenile steelhead, as well as the attraction of non-Yuba River salmonids into the lower Yuba River, during the summer water transfer period. Movement of juvenile steelhead downstream of Daguerre Point Dam as a result of the water transfer, if it occurs, could result in the exposure of juvenile steelhead to elevated water temperatures resulting from extremely hot summer weather or reduced flows after water transfers cease. Additionally, juvenile steelhead potentially have a diminished capacity to move upstream to more suitable conditions because they are now below a potential migration barrier. Attraction of non-indigenous salmonids into the lower Yuba River may encourage genetic introgression and intra- and inter-specific competition, and may facilitate disease transmittal. The impact assessment also includes a discussion of these potential relationships. The sponsoring and cooperative effort by Yuba County WA has resulted in the availability of this preliminary information. Moreover, it is anticipated that future water transfers within the Yuba River Basin will be appropriately monitored and evaluated, in cooperation with resource management agency and non-governmental organization representatives, to avoid or minimize potential effects.

9.2.1.2.4 American River Area of Analysis

The American River Basin represents a division of the CVP that has the most, and the largest (in number and volume) reasonably foreseeable water development actions. As such, numerous basin-specific evaluations have been conducted, thereby resulting in a large amount of environmental documentation pertaining to the American River. Included in the recent body of environmental documentation is the Water Forum Agreement, the extensive regional water planning effort that establishes regional water needs for consumptive and environmental purposes through the year 2030. Reclamation has conducted another major environmental analysis, the American River Basin Cumulative Impact Report, for the same reasons that prompted the Water Forum's planning efforts. Because of the attention has been paid to it in recent years, more extensive methodologies, evaluation criteria, and analyses have been developed for fisheries resources within the American River Basin.

The EWA program may utilize sources from two reaches within the American River Basin. EWA assets may be acquired from and/or stored in two non-Project reservoirs (French Meadows and Hell Hole Reservoirs) on the Middle Fork of the American River and one Project reservoir (Folsom Reservoir) on the lower American River. Because of differences in management, fish passage, and species distribution, these reaches were evaluated separately.

Middle Fork American River

Acquisition of stored reservoir water from French Meadows and/or Hell Hole reservoirs under the Flexible Purchase Alternative could affect Middle Fork American River flows and water temperatures during portions of the year. To assess potential effects on fish species of the Middle Fork American River, median flows downstream of Ralston afterbay were assessed throughout all months of the year. By examining flows throughout the year, the analysis covers all months of the spawning, incubation, and juvenile emergence periods for brown and rainbow trout (November through April and February through September, respectively). It is assumed that the range of potential impacts on salmonids in the Middle Fork American River encompasses the range of potential impacts on other species in the Middle Fork American River (hitch, Sacramento sucker, pikeminnow, and riffle sculpin), and therefore, species-specific analyses are not conducted for other resident species within this segment of the Middle Fork American River.

Changes in releases from Hell Hole and French Meadows reservoirs could affect flows, and hence water temperatures, in the Middle Fork American River downstream of Ralston Afterbay. However, there is no temperature model currently available for the Middle Fork American River. Consequently, potential changes to water temperatures are evaluated through a qualitative discussion of Middle Fork Project operations and potential effects on fish species and other aquatic organisms.

Changes in the operation of the Middle Fork Project have the potential to affect the coldwater pool volume at Folsom Reservoir. A discussion of potential impacts on coldwater pool volume at Folsom Reservoir is included in the analysis of coldwater fisheries resources at Folsom Reservoir. (Refer to Section 9.2.5.1.4.)

Nimbus Hatchery

Because changes in Folsom Reservoir releases under the Flexible Purchase Alternative could alter water temperatures in Lake Natoma during some months, and because Nimbus Hatchery diverts its water supply directly from Lake Natoma throughout the year, the Flexible Purchase Alternative could change hatchery water temperatures during some months of the year. Nimbus Hatchery production remains relatively unaffected when hatchery temperatures remain below 60°F. However, increased disease and mortality of hatchery-reared fish often occurs when water temperatures exceed 60°F. Losses from these factors become a particular problem when hatchery water temperatures exceed 65°F for extended periods. Water temperatures exceeding 68°F for even short periods (days) are particularly detrimental to hatchery fish held at high densities, and could require the hatchery to release and/or transfer most or even all of its fish to prevent unacceptably high mortality (B. Barngrover 1997).

To assess potential water temperature-related impacts on Nimbus Hatchery operations, monthly mean temperatures of water released from Nimbus Dam under the Flexible Purchase Alternative were modeled and compared to those modeled under the basis of comparison for each month of the year. The number of years of the 69 years modeled that monthly mean Nimbus Dam release temperatures would exceed the index values of 60°F, 65°F, and 68°F under the Flexible Purchase Alternative were determined and compared to the frequency of exceedance of these temperature index values under the Baseline Condition. In addition, for each month of the year, the mean temperature of water released from Nimbus Dam for the years exceeding each of these temperature index values was determined.

Lower American River

Flows and water temperatures in the lower American River are controlled by operations of Folsom Reservoir. Folsom Reservoir, because of its proximity to the Delta, is often used by Reclamation to make releases when additional Delta outflow is required to meet Delta salinity standards. Consequently, Folsom Reservoir storage can be reduced, resulting in reduced coldwater pool volume. If the coldwater pool disappears, releases from Nimbus Dam are warmer and have the potential to exceed suitable temperature ranges for fish species of primary management concern in the lower American River. Seasonal changes in releases from Folsom Reservoir resulting from the management of EWA assets under the Flexible Purchase Alternative could affect lower American River flows and water temperatures during portions of the year. Because a number of fish species of primary management concern utilize the lower American River for one or more of their lifestages, and because potential temperature impacts are a concern under the Baseline Condition, species-specific impact assessments were warranted for the lower American River and were conducted for the following five species of primary management concern:

- Fall-run Chinook salmon;
- Steelhead;
- Splittail;
- American shad; and
- Striped bass.

These species are of primary management concern due either to the importance of their commercial and/or recreational fisheries (Chinook salmon, steelhead, American shad, and striped bass) and/or because they are a species currently listed or proposed for listing under the Federal ESA and/or CESA (steelhead, Chinook salmon, and splittail). Because the species selected for species-specific assessments include those sensitive to changes in both river flow and water temperature throughout the year, an evaluation of effects on these species is believed to reasonably encompass the range of potential effects on lower American River fish resources that could occur under the Flexible Purchase Alternative.

<u>Fall-run Chinook Salmon</u>
Watt Avenue represents the river location above which approximately 98 percent of fall-run Chinook salmon spawning occurs. To assess flow-related effects on adult fall-run Chinook salmon spawning, egg incubation and initial rearing, monthly mean flows at Watt Avenue and below Nimbus Dam under the Flexible Purchase Alternative were compared to monthly mean flows under the Baseline Condition for each month of the October through February period.

Changes in flows during the period March through June also were assessed at Watt Avenue to further address potential effects on fry and juvenile lifestages rearing during these months. Flows at the mouth were compared between modeling simulations to assess potential flow-related effects on adult immigration and juvenile emigration. The frequency with which specified flow levels were met was determined under the alternatives, and was compared to that under the existing condition.

Potential water temperature-related effects on lower American River fall-run Chinook salmon were evaluated through three distinct assessments focusing on distinct lifestages and periods, including: 1) adult immigration (September through November); 2) spawning/incubation and initial rearing (October through February); and 3) juvenile rearing and emigration (March through June) using the multi-step analysis described below.

Adult Immigration (September through December)

Temperature-related effects on adult immigration were based on water temperature at the mouth of the American River and at Freeport in the Sacramento River. The 69-year average water temperatures for each month of the September through November period that would occur at the American River mouth and at Freeport under the Flexible Purchase Alternative were compared to those under the Baseline Condition. In addition, monthly mean water temperatures at the American River mouth and at Freeport were compared for each month of the adult immigration period over the 69-year period of record. Therefore, a total of 207 months were included in the analysis.

Spawning/Incubation and Initial Rearing (October through February)

First, the long-term average water temperatures for each month of the October through February period that would occur below Nimbus Dam or at Watt Avenue under the Flexible Purchase Alternative were compared to the long-term average water temperatures for each of these months, at these same locations, under the Baseline Condition. Because water temperatures generally warm with increasing distance downstream during October, and because 98 percent of all spawning occurs upstream of Watt Avenue, the most conservative assessment of thermal effects (assessment of the greatest potential impacts) on Chinook salmon spawning and egg incubation during October is based on Watt Avenue temperatures. Therefore, all water temperature assessments for the month of October are based on temperatures at Watt Avenue. Conversely, because water temperatures generally cool with increasing distance downstream during the period November through January, and because water temperatures generally change little between Nimbus Dam and Watt Avenue during February, water temperature impact assessments for spawning and egg incubation during the months November through February are based on water temperatures below Nimbus Dam, thereby providing the most conservative assessment.

Second, the number of years (of the 69 years modeled) that monthly mean water temperatures would exceed 56°F below Nimbus Dam or at Watt Avenue was determined for each month of the October through February period and compared to those modeled under the Baseline Condition.

Third, for each month of the October through February period, the mean water temperature below Nimbus Dam or at Watt Avenue for the years (of the 69 years modeled) exceeding the 56°F index value was determined under the Flexible Purchase Alternative and compared to those under the Baseline Condition.

Finally, Reclamation's Lower American River Fall-Run Chinook Salmon Mortality Model was used to assess potential water temperature-related effects on the early lifestage of Chinook salmon. Annual early lifestage survival (the complement of mortality) estimated for the Flexible Purchase Alternative was compared to that estimated for the Baseline Condition for each year of the 69-year period of record.

Juvenile Rearing and Emigration (February through June)

The same methodology was used to evaluate potential water temperature-related effects on juvenile fall-run Chinook salmon rearing and emigration with the following modifications:

- The period of assessment was February through June;
- The number of years (of the 69 years modeled) that monthly mean water temperatures would exceed the index value of 65°F were determined at Watt Avenue and the lower American River mouth;
- Mean water temperatures for the years (of the 69 years modeled) that were shown to exceed the 60°F and 65°F index values were determined at Watt Avenue; and
- Reclamation's Salmon Mortality Model was not used, because it does not assess mortality beyond the emergent fry lifestage.

Because the majority of juvenile fall-run Chinook salmon and steelhead rearing is believed to occur above Watt Avenue (River Mile (RM) 9.5), and because water temperatures generally increase between Nimbus Dam and Watt Avenue during the February through June period, use of Watt Avenue water temperatures for assessing water temperature-related effects on juvenile Chinook salmon during this period provides the most conservative assessment. In addition to the assessments described above, potential water temperature-related effects on juvenile emigration through the lower portion of the river were assessed based on temperatures at the mouth using the water temperature index value described above.

<u>Steelhead</u>

Because environmental conditions required by steelhead are not significantly different from those required by fall-run Chinook salmon, flow- and temperature-related impact determinations for steelhead for the period October through June were based on the same modeling output used to assess effects on fall-run Chinook salmon during this period, with a separate analysis conducted for adult steelhead spawning and egg incubation, which occurs from December through April. However, because juvenile steelhead rear within the lower American River year-round, additional flow and water temperature impact assessments were made for the months of the year not addressed by the fall-run Chinook salmon assessments (July through September and October through January). Flow-related effects on steelhead rearing during the July through September and October through January periods were assessed via the same methods used to assess flow-related effects on fall-run Chinook salmon during the October through June period.

Temperature-related effects on juvenile steelhead rearing during the July through September and October through January periods were assessed via the same methods used to assess water temperature-related effects on juvenile fall-run Chinook salmon rearing and emigration during the March through June period. In addition, the number of months exceeding 65°F for each model simulation, as well as the average water temperature for the months exceeding this index value, also was determined for the July through September over-summer rearing period. Because no steelhead mortality model has been developed for the lower American River, no steelhead mortality modeling could be performed as a part of the assessment for this species.

Splittail

Splittail may spawn in the lower American River in extremely low numbers, with the majority of splittail spawning that could occur taking place in the lower sections of the river (downstream of RM 12). Consequently, altered river flows resulting from the management of EWA assets at Folsom Reservoir could affect the availability of potential splittail spawning habitat within the lower American River by reducing the amount of riparian vegetation that would be submerged during the splittail spawning season (February through May).

The lower American River from RM 5 to the mouth is largely influenced by the water surface elevation of the Sacramento River. Sacramento River stage often controls the water surface elevation here, and the extent to which splittail spawning habitat, particularly submerged vegetation, along this lower reach of the river channel would be available. Conversely, river stage in the portion of the river between RM 8 and RM 12, which is characterized by abundant backwater habitat, is controlled primarily by lower American River flows. The frequency and duration of riparian vegetation flooding in this area and, therefore, the quality and quantity of potential splittail spawning habitat has the potential to be impacted by reduced flows.

Field measurements conducted for the interim reoperation of Folsom Dam and Reservoir indicated that the total amount of submerged vegetation within RM 8 to RM 9 ranged from 2.4 acres at a river flow of 4,540 cfs to 35.8 acres at a river flow of 22,570 cfs (SAFCA 1999). A positive, statistically significant ($r^2=0.99$; $P<0.001$) relationship between flow and the total acreage of submerged vegetation exists between RM 8 to RM 9 in the lower American River. This relationship is defined by the equation:

$$\text{Habitat} = (0.001874 \times Q) - 6.4585$$

Where: Habitat = the total amount of submerged vegetation within the Area of analysis (acres); and

Q = flow within the Area of analysis (cfs).

The x-intercept of the linear regression line occurs at 3,456 cfs, which indicates that zero acres of submerged vegetation within the Area of analysis at river flows of approximately 3,456 cfs or less. For river flows between 3,456 cfs and 22,571 cfs, the total acreage of submerged riparian vegetation within the Area of analysis increased by approximately 1.9 acres for each 1,000 cfs increase in flow. As previously discussed, field observations determined that the first 2.4 acres of submerged vegetation primarily occurred within a narrow strip along the riverbank. This inundation zone was noted as being very shallow (generally less than two feet deep) and, therefore, unlikely to provide suitable potential habitat for splittail. Based on this observation, more than 2.4 acres of submerged vegetation must be present within the Area of analysis before potentially suitable splittail spawning habitat would be available.

To assess flow-related effects on potential splittail spawning habitat availability during each month of the February through May period, the amount of submerged vegetation in acres (dependent variable) was regressed against flow in cfs (independent variable) according to the equation described above, for each year of the 72-year period of record. Using river flows at Watt Avenue (RM 9.5), the number of acres of flooded riparian habitat between RM 8 and RM 9 was determined under the Flexible Purchase Alternative and compared to that available under the Baseline Condition.

Splittail reportedly spawn at water temperatures from 48°F to 68°F (Wang 1986). To evaluate potential water temperature-related effects on splittail, the number of years (of the 69 years modeled) that monthly mean water temperatures at Watt Avenue and the mouth would be within this preferred range during the period of February through May was determined under the Flexible Purchase Alternative, and compared to that under the Baseline Condition. For the purposes of assessing temperature-related effects on splittail in the American River, water temperatures at Watt Avenue and the mouth effectively represent the range of water temperatures that splittail would encounter when using the lower portion of the river for spawning and initial rearing.

American Shad

Because the majority of American shad spawning migrations into the lower American River are believed to occur during May and June, changes in river flows during these months warrant further assessment for this species. The relative number of adult American shad entering the lower American River during May and June is believed to be largely influenced by flows at the mouth. Snider and Gerstung (1986) recommended flow levels of 3,000 to 4,000 cfs during May and June as sufficient "attraction flows" to sustain the American shad fishery in the lower American River. Effects on American shad attraction flows were assessed by determining the number of years (of the 72-year period of record) in which May and June flows at the mouth would be less than 3,000 cfs under the Flexible Purchase Alternative, and compared to the frequency of flows below this value under the Baseline Condition.

To evaluate potential water temperature-related effects on American shad spawning, monthly mean water temperatures under the Flexible Purchase Alternative and the cumulative condition were determined and compared to those under the existing condition for the months of May and June. A conservative approach for assessing potential water temperature-related effects was to assume that American shad may spawn throughout the river and, therefore, to evaluate water temperature conditions below Nimbus Dam and the mouth. Specifically, the number of years (of the 69 years modeled) that mean May and June water temperatures below Nimbus Dam and the mouth would be within the reported preferred range for American shad spawning (60°F to 70°F) was determined under the Flexible Purchase Alternative and the cumulative condition and compared to that under the Baseline Condition.

Striped Bass

Although no study to date has definitively determined whether striped bass spawn in the lower American River, it is believed that little, if any, striped bass spawning occurs there (DeHaven 1978 *in* Snider and Gerstung 1986). Nevertheless, the lower American River is used by juvenile striped bass for rearing and supports a striped bass sport fishery during May and June. In addition to juvenile rearing considerations, the number of adult striped bass entering the lower American River during the summer is believed to vary with flow levels and food production. Snider and Gerstung (1986) suggested that flows of 1,500 cfs at the mouth during May and June would be sufficient to maintain the striped bass sport fishery in the lower American River. Hence, potential flow-related effects on the striped bass sport fishery were assessed by determining the number of years (of the 72-year period of record) that flows at the mouth would be less than 1,500 cfs in May and June under the Flexible Purchase Alternative, and compared to the number of years flows would be below this value under the Baseline Condition.

As discussed in the Sacramento River methodology, optimal water temperatures for striped bass spawning and initial rearing are reported to range from approximately 59°F to 68°F. Therefore, to evaluate potential water temperature-related effects on striped bass juvenile rearing, the number of years (of the 69 years modeled) that monthly mean water temperatures below Nimbus Dam and at the mouth during May and June would be within the preferred range of 59°F to 68°F was determined under the Flexible Purchase Alternative and compared to the frequency within this range under the Baseline Condition.

9.2.1.2.5 San Joaquin River Area of Analysis

EWA acquisitions potentially could alter seasonal flows in the Merced and San Joaquin Rivers due to changes in releases from McClure Reservoir during portions of the year. A number special-status and recreationally important fish species utilize the Merced and San Joaquin rivers during one or more of their lifestages. For these reasons, species-specific impact assessments were warranted for these water bodies and were conducted for the following species[8]:

- Fall-run Chinook salmon;
- Steelhead;
- Splittail;
- Striped bass;
- Delta smelt; and
- American shad.

There are successful fishery management plans already in place throughout the San Joaquin River Area of analysis that manage in-stream flows to sustain viable fish populations, such as the San Joaquin River Agreement (USBR and SJRGA 1999), which was developed to support the Vernalis Adaptive Management Plan study. The agreement identifies where the water used in the VAMP study would be obtained, specifically from willing sellers who are members of The San Joaquin River Group Authority (SJRGA). The flow objectives are designed to provide suitable habitat for spawning and rearing, as well as passage into and out of the Delta for anadromous species of fish (USBR and SJRGA 1999).

The SJRA EIS/EIR was used to develop the methodology and significance criteria utilized for the analysis of potential flow-related effects resulting from the implementation of the Flexible Purchase Alternative. Specifically, life history descriptions for fall-run Chinook salmon and steelhead adult immigration, spawning, egg incubation, and initial rearing, and juvenile rearing and emigration were used to develop the appropriate time periods for lifestage-specific impact analyses. In addition, the criteria used by the SJRGA to determine the level of impact associated with implementation of the Flexible Purchase Alternative were taken directly, as follows (USBR and SJRGA 1999):

Greater than + 10 percent change	Beneficial effect
Less than +/- 10 percent change	No significant effect
Between -11 and -25 percent change	Less than significant effect
Greater than –25 percent change	Potentially significant or significant adverse effect

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8 As discussed in the Affected Environment/Environmental Setting, only fall-run Chinook salmon and striped bass are reported in the potentially affected reach of the Merced River.

Fall-Run Chinook Salmon

Fall-run Chinook salmon in the San Joaquin River typically spawn in the upper reaches of the major tributaries. In the Merced River, it is the only anadromous species present. To assess potential flow-related effects on fall-run Chinook salmon spawning, egg incubation and initial rearing, monthly-mean flows released in the Merced River below Crocker-Huffman Dam and at the mouth under the Flexible Purchase Alternative were compared to releases under the Baseline Condition for each month of the October through December adult fall-run Chinook salmon immigration and spawning period (USBR and SJRGA 1999). In the San Joaquin River, potential flow-related effects on adult fall-run Chinook salmon immigration and spawning were evaluated from October through January, in conjunction with the analysis of potential flow-related effects on steelhead (refer to the steelhead discussion, below, for a complete explanation of life history similarities). Effects on fall-run Chinook salmon in the San Joaquin River were evaluated below the confluence of the Merced River and at Vernalis. Flow changes were also assessed from January through June, when juvenile rearing and emigration occurs (USBR and SJRGA 1999). The frequency with which specified flow levels were met was determined under the Flexible Purchase Alternative, and was compared to that under the Baseline Condition.

Any changes in McClure Reservoir operations could alter water temperatures seasonally in the Merced River downstream of the reservoir. To assess potential water temperature-related effects, mean monthly water temperature data from temperature models would be required. Currently, no temperature models are available to simulate temperature conditions on the Merced or San Joaquin rivers. Consequently, the analysis of potential effects on fall-run Chinook salmon is based on potential changes in monthly mean flows. Minimum flow requirements have been established for the Merced River by both the FERC license and the Davis-Grunsky contract (USBR and SJRGA 1999). The SJRGA maintains these requirements as the minimum flow standard and monitors the effectiveness these standards have in providing suitable habitat (viable temperatures) for fish.

Steelhead

While Central Valley steelhead habitat exists below Crocker-Huffman Dam in the Merced River, there is no conclusive evidence that steelhead are actually present in the Merced River (CDFG 1996; USBR and SJRGA 1999). Therefore, this specific assessment of steelhead will pertain to the San Joaquin River from the confluence with the Merced to Mossdale. CALSIM II post-processing output for the San Joaquin River below the Merced River confluence and at Vernalis were evaluated for potential flow changes during the periods for each lifestage and compared to flows at these locations under the Baseline Condition.

Because environmental conditions required by steelhead are not significantly different from those required by fall-run Chinook salmon, and because steelhead have a similar life history to fall-run Chinook salmon in the San Joaquin Area of analysis, impact analyses for adult steelhead immigration and spawning in the San Joaquin River were conducted concurrently with those for fall-run Chinook salmon. The adult immigration and spawning period for steelhead begins slightly later than that for fall-run Chinook salmon, from November through January (USBR and SJRGA 1999). Therefore, the period of October through January was assessed for potential flow-related impacts on fall-run Chinook salmon and steelhead in the San Joaquin River. In addition, steelhead can rear year round. Thus, the over-summer rearing period of July through September and the fall/winter rearing period of October through December were evaluated for steelhead in the San Joaquin River. Finally, juvenile steelhead emigration was evaluated from November through May (USBR and SJRGA 1999). As described above for fall-run Chinook salmon, potential water temperature-related effects on steelhead cannot be directly assessed, because water temperature models are not available for the Merced and San Joaquin rivers. Consequently, the analysis of potential effects on steelhead is based on potential changes in monthly mean flows and is consistent with the methods used to assess flow-related effects on fall-run Chinook salmon.

Splittail

Splittail are confined to the lower reaches of the San Joaquin and Sacramento rivers. Splittail may spawn in the lower San Joaquin River in extremely low numbers, with the majority of splittail spawning that could occur taking place in sloughs of the Delta, Napa Marsh, Suisun Marsh, and on the inundated floodplains of large rivers during wet years (USBR and SJRGA 1999). Consequently, altered river flows under the Flexible Purchase Alternative could affect the availability of potential splittail spawning habitat within the lower reaches of the San Joaquin River by reducing the amount of submerged vegetation available during the splittail spawning season (February through May).

Typically, an analysis of potential flow-related effects on splittail spawning habitat availability during each month of the February through May period would be based on a direct relationship between flow and known quantities of submerged vegetation. However, such a relationship for flooded riparian habitat has not been determined for the San Joaquin River. Similarly, water temperature-related effects on splittail cannot be directly assessed, since temperature models are not available to simulate temperature conditions on the Merced or San Joaquin Rivers. Therefore, the analysis of potential effects of changes in San Joaquin River flows to the availability of splittail spawning habitat focuses on the frequency and magnitude of monthly mean flow changes under the Flexible Purchase Alternative, relative to the Baseline Condition.

Delta Smelt

In the San Joaquin River basin, delta smelt are known to inhabit the lower reaches of the San Joaquin River, extending from San Pablo Bay and continuing as far upstream as Mossdale. Under the Flexible Purchase Alternative, changes in flows could affect the availability of potential delta smelt spawning habitat within the lower reaches of the San Joaquin River by reducing the amount of submerged vegetation that would be available during the spawning season (January through June).

To evaluate potential effects on delta smelt at the mouth of the San Joaquin River basin, monthly mean flows in the San Joaquin River at Vernalis under the Flexible Purchase Alternative were evaluated for each month of the spawning period and compared to monthly mean flows under the Baseline Condition.

American Shad

As discussed in Section 9.1, American shad spawning is influenced mostly by flow rather than other habitat characteristics. Consequently, the analysis of potential effects on American shad in the San Joaquin River is based upon the potential for the Flexible Purchase Alternative to alter flows suitable to support American shad attraction and spawning. Because the majority of American shad spawning migrations are believed to occur during May and June, the analysis of potential flow-related effects on American shad focuses on these months. To assess flow-related impacts on American shad migration and spawning activities, the frequency and magnitude of flows in the San Joaquin River below the Merced River confluence and at Vernalis under the Flexible Purchase Alternative were evaluated and compared to those under the Baseline Condition throughout the May through June period.

Striped Bass

Potential flow-related effects on the striped bass sport fishery were assessed by determining the frequency and magnitude in which flows in the Merced River below Crocker Huffman-Dam and at the mouth, and San Joaquin River below the confluence with the Merced River and at Vernalis under the Flexible Purchase Alternative would be reduced, relative to the Baseline Condition, during the May and June spawning and initial rearing period. Because no temperature model has been developed for the San Joaquin River, the analysis of potential impacts on striped bass focuses on the potential for changes in flows under the Flexible Purchase Alternative to affect striped bass spawning and initial rearing.

9.2.1.3 Estuarine Fish Species Within the Delta Hydrologic Modeling

Hydrologic modeling results provide the technical foundation for assessing both potential beneficial and adverse effects of EWA operations on fish species and their habitat within the Delta. The assessment relies on a comparative analysis of operational and resulting environmental conditions within the Delta under assumed baseline operational criteria and operations assumed to occur in response to EWA allocations. EWA operations have the potential to affect Delta fisheries in two primary ways: 1) modifications to habitat quality and availability for various fish species within the Sacramento and San Joaquin rivers and Delta; and 2) mortality resulting from State Water Project (SWP) and Central Valley Project (CVP) export operations from the south Delta.

The evaluation of potential impacts on Delta fisheries involves two study scenarios, including: 1) the Maximum Water Purchase Scenario; and 2) the Typical Water Purchase Scenario. Although the Maximum Water Purchase Scenario represents potential worst-case impacts on fish resources upstream from the Delta, the Typical Water Purchase Scenario was developed to analyze a more likely representation of potential worst-case impacts within the Delta. Potential impacts on fish resources within the Delta with implementation of the EWA Program were analyzed under both the Maximum Water Purchase Scenario and the Typical Water Purchase Scenario, relative to the Baseline Condition. Attachment 1, Modeling Description, provides a more detailed discussion of the these two scenarios, the modeling process, and its application to the EWA Program, including: a) the primary assumptions and model inputs used to represent hydrologic, regulatory, structural and operational conditions; and b) the simulations performed from which effects were estimated.

Results of hydrologic modeling provide monthly information that can be used as part of a general evaluation of potential effects of project operations on habitat quality and availability for various fish and macroinvertebrate species inhabiting the Bay-Delta estuary. Modeling results can also be used to estimate potential salvage losses, based upon historical estimates of fish density at both the SWP and CVP salvage facilities, for use as part of these environmental analyses. Modeling parameters selected to be included as part of this analysis include:

- Hydrologic conditions within the central Delta as reflected by the calculation of QWEST;
- Export: Inflow (E/I ratio);
- Delta outflow; and
- Location of the two-part per thousand salinity isohaline (X_2) location, and
- Salvage at CVP and SWP Delta facilities.

The comparative analysis of hydrologic conditions and associated effects on fisheries are discussed below.

9.2.1.3.1 Impacts on Delta Aquatic Habitats

One of the concerns regarding water project operations on the distribution of fish and habitat conditions within the south Delta identified by resource agencies and others has been associated with changes in hydrologic conditions. One of the parameters that has been included in hydrologic modeling that has been used as a surrogate for evaluating changes in hydrologic conditions as a result of SWP and CVP export operations is a calculation of reverse flows within the lower San Joaquin River (referred to as QWEST) within the hydrologic model output. Although analyses have failed to show a strong relationship between calculated values of QWEST and the resulting biological response (e.g., increased or decreased juvenile Chinook salmon smolt survival, changes in species geographic distribution, etc.), the calculation of QWEST and an examination of the change in frequency and magnitude of negative QWEST values within the monthly modeling output has typically been used as one indicator of changes in habitat conditions.

The ratio between SWP and CVP exports and freshwater inflow to the Delta from the Sacramento and San Joaquin river systems (export/inflow ratio) has also been used as a surrogate for assessing and evaluating the effects of project operations on Bay-Delta habitat conditions and the vulnerability of fish and macroinvertebrates to salvage losses. Although no relationships between export/inflow ratios and resulting changes in biological response, such as a reduction in juvenile Chinook salmon smolt survival or a change in geographic distribution and increased vulnerability of the species to SWP or CVP salvage losses, has been established, the framework for environmental analyses has typically assumed that the higher the export rate relative to freshwater inflow, on a seasonal basis, the greater the probability that adverse affects on geographic distribution and/or the risk of salvage losses as a result of SWP and CVP export operations.

Other indices of habitat conditions typically used as part of an environmental assessment of project operations include Delta outflow and changes in the geographic distribution of low-salinity (2 ppt) gradients within Suisun Bay and the western Delta on the availability and quality of estuarine habitat, particularly during the late winter and spring months, that are thought to be important for survival and growth of a variety of fish and macroinvertebrate species.

The USFWS, CDFG, and others have established biological relationships based upon results of fisheries investigations conducted for use in evaluating the biological effects of changes in many of the habitat-related parameters affected by EWA operations. As noted above, biological relationships have not been established for some of the indices, such as QWEST and the export/inflow (E/I) ratio, and hence findings of the environmental analysis are based on a combination of established biological relationships, the best available scientific information on the life history and habitat requirements for various species, the results of hydrologic modeling analyses, and professional judgment.

Seasonal changes in the timing of CVP/SWP diversions could alter the quantity of freshwater flowing into and through the Delta. The abundance and distribution of several fish species of management concern that rely heavily upon the Delta for one or more of their lifestages, including delta smelt (Federally threatened), splittail (treated as a Federally listed threatened species), and longfin smelt (State species of special concern), can be affected by total Delta outflow, the location of X_2 (two parts per thousand (ppt) isohaline in the Delta), and the export/inflow ratio. These parameters also have the potential to affect Delta fish species to be evaluated in accordance with the Magnuson-Stevens Act. However, NOAA Fisheries has indicated that the there are no species requiring EFH consultation under the Magnuson-Stevens Act related to the EWA Program.

To evaluate potential effects on Delta fish resources due to seasonal changes in CVP/SWP diversions, changes in monthly mean Delta outflow for the 15–year period of record under the Flexible Purchase Alternative were determined for each month of the year and were compared to monthly mean Delta outflow under the Baseline Condition. The frequency and magnitude of differences in Delta outflow were evaluated relative to life history requirements for Delta fish. In addition, changes in monthly mean X_2 position were determined for all months of each year, with an emphasis on the February through June period.

Effects on delta smelt, splittail, and other Delta fishery resources were considered adverse if hydrology under the Flexible Purchase Alternative showed a substantial decrease in monthly mean Delta outflow, relative to hydrology under the Baseline Condition, during one or more months of the February through June period, if a substantial shift in the long-term monthly mean X_2 position occurred (more than one kilometer (km)), or if Delta export/inflow ratios were increased above Baseline Condition. The USFWS and Reclamation have in past documents (Draft Trinity River Mainstem Fishery Restoration EIS/EIR) applied a 10 percent modeled exceedance in changes in X_2 position during the February through June period to determine potential effects on fish populations in the Delta. Therefore, the evaluation criteria utilized in this document (1 km or more shift in X_2 position) to determine potential effects on Delta fish populations are very conservative (rigorous) relative to the significance criteria utilized by the resource agencies in previous environmental assessment documents.

9.2.1.3.2 Salvage at the SWP and CVP Export Facilities

The main purpose of the salvage operations at the SWP and CVP export facilities is to reduce the number of fish adversely impacted by entrainment (direct loss) at the export facilities. Salvage operations at the John E. Skinner Fish Protection Facility and the Tracy Fish Collection Facility are described in detail in Section 9.1.2.2, Facilities and Operations of the SWP and CVP and Their Effects on Aquatic Resources. Salvage estimates are defined as the number of fish entering a salvage facility and subsequently returned to the Delta through a trucking and release operation. Since survival of species that are sensitive to handling is believed to be low for most fish species (delta smelt), increased salvage is considered an adverse impact and decreased salvage is considered a beneficial impact on fisheries resources.

Calculations of salvage loss at the SWP and CVP, as a function of changes in the seasonal volume of water diverted, have also been used as an indicator of potential effects resulting from changes in water project operations. Export operations of the SWP and CVP directly affect mortality of fish within the Delta as a consequence of entrainment and associated stresses. The magnitude of direct losses resulting from export operations is a function of the magnitude of monthly water exports from each facility and the density (number per acre-foot) of fish vulnerable to entrainment at the facilities. Results of the hydrologic modeling provide estimates of the average monthly export operations for both the SWP and CVP under baseline and EWA operations. Extensive data are available on species-specific salvage at both the SWP and CVP facilities for use in estimating the risk of fishery losses. Average densities (number per acre-foot) were calculated monthly for both the SWP and CVP facilities for selected fish species over a range of water year conditions (e.g., wet, above normal, below normal, dry, and critical years). Data selected for use in these analyses extended over a 15-year period from 1979 to 1993. This data period was selected based on consideration of the reliability of salvage data (e.g., accurate species identification, expansion calculations, etc.) and the hydrologic model period, which extended through 1993.

SWP and CVP estimates of direct loss were calculated for the following fish species:

- Chinook salmon;
- Steelhead;
- Delta smelt;
- Striped bass; and
- Sacramento splittail.

An index of salvage was developed for purposes of evaluating the incremental effects of EWA operations on direct losses at the export facilities. The salvage index was derived using records of species-specific salvage at the SWP and CVP facilities, which was used to calculate the average monthly density (number of fish per TAF), which could then be multiplied by the calculated SWP and CVP monthly exports (in TAF) obtained from the hydrologic modeling output. The salvage index was calculated separately for the SWP and CVP export operations under both the Baseline Condition and EWA operations. The resulting salvage index was then used to determine the incremental benefits (reduced salvage) and incremental impacts (increased salvage) calculated to result from EWA operations.

Average monthly salvage densities for each species were calculated from daily salvage records over the period from 1979 through 1993 (R. Brown, unpublished data; CDFG, unpublished data). Based on the daily salvage, expanded for sub-sampling effort, a daily density estimate was calculated using the actual water volume diverted at each of the two export facilities. The daily density estimates were then averaged to calculate an average monthly density. For consistency, the average monthly density of each of the individual target species was then used to calculate the salvage index for the period from January 1979 through September 1993 using hydrologic modeling results for the baseline operation and operations under EWA. After calculating the monthly salvage index for each species assuming EWA operations, the baseline estimate was subtracted from the monthly salvage index for each species to determine the net difference in salvage estimates (EWA operations - baseline estimate = net change) that are anticipated to occur with implementation of the Flexible Purchase Alternative.

For purposes of evaluating potential impacts and benefits of EWA operations on fish salvage, the incremental difference in the annual salvage indices reflect the benefit (reduced salvage under EWA operations) as a negative index and an incremental adverse impact (increased salvage under EWA operations) as a positive index.

9.2.2 Significance Criteria

Impact indicators and evaluation criteria developed for use in assessing the significance of potential impacts upon fish resources and aquatic habitat that may result from EWA program alternatives are provided in Table 9-4. The impact indicators and significance thresholds presented in Table 9-4 are consistent with the criteria for Mandatory Findings of Significance provided in Section 15065(a) of the CEQA 2002 Guidelines. This section of the CEQA Guidelines that is specifically related to fish and wildlife resources states that a project may have a significant effect on the environment if *"the project has the potential to substantially degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, or reduce the number or restrict the range of an endangered, rare, or threatened species."*

For the fisheries and aquatic resources impact assessment, impact indicators such as water temperature, flows, nest dewatering events, and littoral habitat availability are used to evaluate if the project will have an adverse effect on the species' habitat and range. Exceedance of monthly mean water temperatures identified by NOAA Fisheries for certain species (e.g., 56ºF at Bend Bridge from April 15 through September 30 for winter-run Chinook salmon) is one such impact indicator. Reduction of reservoir water surface elevations can reduce the availability of nearshore littoral habitat used by warmwater fish for spawning and rearing, thereby reducing spawning and rearing success and subsequent year class strength, therefore reservoir water surface elevation is another impact indicator used. In addition, decreases in reservoir water surface elevations during the primary spawning period for nest building by warmwater fish may result in reduced initial year class strength through warmwater fish nest "dewatering." Changes in river flows and water temperatures during certain periods of the year have the potential to affect spawning, fry emergence, and juvenile emigration. Therefore, changes in monthly mean river flows and water temperatures during certain times of the year (during spawning, incubation, and initial rearing) are also used as impact indicators. The rationale for development of the impact indicators and evaluation criteria detailed in Table 9-4 is provided in Section 9.2.1, Assessment Methods.

Table 9-4
Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria

Impact Indicators	***Evaluation Criteria***
Shasta, Oroville, and Folsom Reservoirs	
Warmwater Fisheries	
Mean number of acres of littoral habitat for each month of the primary rearing period (April through November).	Decrease in monthly mean quantity (acres) of littoral habitat (or median reservoir water surface elevation for Lake Oroville), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect long-term population levels of warmwater fish, for a given month of this period over the 72-year period of record.
End-of-month reservoir water surface elevation (feet/msl) occurring each month of the primary spawning and rearing period for nest-building warmwater fish (March through June).	Decrease in monthly mean reservoir water surface elevation more than nine feet per month, relative to the Baseline Condition, of sufficient frequency to adversely affect long-term population levels of warmwater fish, for a given month of this period over the 72-year period of record.

Table 9-4
Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria

Impact Indicators	Evaluation Criteria
Coldwater Fisheries	
End-of-month storage (TAF) for each month of the April through November period.	Decrease in monthly mean reservoir storage, relative to the Baseline Condition, which also would reduce the coldwater pool, of sufficient magnitude to adversely affect long-term population levels of coldwater fish, for a given month of this period over the 72-year of record.
Little Grass Valley, Sly Creek, New Bullards Bar, French Meadows, Hell Hole, and McClure Reservoirs	
Warmwater Fisheries	
Median reservoir water surface elevation (feet/msl) occurring each month of the primary spawning and rearing period for nest-building warmwater fish (March through June).	Decrease in median reservoir water surface elevation more than nine feet per month, relative to the Baseline Condition, of sufficient frequency to adversely affect long-term population levels of warmwater fish, for a given month of this period over the historical period of record.
Median reservoir water surface elevation (feet/msl) occurring each month of the primary rearing period for nest-building warmwater fish (April through November).	Decrease in monthly mean reservoir water surface elevation resulting in loss of littoral habitat, relative to the Baseline Condition, of sufficient frequency to adversely affect rearing of warmwater fish, for a given month of this period over the 72-year period of record.
Coldwater Fisheries	
Median storage (TAF) for each month of the April through November period.	Decrease in median reservoir storage, relative to the Baseline Condition, which also would reduce the coldwater pool, of sufficient magnitude to adversely affect long-term population levels of coldwater fish, for a given month of this period over the historical period of record.
Sacramento River	
Winter-run Chinook Salmon	
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the adult immigration period (December through July).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration (e.g., resulting flows <3,250 cfs), for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the adult immigration period (December through July).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 69-year period of record.
Monthly mean flows (cfs) below Keswick Dam and at Freeport for each month of the spawning, egg incubation, and initial rearing period (April through August).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at Bend Bridge and Jelly's Ferry for each month of the spawning, egg incubation, and initial rearing period (April through August).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the juvenile rearing and emigration period (August through December).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration (e.g., resulting flows <3,250 cfs), for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the juvenile rearing and emigration period (August through December).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Annual early lifestage survival.	Decrease in annual or long-term average early lifestage survival, relative to the Baseline Condition, of sufficient magnitude to adversely affect initial year-class strength over the 72-year period of record.
Spring-run Chinook Salmon	
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the adult immigration and holding period (March through September).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the adult immigration and holding period (March through September).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 69-year period of record.
Monthly mean flows (cfs) below Keswick Dam and at Freeport for each month of the spawning, egg incubation and initial rearing period (August through January).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.

Table 9-4
Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria

Impact Indicators	Evaluation Criteria
Monthly mean water temperatures (°F) at Bend Bridge and Jelly's Ferry for each month of the spawning, egg incubation, and initial rearing period (August through January).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the juvenile rearing and emigration period (December through April).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the juvenile rearing and emigration period (December through April).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Annual early lifestage survival.	Decrease in annual or long-term average early lifestage survival, relative to the Baseline Condition, of sufficient magnitude to adversely affect initial year-class strength over the 72-year period of record.
Fall-run Chinook Salmon	
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the adult immigration period (September through November).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the adult immigration period (September through November).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 69-year period of record.
Monthly mean flows (cfs) below Keswick Dam and at Freeport for each month of the spawning, egg incubation, and initial rearing period (October through February).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the spawning, egg incubation, and initial rearing period (October through February).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the juvenile rearing and emigration period (February through June).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the juvenile rearing and emigration period (February through June).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Annual early lifestage survival.	Decrease in annual or long-term average early lifestage survival, relative to the Baseline Condition, of sufficient magnitude to adversely affect initial year-class strength over the 72-year period of record.
Late-fall-run Chinook Salmon	
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the adult immigration and holding period (October through April).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the adult immigration and holding period (October through April).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 69-year period of record.
Monthly mean flows (cfs) below Keswick Dam and at Freeport for each month of the spawning, egg incubation, and initial rearing period (December through April).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the spawning, egg incubation, and initial rearing period (December through April).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.

Table 9-4
Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria

Impact Indicators	Evaluation Criteria
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the juvenile rearing and emigration period (April through October).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the juvenile rearing and emigration period (April through October).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Annual early lifestage survival.	Decrease in annual or long-term average early lifestage survival, relative to the Baseline Condition, of sufficient magnitude to adversely affect initial year-class strength over the 72-year period of record.
Steelhead	
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the adult immigration period (September through March).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and at Freeport for each month of the adult immigration period (September through March).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the spawning and egg incubation period (December through March),	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and at Freeport in the Sacramento River for each month of the spawning and egg incubation period (December through March),	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the juvenile over-summer rearing period not covered in the fall-run Chinook salmon juvenile rearing analysis (July through September).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength and juvenile rearing, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the juvenile over-summer rearing period not covered in the fall-run Chinook salmon juvenile rearing analysis (July through September).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial adverse affects to juvenile rearing (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the juvenile fall/winter rearing period (October through January).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength and juvenile rearing for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the juvenile fall/winter rearing period (October through January).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial adverse affects to juvenile rearing for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Keswick Dam and at Freeport for each month of the juvenile rearing and emigration period (February through June).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile emigration, for a given month of this period over the 72-year period of record.
Monthly water mean temperature (°F) at Bend Bridge, Jelly's Ferry, and Freeport for each month of the juvenile rearing and emigration period (February through June).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Annual early lifestage survival, based on LSALMON2 output for late-fall run Chinook salmon.	Decrease in annual or long-term average early lifestage survival, relative to the Baseline Condition, of sufficient magnitude to adversely affect initial year-class strength over the 72-year period of record.
Sacramento Splittail	
Monthly mean flows (cfs) at Freeport and below Keswick during each month of the February through May spawning period.	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect potential splittail habitat availability, for each month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at Freeport, Bend Bridge, Jelly's Ferry, and the mouth during each month of the February through May spawning period.	Substantial increase in the frequency, relative to the Baseline Condition, in which monthly mean water temperatures exceed the reported upper temperature range for splittail spawning (68°F), for a given month of this period over the 69-year period of record.

Table 9-4
Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria

Impact Indicators	Evaluation Criteria
Striped Bass	
Monthly mean flows (cfs) at Freeport and below Keswick for each month of the May through June spawning and initial rearing period.	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect potential striped bass habitat availability, for each month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at Freeport, Bend Bridge, and Jelly's Ferry for each month of the May through June spawning and initial rearing period.	Substantial increase in the frequency, relative to the Baseline Condition, in which monthly mean water temperatures exceed the reported upper temperature range for striped bass spawning and initial rearing (59°F to 68°F), for a given month of this period over the 69-year period of record.
American Shad	
Monthly mean flows (cfs) at Freeport and Keswick for each month of the May through June spawning period.	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect potential American shad habitat availability and attraction, for each month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at Freeport, Bend Bridge, and Jelly's Ferry for each month of the May through June spawning period.	Substantial increase in frequency, relative to the Baseline Condition, in which monthly mean water temperatures exceed the reported upper temperature range for American shad spawning (60°F to 70°F), for a given month of the identified period over the 69-year period of record.
Butte Creek	
Spring-run Chinook Salmon	
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the adult immigration period (mid-February through July).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect adult immigration for a given month of this period.
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the juvenile emigration period (December through May).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect juvenile emigration for a given month of this period.
Fall-run Chinook Salmon	
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the adult immigration period (late-September through October).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect adult immigration for a given month of this period.
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the juvenile emigration period (December through June).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect juvenile emigration for a given month of this period.
Late-fall-run Chinook Salmon	
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the adult immigration period (late-December through February).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect adult immigration for a given month of this period.
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the juvenile emigration period (April through June).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect juvenile emigration for a given month of this period.
Steelhead	
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the adult immigration period (late-fall through winter).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect adult immigration for a given month of this period.
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the juvenile rearing period (year-round).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect juvenile rearing for a given month of this period.
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the juvenile emigration period (September through June).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect juvenile emigration for a given month of this period.
Sacramento Splittail	
Agricultural return flows downstream of the Western Canal (Butte Creek) Siphon during the spawning period (February through April).	Decreases in flows, relative to the Baseline Condition, of sufficient frequency and magnitude to adversely affect spawning habitat availability, for a given month of this period.
Lower Feather River	
Spring-run Chinook Salmon	
Monthly mean flow (cfs) at the mouth of the Feather River and below the Thermalito Afterbay Outlet, for each month of the adult immigration and holding period (March through August).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration for a given month of this period over the 72-year period of record.

Table 9-4 ***Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria***	
Impact Indicators	***Evaluation Criteria***
Monthly mean water temperature (°F) at the mouth of the Feather River, below the Thermalito Afterbay Outlet, and in the Low Flow Channel below the Fish Barrier Dam for each month of the adult immigration and holding period (March through August).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration for a given month of this period over the 69-year period of record.
Monthly mean flows (cfs) below the Thermalito Afterbay Outlet for each month of the spawning and egg incubation period (August through November).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) below the Fish Barrier Dam and the Thermalito Afterbay Outlet for each month of the spawning and egg incubation period (August through November).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below the Thermalito Afterbay Outlet and at the mouth of the Feather River for each month of the juvenile rearing and emigration period (November through June).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) in the Low Flow Channel below the Fish Barrier Dam, below Thermalito Afterbay Outlet, and at the mouth of the Feather River for each month of the juvenile rearing and emigration period (November through June).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Fall-run Chinook Salmon	
Monthly mean flow (cfs) at the mouth of the Feather River and below the Thermalito Afterbay Outlet for each month of the adult immigration period (September through November).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at the mouth of the Feather River and below the Thermalito Afterbay Outlet for each month of the adult immigration period (September through November).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 69-year period of record.
Monthly mean flows (cfs) below the Thermalito Afterbay Outlet for each month of the spawning/egg incubation and initial rearing period (October through February).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) below the Fish Barrier Dam and below the Thermalito Afterbay Outlet for each month of the spawning/egg incubation and initial rearing period (October through February).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below the Thermalito Afterbay Outlet and at the mouth of the Feather River for each month of the juvenile rearing and emigration period (February through June).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River for each month of the juvenile rearing and emigration period (February through June).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Steelhead	
Monthly mean flow (cfs) below the Thermalito Afterbay Outlet and at the mouth of the Feather River for each month of the adult immigration period (September through January).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) below the below the Thermalito Afterbay Outlet and at the mouth of the Feather River for each month of the adult immigration period (September through January).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs below Thermalito Afterbay Outlet for the spawning and egg incubation period (December through April).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) below the Fish Barrier Dam, and below Thermalito Afterbay for each month of the spawning and egg incubation period (December through April).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.

Table 9-4 ***Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria***	
Impact Indicators	***Evaluation Criteria***
Monthly mean flow (cfs) below Thermalito Afterbay Outlet and at the mouth of the Feather River for the juvenile over-summer rearing period (July through September).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) below the Fish Barrier Dam, below Thermalito Afterbay, and at the mouth of the Feather River for each month of the juvenile over-summer rearing period (July through September).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial adverse affects to juvenile rearing (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Thermalito Afterbay Outlet and at the mouth of the Feather River for the juvenile fall/winter rearing periods (October through January).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) below the Fish Barrier Dam, below Thermalito Afterbay, and at the mouth of the Feather River for each month of the juvenile fall/winter rearing period (October through January).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial adverse affects to juvenile rearing for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Thermalito Afterbay Outlet and at the mouth of the Feather River for each month of the juvenile rearing and emigration period (February through June).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency, to adversely affect juvenile emigration, for a given month of this period over the 72-year period of record.
Monthly water mean temperature (°F) below the Fish Barrier Dam, below the Thermalito Afterbay Outlet, and at the mouth of the Feather River for each month of the juvenile rearing and emigration period (February through April).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Striped Bass	
Monthly mean flows (cfs) at the mouth of the Feather River and below the Thermalito Afterbay Outlet for each month of the May through June spawning period.	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect potential striped bass habitat availability, for each month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at the mouth of the Feather River below Thermalito Afterbay and below the Fish Barrier Dam for each month of the May through June spawning period.	Substantial increase in the frequency, relative to the Baseline Condition, in which monthly mean water temperatures exceed the reported upper temperature range for striped bass spawning and initial rearing (59°F to 68°F), for a given month of this period over the 69-year period of record.
American Shad	
Monthly mean flows (cfs) at the mouth of the Feather River, below Thermalito Afterbay and below the Fish Barrier Dam for each month of the May through June spawning period.	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect potential American shad habitat availability or attraction, for each month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at the mouth of the Feather River, below Thermalito Afterbay and below the Fish Barrier Dam for each month of the May through June spawning period.	Substantial increase in the frequency, relative to the Baseline Condition, in which monthly mean water temperatures exceed the reported upper temperature range for American shad spawning (60°F to 70°F), for a given month of this period over the 69-year period of record.
Sacramento Splittail	
Monthly mean flows (cfs) at the mouth of the Feather River for each month of the February through May spawning period.	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect potential splittail habitat availability, for each month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at the mouth of the Feather River for each month of the February through May spawning period.	Substantial increase in the frequency, relative to the Baseline Condition, in which monthly mean water temperatures exceed the reported upper temperature range for splittail spawning (68°F), for a given month of this period over the 69-year period of record.
Yuba River	
Mean daily flows (cfs) occurring at the USGS gauge (at Marysville and Smartville) for each month of the year.	Increase in flows, relative to the basis of comparison, of sufficient magnitude and rapidity to attract non-indigenous salmonids into the lower Yuba River.
Mean daily water temperatures (°F) at the USGS gauge (at Marysville and Daguerre Point Dam) for each month of the year.	Decrease in water temperatures, relative to the basis of comparison, of sufficient magnitude and contrast to Feather River water temperatures to attract non-indigenous salmonids into the lower Yuba River.

Table 9-4
Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria

Impact Indicators	*Evaluation Criteria*
Middle Fork American River	
Monthly median flows (cfs) downstream of Ralston Afterbay.	Decrease in median river flows, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect long-term population levels of recreationally important species.
Lake Natoma	
Monthly mean water temperatures (°F) of water released from Nimbus Dam for each month of the year.	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect long-term population levels of coldwater fish, for a given month of the year over the 72-year period of record.
Nimbus Hatchery	
Monthly mean water temperatures (°F) of water released from Nimbus Dam for each month of the year.	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency that would result in reduced hatchery production (using index temperatures of 60°F, 65°F, and 68°F), during any month of this period over the 69-year period of record.
Lower American River	
Fall-run Chinook Salmon	
Monthly mean flow (cfs) at the mouth of the American River for each month of the adult immigration period (September through December).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at the mouth of the American River and at Freeport on the Sacramento River for each month of the adult immigration period (September through December).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 69-year period of record.
Monthly mean flows (cfs) below Nimbus Dam and at Watt Avenue for each month of the spawning, egg incubation, and initial rearing period (October through February).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) below Nimbus Dam and at Watt Avenue for each month of the spawning, egg incubation, and initial rearing period (October through February).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) at Watt Avenue and the mouth of the American River for each month of the juvenile rearing and emigration period (February through June).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) below Nimbus Dam, at Watt Avenue, at the mouth of the lower American River, and at Freeport for each month of the juvenile rearing and emigration period (February through June).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Annual early lifestage survival.	Decrease in annual or long-term average early lifestage survival, relative to the Baseline Condition, of sufficient magnitude to adversely affect initial year-class strength over the 72-year period of record.
Steelhead	
Monthly mean flow (cfs) at the mouth of the American River for each month of the adult immigration period (December through March).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) at the mouth of the American River and at Freeport on the Sacramento River for each month of the adult immigration period (December through March).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) below Nimbus Dam and at Watt Avenue for each month of the spawning and egg incubation period (December through April).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) below Nimbus Dam and at Watt Avenue for each month of the spawning and egg incubation period (December through April).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial egg and alevin loss (e.g., resulting temperatures >56°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) at Watt Avenue for the juvenile over-summer rearing period (July through September)	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing, for a given month of this period over the 72-year period of record.

Table 9-4 ***Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria***	
Impact Indicators	***Evaluation Criteria***
Monthly mean water temperature (°F) below Nimbus Dam and at Watt Avenue for each month of the juvenile over-summer rearing period (July through September).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial adverse affects to juvenile rearing (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) at Watt Avenue for the juvenile fall/winter rearing period (October through January)	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing, for a given month of this period over the 72-year period of record.
Monthly mean water temperature (°F) below Nimbus Dam and at Watt Avenue for each month of the juvenile fall/winter rearing period (October through January).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to result in substantial adverse affects to juvenile rearing for a given month of this period over the 69-year period of record.
Monthly mean flow (cfs) at Watt Avenue, the mouth of the American River and at Freeport for each month of the juvenile rearing and emigration period (February through June).	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency, to adversely affect juvenile emigration, for a given month of this period over the 72-year period of record.
Monthly water mean temperature (°F) at Watt Avenue, at the mouth of the American River, and at Freeport for each month of the juvenile rearing and emigration period (February through June).	Increase in monthly mean water temperature, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile emigration (e.g., resulting temperatures >65°F), for a given month of this period over the 69-year period of record.
Sacramento Splittail	
Monthly mean acreage of flooded riparian habitat at Watt Avenue during each month of the February through May spawning period.	Decrease in monthly mean quantity of submerged vegetation, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect potential splittail habitat availability, for each month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) at Watt Avenue and the mouth of the American River during each month of the February through May spawning period.	Substantial increase in the frequency, relative to the Baseline Condition, in which monthly mean water temperatures exceed the reported upper temperature range for splittail spawning (68°F), for a given month of this period over the 69-year period of record.
American Shad	
Monthly mean flows (cfs) at the mouth of the Lower American River during each month of the May through June spawning period.	Substantial decrease in the frequency, relative to the Baseline Condition, in which monthly mean flows are above the CDFG recommended “attraction flow” of 3,000 cfs for American shad spawning migrations, during each month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) below Nimbus Dam and the mouth of the lower American River during the May through June spawning period.	Substantial increase in frequency, relative to the Baseline Condition, in which monthly mean water temperatures exceed the reported upper temperature range for American shad spawning (60°F to 70°F), for a given month of this period over the 69-year period of record.
Striped Bass	
Monthly mean flows (cfs) at the mouth of the Lower American River during the May through June striped bass spawning period.	Decrease in monthly mean flow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect striped bass juvenile spawning during May and June over the 72-year period of record.
Monthly mean flows (cfs) at the mouth of the Lower American River during the May through June striped bass sport fishery.	Substantial decrease in the frequency, relative to the Baseline Condition, in which monthly mean flows are above the CDFG recommended “attraction flow” of 1,500 cfs for the striped bass sport fishery, for each month of this period over the 72-year period of record.
Monthly mean water temperatures (°F) below Nimbus Dam and at the mouth during the May through June spawning period.	Substantial increase in the frequency, relative to the Baseline Condition, in which monthly mean water temperatures exceed the reported upper temperature range for striped bass spawning (59°F to 68°F), for a given month of this period over the 69-year period of record.
Merced River	
Fall-run Chinook Salmon	
Monthly mean flow (cfs) below Crocker-Huffman Dam and at the mouth of the Merced River for each month of the adult immigration period (October through December).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.

Table 9-4
Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria

Impact Indicators	*Evaluation Criteria*
Monthly mean flows (cfs) below Crocker-Huffman Dam and at the mouth of the Merced River for each month of the spawning, egg incubation, and initial rearing period (October through December).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean flow (cfs) below Crocker-Huffman Dam and at the mouth of the Merced River for each month of the juvenile rearing and emigration period (January through June).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration, for a given month of this period over the 72-year period of record.
Striped Bass	
Monthly mean flows (cfs) below Crocker-Huffman Dam and at the mouth of the Merced River during the May through June striped bass spawning and rearing period.	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect striped bass spawning and juvenile rearing for May and June over the 72-year period of record.
San Joaquin River	
Fall-run Chinook Salmon	
Monthly mean flow (cfs) below the confluence of the Merced River and at Vernalis for each month of the adult immigration period (October through December).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.
Monthly mean flows (cfs) below the confluence of the Merced River and at Vernalis for each month of the spawning and egg incubation period (October through January).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean flow (cfs) below the confluence of the Merced River and at Vernalis for each month of the juvenile rearing and emigration period (January through June).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing and emigration, for a given month of this period over the 72-year period of record.
Steelhead	
Monthly mean flow (cfs) below the confluence of the Merced River and at Vernalis for each month of the adult immigration period (November through January).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect adult immigration, for a given month of this period over the 72-year period of record.
Monthly mean flow (cfs) below the confluence of the Merced River and at Vernalis for each month of the spawning and egg incubation period (November through January).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength, for a given month of this period over the 72-year period of record.
Monthly mean flow (cfs) below the confluence of the Merced River and at Vernalis during the juvenile over-summer rearing period (July through September).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing, for a given month of this period over the 72-year period of record.
Monthly mean flow (cfs) below the confluence of the Merced River and at Vernalis during the juvenile fall/winter rearing period (October through December).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile rearing for a given month of this period over the 72-year period of record.
Monthly mean flow (cfs) below the confluence of the Merced River and at Vernalis for each month of the juvenile emigration period (November through May).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect juvenile emigration, for a given month of this period over the 72-year period of record.
Sacramento Splittail	
Monthly mean flow (cfs) below the confluence of the Merced River and at Vernalis for each month of the spawning period (February through May).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength and juvenile rearing, for a given month of this period over the 72-year period of record.
Delta Smelt	
Monthly mean flow (cfs) at Vernalis for each month of the spawning period (January through June).	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect initial year-class strength and juvenile rearing, for a given month of this period over the 72-year period of record
Striped Bass	
Monthly mean flows (cfs) below the confluence of the Merced River and at Vernalis during the May through June striped bass rearing period.	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect striped bass juvenile rearing for May and June over the 72-year period of record.

Table 9-4
Fish Resources and Aquatic Habitat Impact Indicators and Evaluation Criteria

Impact Indicators	Evaluation Criteria
American Shad	
Monthly mean flows (cfs) below the confluence of the Merced River and at Vernalis for each month of the May through June spawning period.	Decrease in monthly mean flow (> 25%), relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect potential American shad habitat availability, for each month of this period over the 72-year period of record.
Sacramento-San Joaquin Delta	
Monthly mean Delta outflow (cfs) for all months of the year.	Decrease in monthly mean Delta outflow, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect Delta fishery resources over the 15-year period of record.
Monthly mean location of X_2 for all months of the year.	Increase in upstream movement of the monthly mean position of X_2, relative to the Baseline Condition, of sufficient magnitude (1 km) and frequency to adversely affect Delta fish resources over the 15-year period of record.
Export/Inflow (E/I) ratio during the February through June period.	Increase in monthly mean Delta E/I ratio, relative to the Baseline Condition, of sufficient magnitude and frequency to adversely affect Delta fish resources over the 15-year period of record.
Reverse flows (QWEST) during the February through June period.	Increase in reverse flows, relative to the Baseline Condition, of sufficient frequency and magnitude to result in reduced or delayed downstream transport of planktonic eggs and larvae or adverse effects on juvenile salmonid emigration.
Change in annual CVP/SWP salvage estimates (change in number of individuals salvaged per year) for Chinook salmon, steelhead, delta smelt, and Sacramento splittail.	Increase in the annual number of each species captured at the CVP and SWP fish salvage facilities, relative to the Baseline Condition, over the 15-year period (1979 – 1993) included in these analyses.
Change in long-term average annual CVP/SWP salvage estimates (change in number of individuals salvaged) for striped bass.	Increase in the annual number of striped bass captured at the CVP and SWP fish salvage facilities, relative to the Baseline Condition, over the 15-year period (1979 – 1993) included in these analyses.
San Luis Reservoir, Anderson Reservoir, Castaic Lake, Lake Perris, Lake Mathews, and Diamond Valley Lake	
Warmwater and Coldwater Fisheries	
Annual operating procedures	Increase in reservoir drawdown, thereby reducing the availability of habitat for warmwater and coldwater fish species

9.2.3 ASIP Conservation Measures

Conservation measures included in the Action Specific Implementation Plan (ASIP) applicable to the EWA actions for each species that have been incorporated into the program description are described in this section. The MSCS also includes programmatic conservation measures for each species.

Conservation Measure Applicable to all Species

The EWA Project Agencies will coordinate EWA water acquisition and transfer actions with Federal (USFWS and NOAA Fisheries), State (DWR and CDFG), other CALFED agency, and regional programs (e.g., the San Francisco Bay Ecosystem Goals Project, the Anadromous Fish Restoration Program, the Senate Bill [SB] 1086 program, the U.S. Army Corps of Engineers' [USACE's] Sacramento and San Joaquin Basin Comprehensive Study, the Riparian Habitat Joint Venture, the Central Valley Project Improvement Act (CVPIA), the Central Valley Habitat Joint Venture, and the Grassland Bird Conservation Plan) that could affect management of evaluated species. Coordination will avoid conflicts among management objectives.

General Fish Species Conservation Measures

- The EWA agencies will avoid acquisition and transfer of water that would reduce flows essential to maintaining populations of native aquatic species in the source river.
- The EWA water acquisition and transfers will not increase exports during times of the year when anadromous and estuarine fish are most vulnerable to damage or loss at project facilities or when their habitat may be adversely affected.
- The EWA agencies will avoid acquisition and transfer of stored reservoir water quantities that would impair compliance with flow requirements and maintenance of suitable habitat conditions in the source river in subsequent years.

Delta Smelt (T-FESA; T-CESA)

- The EWA agencies will fully adhere to the terms and conditions in all applicable CESA and FESA biological opinions and permits for CVP and SWP operations.
- The Project Agencies will not initiate EWA water exports in July until EWA Management Agencies agree that delta smelt will not be harmed.

Salmonids – General Conservation Measures - Central Valley Fall-run/Late-fall-run Chinook Salmon (C-FESA; SSC-CDFG); Sacramento River Winter-run Chinook Salmon (E-FESA; E-CESA); Central Valley Spring-run Chinook Salmon (T-FESA; CT-CESA); Central Valley Steelhead (T-FESA)

- The EWA agencies will fully adhere to the terms and conditions in all applicable CESA and FESA biological opinions and permits for CVP and SWP operations.
- The EWA agencies will minimize flow fluctuations resulting from the release of EWA assets from project reservoirs to reduce or avoid stranding of juveniles.

Central Valley Fall/Late-Fall Run Chinook Salmon (C-FESA; SSC-CDFG)

- In May, the EWA agencies will evaluate Folsom Reservoir coldwater pool availability to benefit returning adult fall-run Chinook salmon prior to releasing EWA assets.

Central Valley Steelhead (T-FESA)

- In May, the EWA agencies will evaluate Folsom Reservoir coldwater pool availability to benefit over-summering juvenile steelhead prior to releasing EWA assets.
- The EWA agencies will consult with the Multi-agency Team regarding ramping considerations before and after EWA transfers to avoid non-volitional steelhead downstream movement.

9.2.4 Environmental Consequences/Environmental Impacts of the No Action/No Project Alternative

The CEQA basis for comparison is defined as the Affected Environment/ Environmental Setting, as described in Section 9.1. It is anticipated that if the EWA were not implemented, actions to protect fisheries and benefit aquatic environments would continue under existing regulatory requirements, including other CALFED actions intended to protect and enhance fisheries resources. Compliance with existing Biological Opinions, which represent the regulatory baseline, would result in pumping curtailments, resulting in reduced deliveries to the Export Service Area, particularly in dry years. DWR and Reclamation would continue to attempt to re-operate the SWP and CVP, respectively, to avoid decreased deliveries to export users. These actions are described in Sections 2.3.1 and 2.3.2.

There would be no variation in CVP/SWP reservoir storage levels, river flows, or water temperatures under the No Action/No Project Alternative, as described for the Affected Environment/Environmental Setting. Therefore, there would be no impacts on fisheries and aquatic ecosystems associated with the No Action/No Project Alternative.

As described in Section 3.4, the CEQA basis for comparison is the Affected Environment. The NEPA basis for comparison is the Future Conditions Without the Project. As described in the above paragraphs, the Affected Environment and the Future Conditions Without the Project are the same; therefore, they are collectively referred to as the Baseline Condition in the following sections.

9.2.5 Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative

The analysis provides a program-specific evaluation of how the Flexible Purchase Alternative would affect the resources described in the Affected Environment/Environmental Setting. As described in Section 3.4, the basis of comparison is future conditions without the EWA Program (operating conditions of the CVP/SWP without the project). The No Action/No Project Alternative and Affected Environment/Existing Conditions are termed "Baseline Condition" as referred to through the analysis of EWA Program alternatives (the Flexible Purchase Alternative and Fixed Purchase Alternative). The analysis of the Flexible Purchase Alternative incorporates implementation of the variable operational assets described in Attachment 1, Modeling Description.

The impact indicators selected to evaluate the resource topics represent the potential impact issues. A discussion for each impact issue is presented for the alternative. The anticipated change that would occur under each scenario is compared against the significance criteria to ascertain whether the individual alternative would result in a "*beneficial*," "*less-than-significant*," or "*significant*" impact determination. In most instances, where a potential adverse impact may occur, environmental protection measures to reduce environmental impacts on a "less-than-significant" impact have been identified and incorporated. (See Chapter 2, Alternatives, Including the Proposed Action/Proposed Project.)

9.2.5.1 Upstream from the Delta Region

This section analyzes the potential impacts of the EWA Flexible Purchase Alternative on the aquatic communities and associated fish species located in the riverine and lacustrine environments upstream from the Delta. Fishery resources of primary management concern included in this analysis are those species that are:

Recreationally or commercially important:

- Fall-run and late-fall run Chinook salmon (*Oncorhynchus tshawytscha*)[9];
- American shad (*Alosa sapidissima*);
- Striped bass (*Morone saxatilis*); and
- Various reservoir fish species[10].

Federally- and State-listed (or proposed for listing) species that occur within the Upstream from the Delta Region:

- Winter-run Chinook salmon (*Oncorhynchus tshawytscha*);
- Spring-run Chinook salmon (*Oncorhynchus tshawytscha*);
- Steelhead (*Oncorhynchus mykiss*);
- Delta smelt (*Hypomesus transpacificus*); and
- Sacramento splittail (*Pogonichthys macrolepidotus*).

Special emphasis is placed on these species to facilitate compliance with applicable laws, particularly State and/or Federal ESA, and to be consistent with other State and Federal restoration/recovery plans and Federal biological opinions. This focus is consistent with: 1) CALFED's 2000 Ecosystem Restoration Program Plan (ERPP) and Multi-Species Conservation Strategy (MSCS); 2) the programmatic determinations for the CALFED program, which include CDFG's Natural Communities Conservation Planning Act (NCCPA) approval and the programmatic biological opinions (BOs) issued by NOAA Fisheries and USFWS; 3) USFWS's 1997 Draft Anadromous Fish Restoration Program (AFRP), which identifies specific actions to protect anadromous salmonids; 4) CDFG's 1996 Steelhead Restoration and Management Plan for

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[9] Late-fall-run Chinook salmon is also a candidate for federal and State listing.

[10] For a full listing of reservoir fish species evaluated, refer to Section 9.1, Affected Environment/Existing Conditions.

California, which identifies specific actions to protect steelhead; and 5) CDFG's Restoring Central Valley Streams, A Plan for Action (1993), which identifies specific actions in the Sacramento River system to protect salmonids. Improvement of habitat conditions for these species of priority management concern will likely maintain, protect, or enhance conditions for other fish resources, including native resident species.

Potential impacts on fisheries resources are organized by river basin, starting with the Sacramento River and moving south through the Central Valley to the Merced and San Joaquin rivers. Potential impacts on reservoir fisheries are presented in the river basin in which each reservoir occurs.

9.2.5.1.1 Sacramento River Area of Analysis

EWA acquisition of Sacramento River contractor water via groundwater substitution and crop idling would alter Sacramento River flows downstream from Lake Shasta during June. EWA acquisition of Sacramento River contractor water via groundwater substitution and crop idling would alter surface water elevations at Lake Shasta from June through September.

This section includes an analysis of the warmwater and coldwater fisheries resources for Lake Shasta on the Sacramento River, followed by analyses for fish species of the Sacramento River. For individual fish species, flow- and temperature-related impacts are discussed separately below by species and lifestage. Organizationally, flow- and temperature-related impacts on winter-run Chinook salmon are presented after the discussion of Lake Shasta fisheries resources, and are followed by flow- and temperature-related impacts on spring-run Chinook salmon. Then, fall-run Chinook salmon and steelhead are discussed together, followed by impact discussions for Sacramento splittail, American shad, and striped bass.

Impacts on Lake Shasta Warmwater Fisheries

Hydrologic conditions under the Flexible Purchase Alternative would result in a negligible decrease in long-term average end-of-month water surface elevation in Lake Shasta during the April through November period, when warmwater fish juvenile rearing occurs (Table 9-5). As shown in Table 9-5, the long-term average end-of-month elevation would not differ between Flexible Purchase Alternative and Baseline Condition in the April through July and September through November periods, and would be reduced by 1 foot in August under the Flexible Purchase Alternative, relative to the Baseline Condition. Monthly mean end-of-month water surface elevation in Lake Shasta would be essentially equivalent to or greater than the Baseline Condition for 543 of the 576 months included in the analysis. (See Appendix H pgs. 181-192.)

Table 9-5
Long-term Average Shasta Reservoir End of Month Elevation Under Baseline and Flexible Purchase Alternative Conditions

Month	Average Elevation[1] (feet msl)		
	Baseline	Flexible Purchase Alternative	Difference
Mar	1027	1027	0
Apr	1037	1037	0
May	1036	1036	0
Jun	1024	1024	0
Jul	1001	1001	0
Aug	984	983	-1
Sep	977	977	0
Oct	973	973	0
Nov	977	977	0
Dec	985	985	0

[1] Based on 72 years modeled.

Changes in water surface elevation in Lake Shasta during the April through November period would result in corresponding changes in the availability of reservoir littoral habitat containing submerged vegetation (willows and button brush). Such shallow, near shore waters containing physical structure are important to producing and maintaining strong year-classes of warmwater fish annually. As shown in Table 9-6, the difference in the long-term average amount of littoral habitat potentially available to warmwater fish for spawning and/or rearing in Lake Shasta during the April through November period under the Flexible Purchase Alternative would be identical to the amount available under the Baseline Condition. Further, the monthly mean amount of littoral habitat would not be reduced under the Flexible Purchase Alternative, relative to the Baseline Condition, in any of the 576 months simulated for the April through November period. (See Appendix H pgs. 277-288.) Consequently, seasonal changes in water surface elevation under the Flexible Purchase Alternative would not result in reductions in littoral habitat availability, relative to the Baseline Condition.

Table 9-6
Long-term Average Number of Acres of Lake Shasta Littoral Habitat Under Baseline and Flexible Purchase Alternative Conditions

Month	Average Amount Of Littoral Habitat[1] (Acres)		Difference	
	Baseline	Flexible Purchase Alternative	(Acres)	(%)[2]
Mar	3,257	3,257	0	0.0
Apr	4,218	4,218	0	0.0
May	4,145	4,145	0	0.0
Jun	3,179	3,179	0	0.0
Jul	1,719	1,719	0	0.0
Aug	813	813	0	0.0
Sep	435	435	0	0.0
Oct	216	216	0	0.0
Nov	268	268	0	0.0
Dec	539	539	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

In addition, the Flexible Purchase Alternative could alter the extent to which water surface elevations in Lake Shasta change during each month of the primary warmwater fish-spawning period (March through June). As discussed in Section 9.2.1.1, adverse effects on spawning from nest dewatering are assumed to have the potential to occur when reservoir elevation decreases by more than nine feet within a given month. Modeling results, shown in Table 9-7, indicate that there is no difference in the frequency with which potential nest dewatering events could occur in Lake Shasta under the Flexible Purchase Alternative, compared to the Baseline Condition, during the spawning period.

Table 9-7
Long-term Average Surface Elevation and Number of Years with Elevation Decrease Greater than 9 feet in Shasta Reservoir Under Baseline and Flexible Purchase Alternative Conditions

Month	Average Reservoir Surface Elevation[1] (feet msl)			No. Years[1] w/Monthly Elevation Decrease During Month > 9 ft	
	Baseline	Flexible Purchase Alternative	Difference	Baseline	Flexible Purchase Alternative
Mar	1027	1027	0	1	1
Apr	1037	1037	0	5	5
May	1036	1036	0	9	9
Jun	1024	1024	0	46	46

[1] Based on 72 years modeled.

In summary, the Flexible Purchase Alternative is not likely to result in changes in the availability of littoral habitat at Lake Shasta, and thus, would not likely beneficially or adversely affect warmwater fish rearing. The Flexible Purchase Alternative does not change the frequency of potential nest dewatering events in Lake Shasta, and thus, would not beneficially or adversely affect long-term warmwater fish nesting success. Therefore, under the Flexible Purchase Alternative, impacts on Lake Shasta warmwater fisheries would be less than significant, relative to the Baseline Condition.

Impacts on Lake Shasta Coldwater Fisheries

Long-term average end-of-month storage during the April through November period would not change in April, May, June, October, and November, and would be reduced by 19 TAF in July, 10 TAF in August and 1 TAF in September with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, as shown in Table 9-8. Lake Shasta long-term average end-of-month storage under the Flexible Purchase Alternative would be essentially equivalent to or greater than the Baseline Condition for 539 of the 576 months included in the analysis (April through November, when the reservoir stratifies). Anticipated reductions in reservoir storage would not be expected to adversely affect the reservoir's coldwater fisheries because: 1) coldwater habitat would remain available within the reservoir during all months of all years; 2) physical habitat availability is not believed to be among the primary factors limiting coldwater fish populations; and 3) anticipated seasonal reductions in storage would not be expected to adversely affect the primary prey species utilized by coldwater fish. Therefore, changes in Lake Shasta end-of-month storage under the Flexible Purchase Alternative represent a less-than-significant effect on coldwater fish resources, relative to the Baseline Condition.

Table 9-8
Long-term Average Shasta Reservoir End of Month Storage Under Baseline and Flexible Purchase Alternative Conditions

Month	Average Storage[1] (TAF)		Difference	
	Baseline	Flexible Purchase Alternative	(TAF)	(%)[2]
Apr	3793	3793	0	0.0
May	3780	3780	0	0.0
Jun	3495	3495	0	0.0
Jul	3018	2999	-19	-0.6
Aug	2655	2645	-10	-0.4
Sep	2511	2510	-1	0.0
Oct	2432	2432	0	0.0
Nov	2509	2509	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Impacts on Winter-run Chinook Salmon in the Sacramento River

Flow-related Impacts on Winter-run Chinook Salmon Adult Immigration (December through July)

Table 9-9 shows that the long-term average flow in the Sacramento River below Keswick Dam differs by less than 0.9 percent under the Flexible Purchase Alternative, compared to the Baseline Condition, during all months of the adult immigration period (December through July). In fact, long-term average Sacramento River flow below Keswick Dam under the Flexible Purchase Alternative would not differ from flows under the existing condition from December through June, and July flows under the Flexible Purchase Alternative would be approximately 114 cfs greater than flows under the Baseline Condition. Further, in 576 out of the 576 months simulated in this period, monthly mean flows under the Flexible Purchase Alternative in the Sacramento River below Keswick Dam would be essentially equivalent to or greater than those under the Baseline Condition. (See Appendix H pgs. 351-358.)

Table 9-10 shows that long-term average flow in the Sacramento River at Freeport differs by less than 18 percent under the Flexible Purchase Alternative, compared to the Baseline Condition, during the December through July period. Flows simulated under the Flexible Purchase Alternative would not differ from flows under the Baseline Condition from December through March, and would be from approximately 350 to 3,142 cfs greater under the Flexible Purchase Alternative from April through July. Monthly mean flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 576 out of the 576 months simulated for the December through July period. (See Appendix H pgs. 387-394.) The Flexible Purchase Alternative would not result in reductions in long-term average flows in any month of the adult winter-run Chinook salmon immigration period, relative to the Baseline Condition.

Table 9-9 ***Long-term Average Release From Keswick Dam Under Baseline and Flexible Purchase Alternative Conditions***				
Month	***Monthly Mean Flow[1] (cfs)***		***Difference***	
	Baseline	***Flexible Purchase Alternative***	***(cfs)***	***(%)[2]***
Oct	5842	5842	0	0.0
Nov	4854	4854	0	0.0
Dec	6672	6672	0	0.0
Jan	7951	7951	0	0.0
Feb	10056	10056	0	0.0
Mar	8249	8249	0	0.0
Apr	7706	7706	0	0.0
May	8381	8381	0	0.0
Jun	10529	10529	0	0.0
Jul	13284	13398	114	0.9
Aug	10556	10498	-58	-0.5
Sep	7278	7222	-56	-0.8

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

The minimum flow objective for Keswick Dam releases stipulated in the NOAA Fisheries Biological Opinion (1993, as revised in 1995) for the protection of winter-run Chinook salmon rearing and downstream passage is 3,250 cfs between October 1 and March 31. The minimum flow objective is applicable from December through March of the adult immigration period. Modeling output shows that the Flexible Purchase Alternative would not result in additional reductions below 3,250 cfs, relative to the Baseline Condition, throughout the December through March period. (See Appendix H pgs. 351-354.)

Table 9-10 ***Long-term Average Flow at Freeport Under Baseline and Flexible Purchase Alternative Conditions***				
Month	***Monthly Mean Flow[1] (cfs)***		***Difference***	
	Baseline	***Flexible Purchase Alternative***	***(cfs)***	***(%)[2]***
Oct	11956	12044	88	0.7
Nov	14769	14783	14	0.1
Dec	24922	24927	5	0.0
Jan	33069	33071	2	0.0
Feb	39225	39226	1	0.0
Mar	34296	34299	3	0.0
Apr	25184	25665	481	1.9
May	19724	20076	352	1.8
Jun	18183	18533	350	1.9
Jul	17777	20919	3142	17.7
Aug	13762	15929	2167	15.7
Sep	13729	14373	644	4.7

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Temperature-related Impacts on Winter-run Chinook Salmon Adult Immigration (December through July)

Long-term average water temperature in the Sacramento River at Freeport would not differ by more than 0.1°F during any month of the December through July period, relative to the Baseline Condition. (See Table 9-11.) Similarly, long-term average water temperatures in the Sacramento River at Bend Bridge and Jelly's Ferry would not differ during any month of the December through July period, as shown in Tables 9-12 and 9-13.

Table 9-11
Long-term Average Water Temperature in the Sacramento River at Freeport Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	60.1	60.1	0.0
Nov	52.5	52.5	0.0
Dec	46.0	45.9	-0.1
Jan	44.8	44.8	0.0
Feb	49.3	49.3	0.0
Mar	53.9	53.9	0.0
Apr	59.5	59.6	0.1
May	64.9	65.0	0.1
Jun	69.0	69.1	0.1
Jul	71.6	71.6	0.0
Aug	71.6	71.5	-0.1
Sep	68.4	68.3	-0.1

[1] Based on 69 years modeled.

Table 9-12
Long-term Average Water Temperature in the Sacramento River at Bend Bridge Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	53.6	53.6	0.0
Nov	51.0	51.0	0.0
Dec	47.0	47.0	0.0
Jan	44.9	44.9	0.0
Feb	48.3	48.3	0.0
Mar	52.1	52.1	0.0
Apr	54.5	54.5	0.0
May	54.6	54.6	0.0
Jun	54.6	54.6	0.0
Jul	54.6	54.6	0.0
Aug	56.8	56.8	0.0
Sep	55.8	55.8	0.0

[1] Based on 69 years modeled.

Table 9-13
Long-term Average Water Temperature in the Sacramento River at Jelly's Ferry Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	53.4	53.4	0.0
Nov	51.0	51.0	0.0
Dec	47.1	47.1	0.0
Jan	45.0	45.0	0.0
Feb	48.3	48.3	0.0
Mar	52.1	52.1	0.0
Apr	54.3	54.3	0.0
May	54.2	54.2	0.0
Jun	54.1	54.1	0.0
Jul	54.1	54.1	0.0
Aug	56.3	56.3	0.0
Sep	55.3	55.4	0.1

[1] Based on 69 years modeled.

The NOAA Fisheries Biological Opinion (1993, as revised in 1995) for winter-run Chinook salmon provides temperature requirements for Bend Bridge and Jelly's Ferry in the Sacramento River from April through October. The temperature criteria are applicable from April through July of the adult winter-run Chinook salmon immigration period (the most rigorous are maximum temperatures of 56°F from April through September and 60°F during October at Bend Bridge). As described above, the long-term average water temperatures in the Sacramento River modeled for the Flexible Purchase Alternative would not differ from those under the Baseline Condition at Bend Bridge and at Jelly's Ferry during all months of the April through July period. Monthly mean water temperatures in the Sacramento River at Bend Bridge under the Flexible Purchase Alternative would remain essentially equivalent to those under the Baseline Condition in 276 out of the 276 months included in the analysis. (See Appendix H pgs. 475-478.) Similarly, water temperatures at Jelly's Ferry under the Flexible Purchase Alternative also would remain essentially equivalent to the Baseline Condition in 276 out of the 276 months included in the analysis. (See Appendix H pgs. 463-466.) Further, while water temperatures at Bend Bridge would exceed 56°F in 32 out of 276 months modeled for the April through July period under the Baseline Condition, the Flexible Purchase Alternative would not result in additional occurrences in which Sacramento River water temperatures would exceed 56°F. (See Appendix H pgs. 471-478.)

Flow-related Impacts on Adult Winter-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (April through August)

The long-term average flow in the Sacramento River below Keswick Dam under the Flexible Purchase Alternative would be within 0.9 percent of the flow under the Baseline Condition during all months of the April through August period, as shown in Table 9-9. In 344 of the 360 months simulated during this period, flow in the Sacramento River below Keswick Dam would be either essentially equivalent to or greater than flows under the Baseline Condition. (See Appendix H pgs. 355-359.)

Figure 9-6 through Figure 9-10 shows exceedance curves for the Sacramento River below Keswick Dam for the April through August period. The basis for development of these exceedance curves was the 1922-1993 period of record. These curves demonstrate that flows under the Flexible Purchase Alternative during April through August would be nearly identical to those under the Baseline Condition. There would be slight increases in simulated flows under the Flexible Purchase Alternative in July, and slight reductions in simulated flows under the Flexible Purchase Alternative during August, relative to the Baseline Condition.

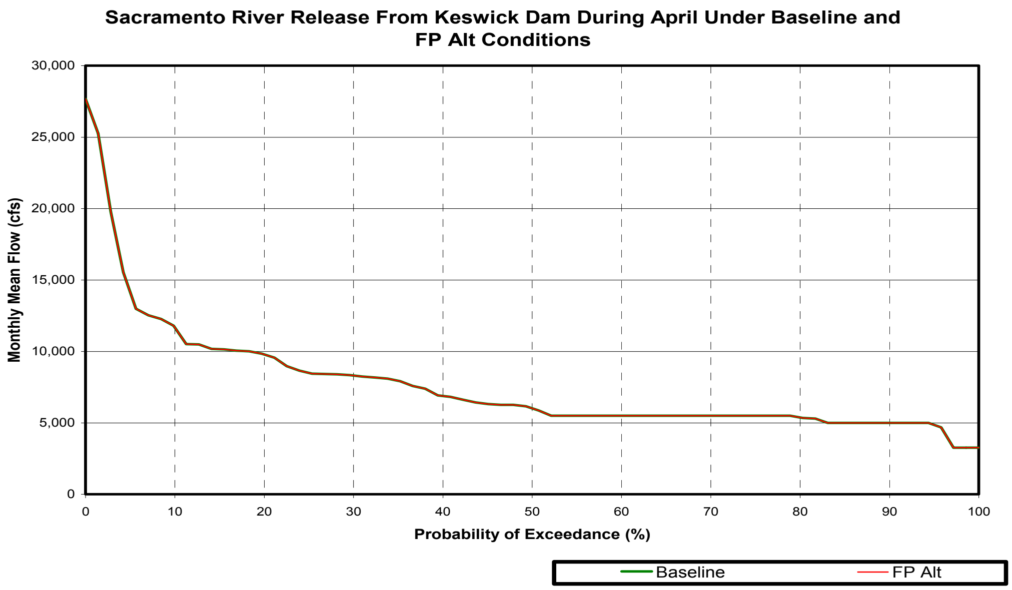

Figure 9-6
Sacramento River Release From Keswick Dam During April Under Baseline And Flexible Purchase Alternative Conditions

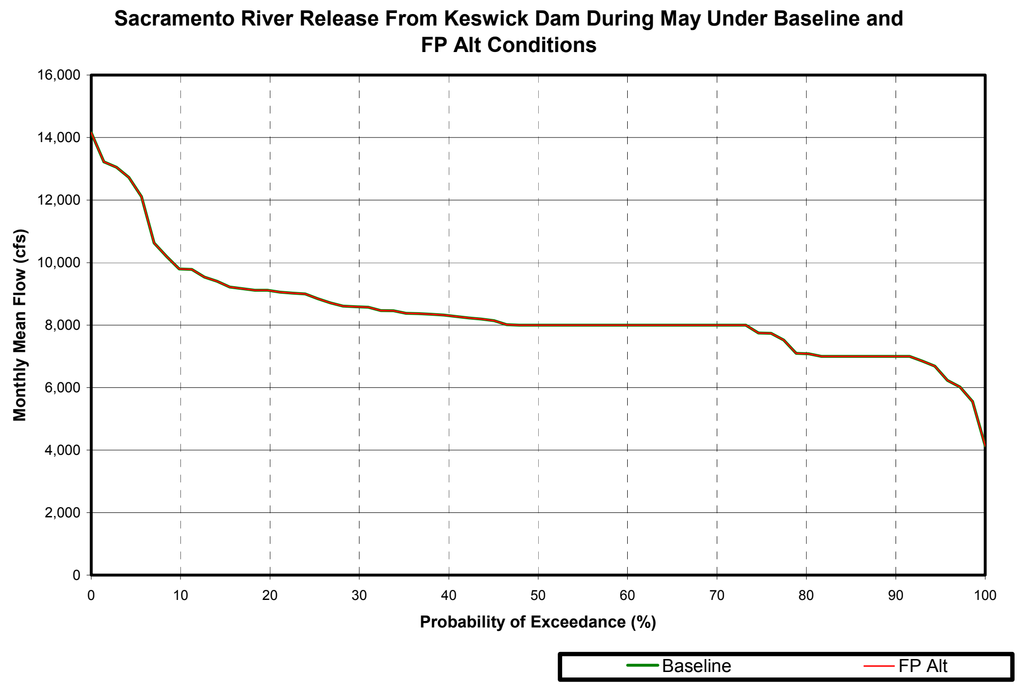

Figure 9-7
Sacramento River Release from Keswick Dam During May Under Baseline and Flexible Purchase Alternative Conditions

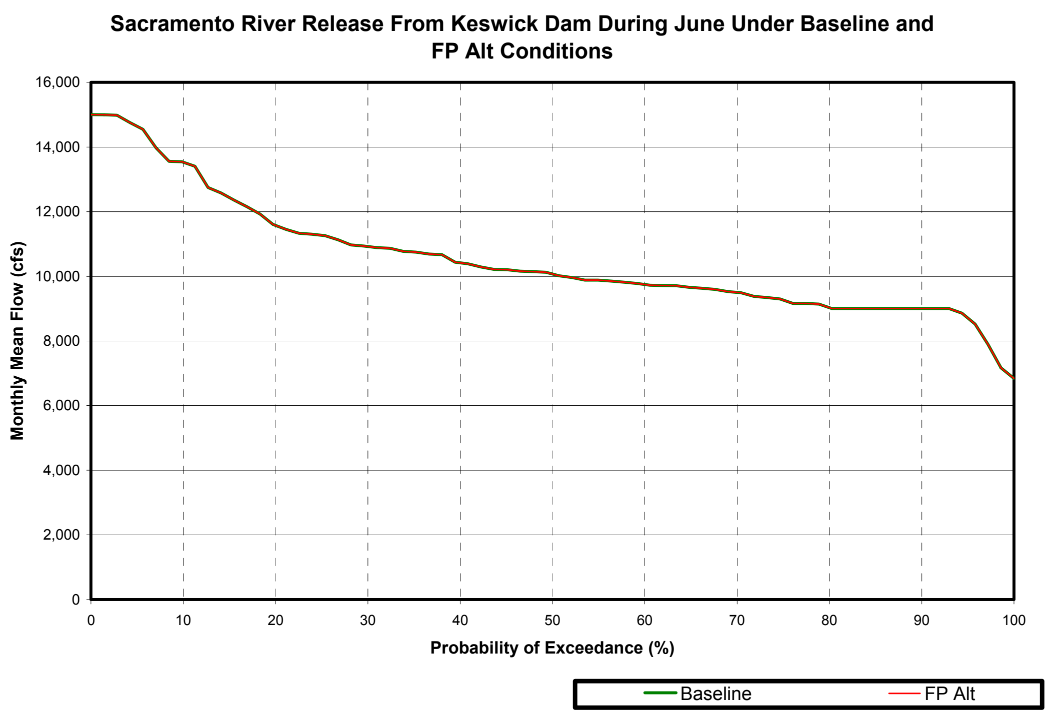

Figure 9-8
Sacramento River Release From Keswick Dam During June Under Baseline and Flexible Purchase Alternative Conditions

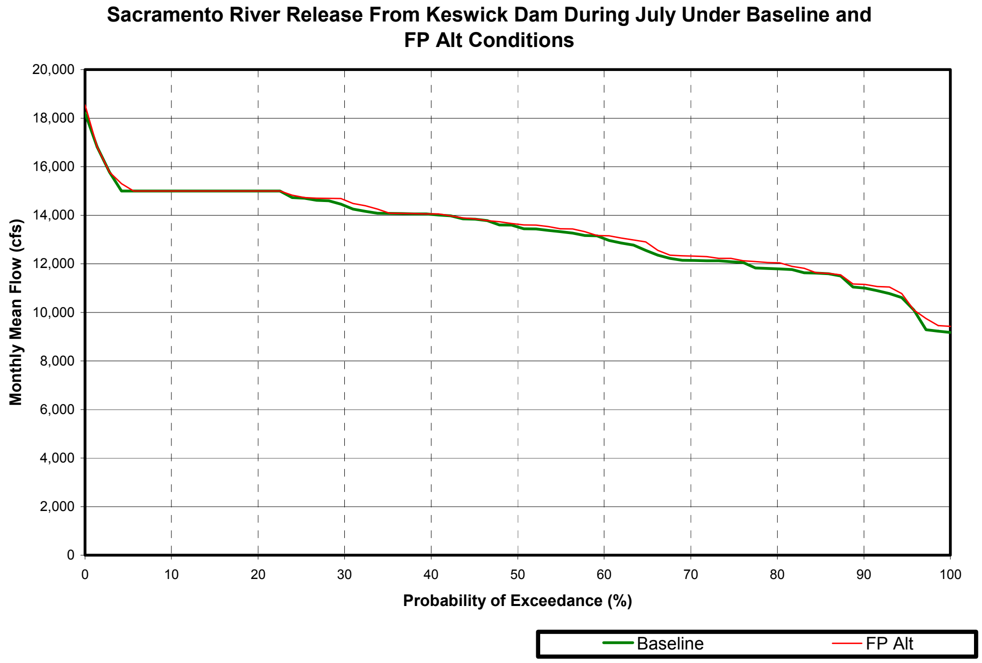

Figure 9-9
Sacramento River Release From Keswick Dam During July Under Baseline and Flexible Purchase Alternative Conditions

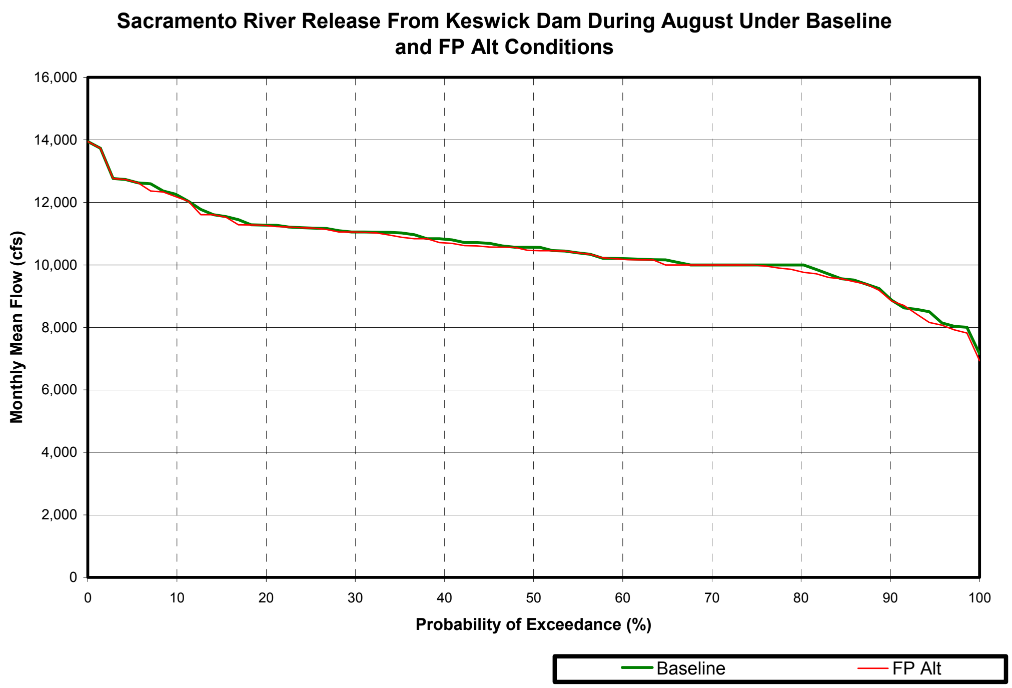

Figure 9-10
Sacramento River Release From Keswick Dam During August Under Baseline and Flexible Purchase Alternative Conditions

Temperature-related Impacts on Winter-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (April through August)

Under the Flexible Purchase Alternative, the long-term average water temperatures would not differ from those under the Baseline Condition during the April through August period at Bend Bridge and at Jelly's Ferry, as shown in Tables 9-12 and 9-13. In fact, in 345 out of the 345 months included in the analysis, the water temperatures under the Flexible Purchase Alternative at these locations would be essentially equivalent to water temperatures under the Baseline Condition. (See Appendix H pgs. 463-467 and 475-479.)

Throughout the April through August period, Sacramento River water temperatures would not exceed NOAA Fisheries temperature criteria more frequently under the Flexible Purchase Alternative than under the Baseline Condition. Under the Flexible Purchase Alternative, there would not be any additional occurrences in which water temperatures at Bend Bridge in the Sacramento River under the Flexible Purchase Alternative would exceed 56°F, relative to the Baseline Condition. (See Appendix H pgs. 475-479.)

Table 9-14 shows the annual survival estimates for winter-run Chinook salmon in the Sacramento River for all 69 years modeled. The long-term average annual early lifestage survival for winter-run Chinook salmon in the Sacramento River would be 93.4 percent under the Baseline Condition and 93.4 percent under the Flexible Purchase Alternative. Substantial increases or decreases in survival would not occur in any individual year of the 69-year simulation. In five years under the Flexible Purchase Alternative, there would be slight reductions in annual early lifestage survival for winter-run Chinook salmon in the Sacramento River. However, the maximum relative reduction in annual early lifestage survival would be 0.1 percent, relative to the Baseline Condition. Potential reductions in annual early lifestage survival could have the greatest impact in years with low survival (dry or critically dry water years, including 1924, 1931, 1932, 1933, 1934, and 1977). However, implementation of the Flexible Purchase Alternative would not result in reductions in simulated annual early lifestage survival in those years, as shown in Table 9-14.

Table 9-14
Sacramento River Salmon Survival – Winter-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	*Baseline Condition Survival (%)*	*Flexible Purchase Alternative Survival (%)*	*Absolute Difference (%)*	*Relative Difference (%)*
1922	98.8	98.7	-0.1	-0.1
1923	95.8	95.8	0.0	0.0
1924	7.1	7.1	0.0	0.0
1925	98.3	98.3	0.0	0.0
1926	97.5	97.5	0.0	0.0
1927	99.2	99.2	0.0	0.0
1928	98.3	98.3	0.0	0.0
1929	99.1	99.1	0.0	0.0

Table 9-14
Sacramento River Salmon Survival – Winter-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	Baseline Condition Survival (%)	Flexible Purchase Alternative Survival (%)	Absolute Difference (%)	Relative Difference (%)
1930	96.8	96.8	0.0	0.0
1931	30.1	30.1	0.0	0.0
1932	67.6	67.6	0.0	0.0
1933	70.4	70.4	0.0	0.0
1934	29.0	29.0	0.0	0.0
1935	97.5	97.5	0.0	0.0
1936	95.4	95.4	0.0	0.0
1937	98.9	98.9	0.0	0.0
1938	98.2	98.2	0.0	0.0
1939	98.2	98.2	0.0	0.0
1940	98.6	98.6	0.0	0.0
1941	99.3	99.2	-0.1	-0.1
1942	98.9	98.9	0.0	0.0
1943	99.1	99.1	0.0	0.0
1944	98.5	98.5	0.0	0.0
1945	99.1	99.1	0.0	0.0
1946	99.3	99.3	0.0	0.0
1947	96.0	96.0	0.0	0.0
1948	98.7	98.7	0.0	0.0
1949	98.8	98.8	0.0	0.0
1950	98.8	98.8	0.0	0.0
1951	99.1	99.1	0.0	0.0
1952	99.1	99.1	0.0	0.0
1953	99.1	99.1	0.0	0.0
1954	99.5	99.5	0.0	0.0
1955	98.5	98.5	0.0	0.0
1956	98.6	98.6	0.0	0.0
1957	98.8	98.8	0.0	0.0
1958	98.7	98.7	0.0	0.0
1959	94.7	94.7	0.0	0.0
1960	97.9	97.9	0.0	0.0
1961	99.0	99.0	0.0	0.0
1962	98.6	98.6	0.0	0.0
1963	98.4	98.4	0.0	0.0
1964	99.2	99.2	0.0	0.0
1965	96.4	96.4	0.0	0.0
1966	99.2	99.2	0.0	0.0
1967	98.9	98.9	0.0	0.0
1968	98.9	98.9	0.0	0.0
1969	99.0	98.9	-0.1	-0.1
1970	98.6	98.6	0.0	0.0
1971	98.7	98.7	0.0	0.0
1972	99.4	99.4	0.0	0.0
1973	98.2	98.2	0.0	0.0
1974	98.2	98.1	-0.1	-0.1
1975	98.7	98.7	0.0	0.0
1976	98.1	98.1	0.0	0.0
1977	43.2	43.2	0.0	0.0
1978	96.5	96.5	0.0	0.0
1979	98.9	98.9	0.0	0.0
1980	99.4	99.4	0.0	0.0
1981	98.8	98.8	0.0	0.0

Table 9-14 Sacramento River Salmon Survival – Winter-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions				
Water Year	**Baseline Condition Survival (%)**	**Flexible Purchase Alternative Survival (%)**	**Absolute Difference (%)**	**Relative Difference (%)**
1982	99.0	98.9	-0.1	-0.1
1983	99.5	99.5	0.0	0.0
1984	99.2	99.2	0.0	0.0
1985	99.1	99.1	0.0	0.0
1986	99.0	99.0	0.0	0.0
1987	99.2	99.2	0.0	0.0
1988	96.0	96.0	0.0	0.0
1989	99.0	99.0	0.0	0.0
1990	98.0	98.0	0.0	0.0
Mean:	93.4	93.4	0.0	0.0
Median:	98.7	98.7	0.0	0.0
Min:	7.1	7.1	-0.1	-0.1
Max:	99.5	99.5	0.0	0.0
Year Counts				
0.0 > X > = -1.0			5	5
-1.0 > X > = -2.0			0	0
-2.0 > X > = -4.0			0	0
-4.0 > X > = -6.0			0	0
X < -6.0			0	0
0.0 < X < = 1.0			0	0
1.0 < X < = 2.0			0	0
2.0 < X < = 4.0			0	0
4.0 < X < = 6.0			0	0
X > 6.0			0	0
No Difference (X = 0.0)			64	64

Flow-related Impacts on Juvenile Winter-run Chinook Salmon Rearing and Emigration (August through December)

Under the Flexible Purchase Alternative, the simulated long-term average flow below Keswick Dam would decrease, relative to the Baseline Condition, as shown in Table 9-9. Long-term average flows in the Sacramento River would decrease by up to 0.5 percent (58 cfs) in August, 0.2 percent (56 cfs) in September, and would increase by 0.9 percent (117 cfs) in July. In 356 out of the 360 months simulated for the Flexible Purchase Alternative, monthly mean flows in the Sacramento River below Keswick Dam would be essentially equivalent to those under the Baseline Condition. (See Appendix H pgs. 349-360.) In addition, flows would not be reduced below the 3,250 cfs flow criterion specified by the NOAA Fisheries winter-run Chinook salmon biological opinion more frequently under the Flexible Purchase Alternative compared to the Baseline Condition during the October through December period in which flow requirements must be maintained. (See Appendix H pgs. 349-360.) Long-term average flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would be increased from August through October, and would not differ substantially during November and December, relative to flows under the Baseline Condition. (See Table 9-10.) In August and September, long-term average flows would increase by approximately 640 cfs to 2170 cfs (up to 15.7 percent). In 360 out of the 360 months modeled, monthly mean flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows simulated under the Baseline Condition. (See Appendix H pgs. 385-396.)

Temperature-related Impacts on Juvenile Winter-run Chinook Salmon Rearing and Emigration (August through December)

Long-term average water temperatures in the Sacramento River at Bend Bridge under the Flexible Purchase Alternative would not change during any month of the August through December period, relative to the Baseline Condition, as shown in Table 9-12. Monthly mean water temperatures at Bend Bridge in the Sacramento River would be essentially equivalent to those under the Baseline Condition in 343 months of the 345 months simulated for the August through December period. Further, monthly mean water temperatures under the Flexible Purchase Alternative would not exceed 65°F, the upper end of the suitable range of water temperatures for juvenile Chinook salmon, more frequently than under the Baseline Condition. (See Appendix H pgs. 469-480.) In fact, monthly mean water temperatures under the Baseline Condition and Flexible Purchase Alternative would remain below 65°F at this location for 339 of the 345 months included in the analysis.

Long-term average water temperatures in the Sacramento River at Jelly's Ferry under the Flexible Purchase Alternative would not change in August, October, November, and December, and would increase by 0.1°F in September, relative to the Baseline Condition, as shown in Table 9-13. Monthly mean water temperatures at Jelly's Ferry in the Sacramento River would be essentially equivalent to those under the Baseline Condition in 344 of the 345 months simulated for the August through December period. Further, monthly mean water temperatures under the Flexible Purchase Alternative would not exceed 65°F, the upper end of the suitable range of water temperatures for juvenile Chinook salmon, more frequently than under the Baseline Condition. In fact, monthly mean water temperatures under the Baseline Condition and Flexible Purchase Alternative would remain below 65°F at this location in 340 of the 345 months included in the analysis. (See Appendix H pgs. 457-468.)

NOAA Fisheries temperature criteria for winter-run Chinook salmon at Bend Bridge and Jelly's Ferry are applicable during August through October of the juvenile emigration period. Under the Flexible Purchase Alternative, there would not be any additional occurrences during August and September in which simulated monthly mean water temperatures in the Sacramento River at Bend Bridge would be above 56°F, relative to the Baseline Condition. (See Appendix H pgs. 479-480.) Similarly, at Jelly's Ferry in the Sacramento River, there would not be any additional occurrences during October when water temperatures would be greater than 60°F (the temperature criterion for Jelly's Ferry in October) during October, relative to the Baseline Condition. (See Appendix H pg. 457.)

Long-term average water temperatures in the Sacramento River at Freeport under the Flexible Purchase Alternative would not change during October and November, relative to the Baseline Condition, and would decrease 0.1°F during August, September, and December. (See Table 9-11.) Monthly mean water temperatures in the Sacramento River at Freeport would be essentially equivalent to or less than water temperatures under the Baseline Condition in 345 out of the 345 months modeled for the August through December period. (See Appendix H pgs. 481-492.) Further, water temperatures under the Flexible Purchase Alternative at this location would not exceed 65°F more frequently than under the Baseline Condition. (See Appendix H pgs. 481-492.)

Summary of Impacts on Sacramento River Winter-run Chinook Salmon

In summary, the increases in flow during the December through July period that would be expected to occur in the Sacramento River below Keswick Dam and at Freeport under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect attraction or passage of adult winter-run Chinook salmon immigrating into the Sacramento River. Changes in Sacramento River flows during the April through August period would not be of sufficient frequency or magnitude to beneficially or adversely affect spawning habitat availability and are not likely to beneficially or adversely impact long-term initial year-class strength. Although small flow reductions in the Sacramento River below Keswick Dam would occur in a few years during the August through December period, such changes would not be of sufficient frequency or magnitude to beneficially or adversely impact juvenile rearing and emigration.

Changes in Sacramento River water temperatures throughout the December through July period would not be of sufficient magnitude or frequency to beneficially or adversely affect adult immigration. Small temperature changes in the Sacramento River during the April through August period would not likely beneficially or adversely affect spawning, egg incubation, and initial rearing success. Changes in annual early lifestage survival would not be of sufficient magnitude to beneficially or adversely affect long-term initial year-class strength. Water temperature changes would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile rearing and emigration during the August through December period. Under the Flexible Purchase Alternative, there would be no additional occurrences, relative to the Baseline Condition, in which Sacramento River water temperatures would exceed the NOAA Fisheries Winter-run Chinook salmon BO temperature criterion.

The changes in flows and water temperatures in the Sacramento River that would occur under the Flexible Purchase Alternative, relative to the Baseline Condition, would not be of sufficient frequency or magnitude to beneficially or adversely affect winter-run Chinook salmon. Therefore, impacts on winter-run Chinook salmon in the Sacramento River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on Spring-run Chinook Salmon in the Sacramento River

Flow-related Impacts on Adult Spring-run Chinook Salmon Immigration and Holding (March through September)

Table 9-9 shows that long-term average flows in the Sacramento River below Keswick Dam under the Flexible Purchase Alternative would be within 0.9 percent of flows under the Baseline Condition, during all months of the adult immigration period (March through September). In 468 out of the 504 months simulated during this period, monthly mean flows in the Sacramento River below Keswick Dam would be essentially equivalent to or greater than flows under the Baseline Condition . (See Appendix H pgs. 349-360.)

Long-term average flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would not differ from flows under the Baseline Condition in March, and would increase by approximately 2 to 18 percent from April through September, relative to the Baseline Condition. (See Table 9-10.) Monthly mean flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 504 out of the 504 months modeled for the March through September period. (See Appendix H pgs. 390-396.)

Temperature-related Impacts on Adult Spring-run Chinook Salmon Immigration and Holding (March through September)

Long-term average water temperatures in the Sacramento River at Bend Bridge under the Flexible Purchase Alternative would not differ from those under the Baseline Condition during the March through September period, as shown in Table 9-12. At Jelly's Ferry, long-term average water temperatures under the Flexible Purchase Alternative would not differ from the Baseline Condition from March through August, and would increase by 0.1°F during September. (See Table 9-13.) Monthly mean water temperatures at Bend Bridge and Jelly's Ferry would be essentially equivalent to those under the Baseline Condition in 481 and 482 months, respectively, of the 483 months simulated for the March through September period. (See Appendix H pgs. 474-480 and 462-468.)

Long-term average water temperatures during the March through September period in the Sacramento River at Freeport under the Flexible Purchase Alternative would not change in March and July, would increase by 0.1°F in April, May and June, and would decrease by 0.1°F in August and September. (See Table 9-11.) Further, monthly mean water temperatures in the Sacramento River at Freeport under the Flexible Purchase Alternative would be essentially equivalent to water temperatures under the Baseline Condition in all of the 483 months included in the analysis. (See Appendix H pgs. 486-492.)

Flow-related Impacts on Adult Spring-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (August through January)

Long-term average flows in the Sacramento River below Keswick Dam under the Flexible Purchase Alternative would be within 0.8 percent of flows under the Baseline Condition during all months of the August through January period, as shown in Table 9-9. In 396 of the 432 months simulated during this period, Sacramento River flow below Keswick Dam would be essentially equivalent to flows under the Baseline Condition. (See Appendix H pgs. 349-360.)

Figures 9-10 through 9-15 show exceedance curves for the Sacramento River below Keswick Dam for the August through January period. The basis for development of these exceedance curves was the 1922-1993 period of record. These curves demonstrate that flows under the Flexible Purchase Alternative would be similar to those under the Baseline Condition at all flow ranges. The Flexible Purchase Alternative would result in only slight reductions in flows, relative to the Baseline Condition.

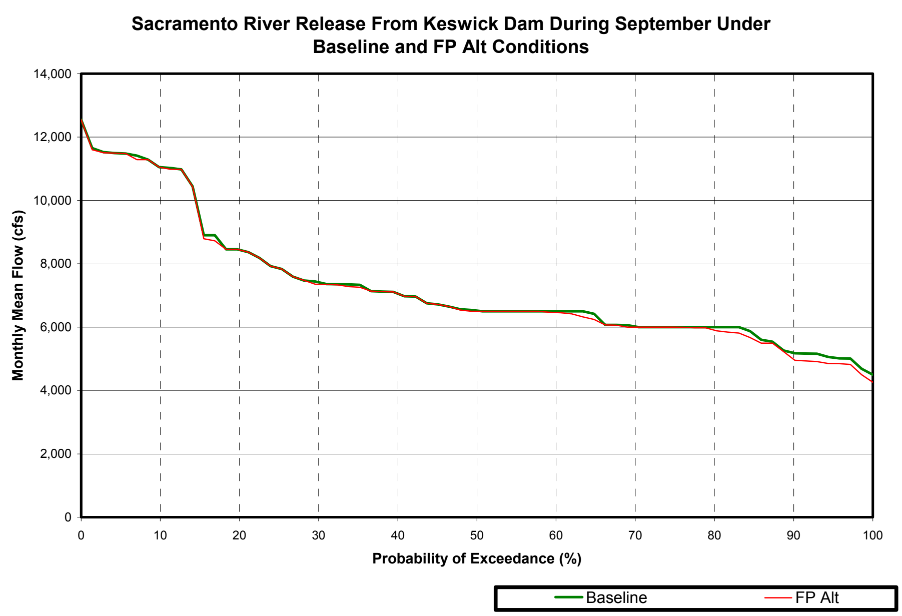

Figure 9-11
Sacramento River Release From Keswick Dam During September Under Baseline and Flexible Purchase Alternative Conditions

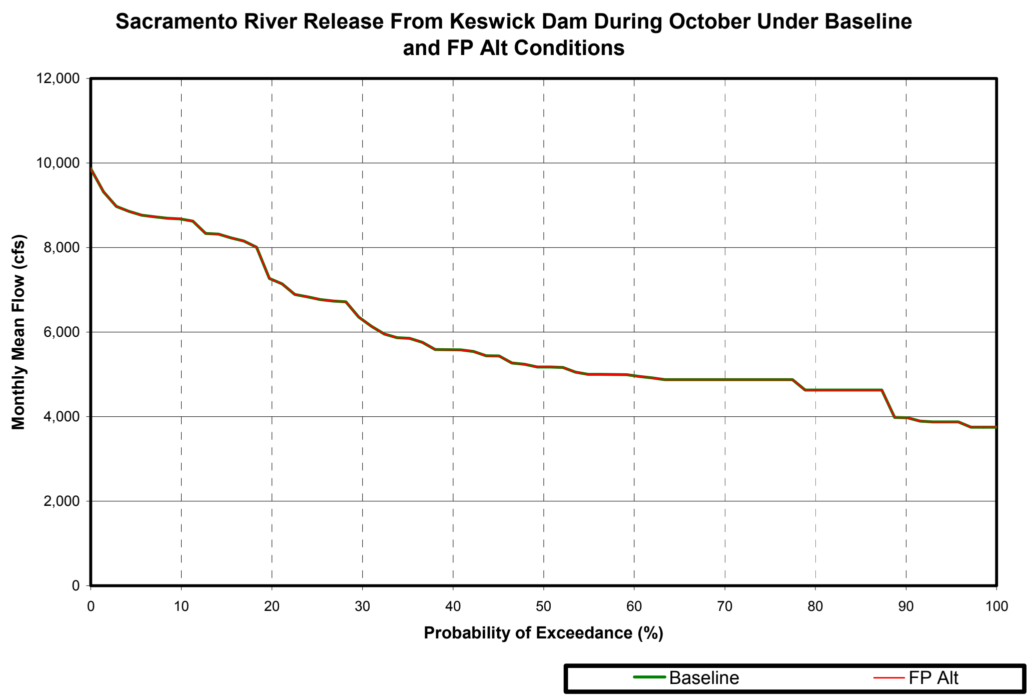

Figure 9-12
Sacramento River Release From Keswick Dam During October Under Baseline and Flexible Purchase Alternative Conditions

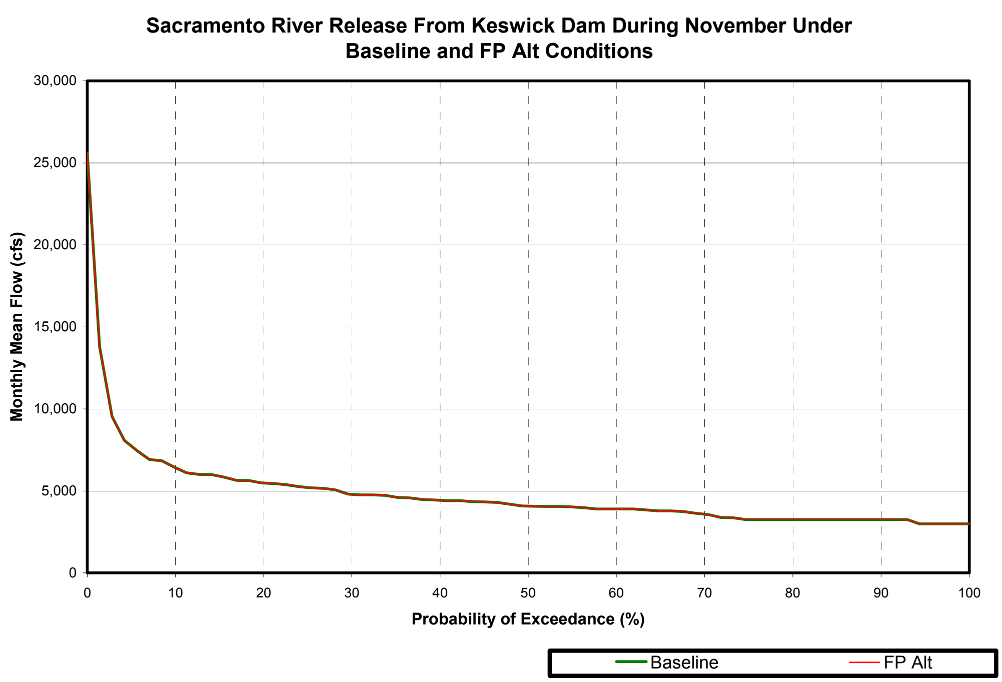

Figure 9-13
Sacramento River Release From Keswick Dam During November Under Baseline and Flexible Purchase Alternative Conditions

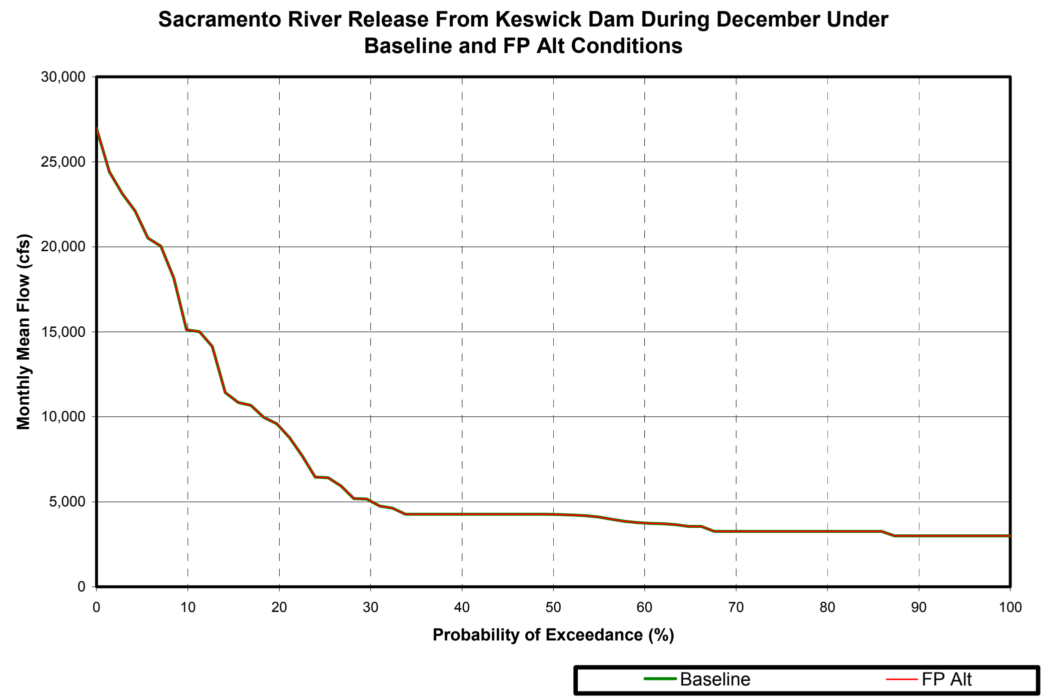

Figure 9-14
Sacramento River Release From Keswick Dam During December Under Baseline and Flexible Purchase Alternative Conditions

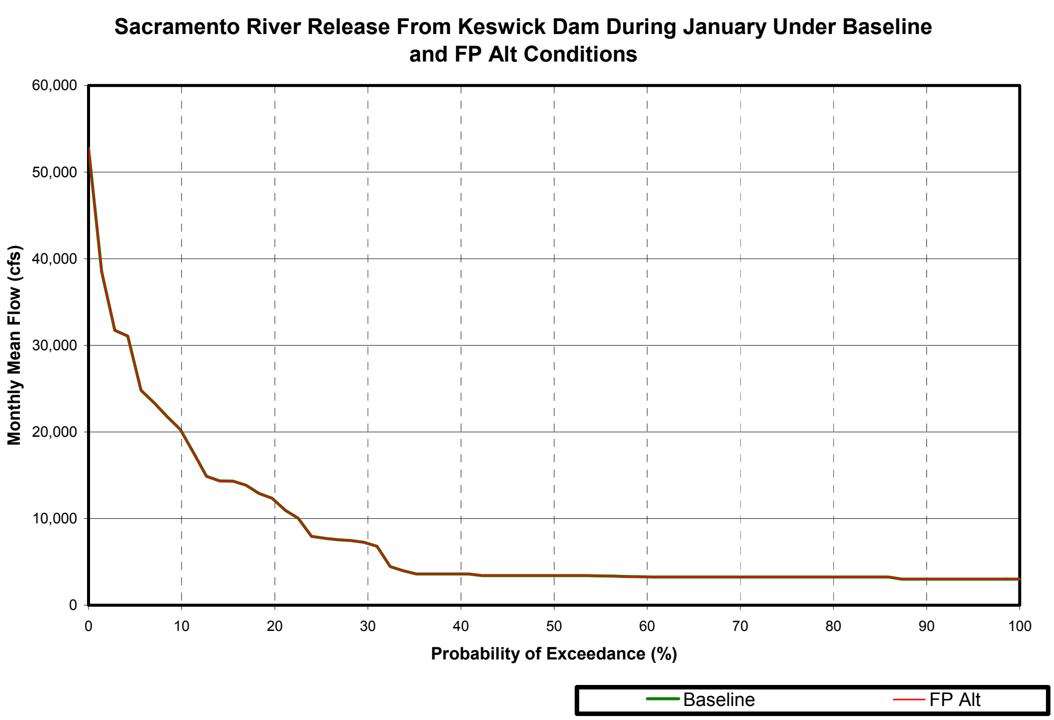

Figure 9-15
Sacramento River Release From Keswick Dam During January Under Baseline and Flexible Purchase Alternative Conditions

Temperature-related Impacts on Spring-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (August through January)

Under the Flexible Purchase Alternative, long-term average water temperatures in the Sacramento River at Bend Bridge would not differ to those under the Baseline Condition in any month of the August through January period. (See Table 9-12.) In fact, in 412 of the 414 months included in the analysis, monthly mean water temperatures at Bend Bridge under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition. (See Appendix H pgs. 457-468.) Further, there would not be any additional occurrences of water temperatures above 56°F under the Flexible Purchase Alternative, relative to the Baseline Condition, at Bend Bridge during the August through January period. (See Appendix H pgs. 457-468.)

Long-term average water temperatures under the Flexible Purchase Alternative at Jelly's Ferry in the Sacramento River would not change in August, October, November, December, and January, and would increase by 0.1°F in September, relative to the Baseline Condition. (See Table 9-13.) Monthly mean water temperatures at this location would be essentially equivalent to those under the Baseline Condition in 413 of the 414 months simulated for the August through January period. (See Appendix H pgs. 469-480.) In addition, implementation of the Flexible Purchase Alternative would not result in an increase in the frequency in which water temperatures would be above 65°F, relative to the Baseline Condition.

The long-term average annual early lifestage survival for spring-run Chinook salmon in the Sacramento River would be 87.5 percent under the Baseline Condition and 87.4 percent under the Flexible Purchase Alternative. Table 9-15 shows the annual survival estimates for spring-run Chinook salmon in the Sacramento River for the 69 years modeled. In 56 out of the 69 years modeled, there would be no difference in annual early lifestage survival of spring-run Chinook salmon between the Flexible Purchase Alternative and the Baseline Condition. In only 3 of 69 years, the relative decrease in survival would be greater than 0.1 percent. Such decreases in percent survival would range from 0.2 to 1.5 percent, relative to the Baseline Condition. Potential reductions in annual early lifestage survival could have the greatest impact in years with low survival (dry or critically dry water years, including 1924, 1931, 1932, 1933, 1934, and 1977). However, implementation of the Flexible Purchase Alternative would not result in reductions in simulated annual early lifestage survival in those years, as shown in Table 9-14.

Table 9-15
Sacramento River Salmon Survival – Spring-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	*Baseline Condition Survival (%)*	*Flexible Purchase Alternative Survival (%)*	*Absolute Difference (%)*	*Relative Difference (%)*
1922	97.0	97.0	0.0	0.0
1923	97.6	97.6	0.0	0.0
1924	5.3	5.3	0.0	0.0
1925	78.0	78.0	0.0	0.0
1926	73.9	73.9	0.0	0.0
1927	97.5	97.4	-0.1	-0.1
1928	96.8	96.8	0.0	0.0
1929	95.5	95.5	0.0	0.0
1930	97.1	97.1	0.0	0.0
1931	2.0	2.0	0.0	0.0
1932	0.4	0.4	0.0	0.0
1933	0.2	0.2	0.0	0.0
1934	1.9	1.9	0.0	0.0
1935	83.4	83.3	-0.1	-0.1
1936	92.5	91.1	-1.4	-1.5
1937	96.8	96.7	-0.1	-0.1
1938	96.6	96.6	0.0	0.0
1939	96.4	96.4	0.0	0.0
1940	97.3	97.3	0.0	0.0
1941	98.0	98.0	0.0	0.0
1942	97.4	97.4	0.0	0.0
1943	97.4	97.4	0.0	0.0
1944	95.6	95.4	-0.2	-0.2
1945	97.3	97.3	0.0	0.0
1946	98.4	98.4	0.0	0.0
1947	97.6	97.6	0.0	0.0
1948	96.4	96.3	-0.1	-0.1
1949	98.1	98.1	0.0	0.0
1950	97.2	97.2	0.0	0.0
1951	97.6	97.6	0.0	0.0
1952	97.2	97.1	-0.1	-0.1
1953	97.6	97.6	0.0	0.0
1954	97.6	97.6	0.0	0.0
1955	96.1	96.1	0.0	0.0
1956	96.9	96.9	0.0	0.0
1957	97.0	97.0	0.0	0.0
1958	96.6	96.5	-0.1	-0.1
1959	92.7	92.7	0.0	0.0
1960	95.9	95.9	0.0	0.0
1961	96.9	96.9	0.0	0.0
1962	96.2	96.2	0.0	0.0
1963	94.5	94.0	-0.5	-0.5
1964	96.4	96.4	0.0	0.0
1965	97.0	97.0	0.0	0.0
1966	97.1	97.1	0.0	0.0
1967	96.4	96.4	0.0	0.0
1968	96.4	96.4	0.0	0.0
1969	96.5	96.5	0.0	0.0

Table 9-15
Sacramento River Salmon Survival – Spring-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	Baseline Condition Survival (%)	Flexible Purchase Alternative Survival (%)	Absolute Difference (%)	Relative Difference (%)
1970	96.5	96.5	0.0	0.0
1971	96.1	96.1	0.0	0.0
1972	97.0	97.0	0.0	0.0
1973	96.4	96.4	0.0	0.0
1974	96.1	96.0	-0.1	-0.1
1975	96.8	96.7	-0.1	-0.1
1976	92.3	92.3	0.0	0.0
1977	2.5	2.5	0.0	0.0
1978	96.3	96.2	-0.1	-0.1
1979	97.1	97.1	0.0	0.0
1980	97.5	97.5	0.0	0.0
1981	96.7	96.7	0.0	0.0
1982	97.0	96.9	-0.1	-0.1
1983	98.4	98.4	0.0	0.0
1984	97.0	97.0	0.0	0.0
1985	98.1	98.1	0.0	0.0
1986	97.6	97.6	0.0	0.0
1987	96.0	96.0	0.0	0.0
1988	92.7	92.7	0.0	0.0
1989	97.3	97.3	0.0	0.0
1990	88.8	88.8	0.0	0.0
Mean:	87.5	87.4	0.0	0.0
Median:	96.7	96.7	0.0	0.0
Min:	0.2	0.2	-1.4	-1.5
Max:	98.4	98.4	0.0	0.0
Year Counts				
0.0 > X > = -1.0			12	12
-1.0 > X > = -2.0			1	1
-2.0 > X > = -4.0			0	0
-4.0 > X > = -6.0			0	0
X < -6.0			0	0
0.0 < X < = 1.0			0	0
1.0 < X < = 2.0			0	0
2.0 < X < = 4.0			0	0
4.0 < X < = 6.0			0	0
X > 6.0			0	0
No Difference (X = 0.0)			56	56

Flow-related Impacts on Juvenile Spring-run Chinook Salmon Rearing and Emigration (December through April)

Under the Flexible Purchase Alternative, long-term average flows in the Sacramento River below Keswick Dam would not differ from flows modeled under the Baseline Condition during the December through April period. (See Table 9-9.) In 360 out of the 360 months simulated, monthly mean flows below Keswick Dam under the Flexible Purchase Alternative would be essentially equivalent to flows under the Baseline Condition. (See Appendix H pgs. 351-355.) Flow exceedance curves during the December through April period are shown for the Sacramento River below

Keswick Dam in Figure 9-16 through Figure 9-20. The basis for development of these exceedance curves was the 1922-1993 period of record. The flow exceedance curves indicate that flows below Keswick Dam under the Flexible Purchase Alternative would be nearly identical to flows under the Baseline Condition.

Long-term average flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would be within approximately 2 percent of flows under the Baseline Condition throughout the December through April period. (See Table 9-10.) Monthly mean flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 360 out of the 360 months modeled for the December through April period. (See Appendix H pgs. 387-391.)

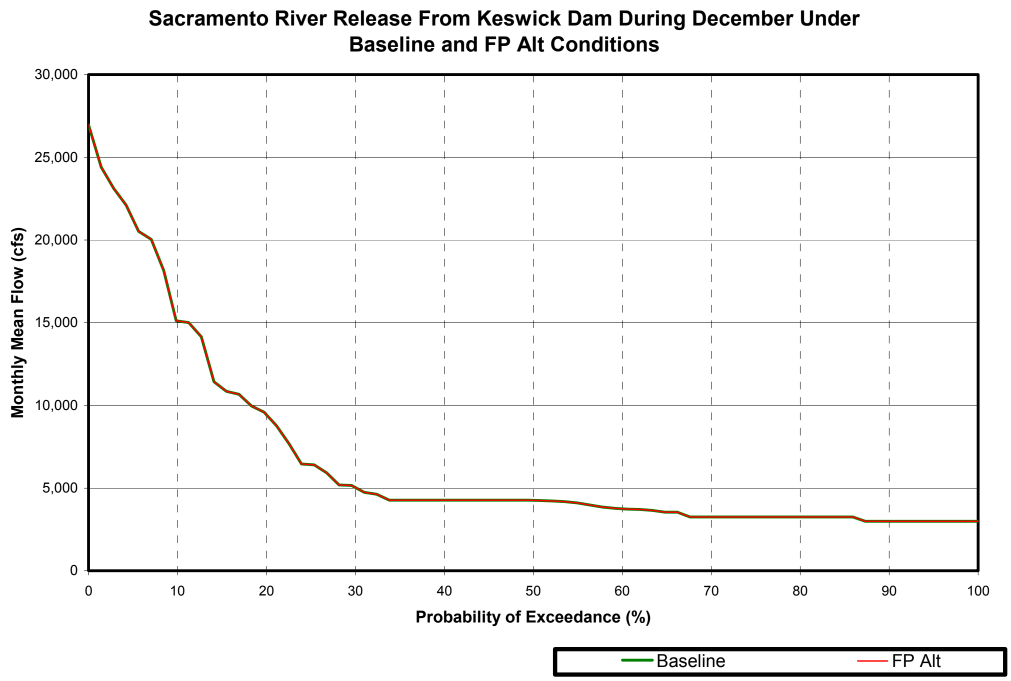

Figure 9-16
Sacramento River Release From Keswick Dam During December Under Baseline and Flexible Purchase Alternative Conditions

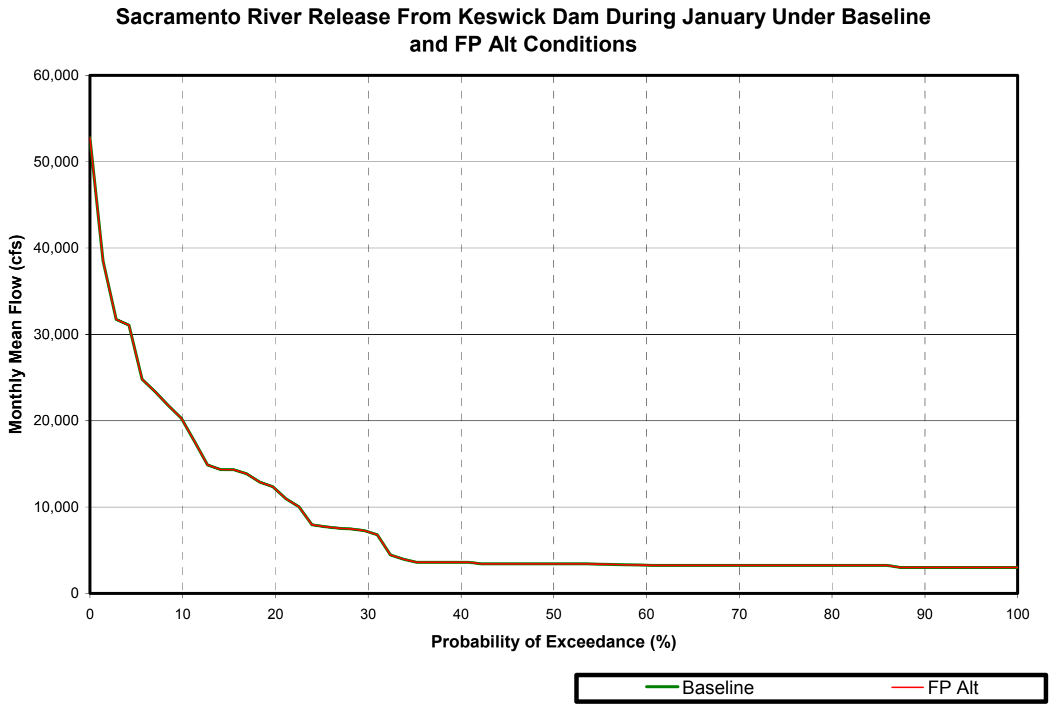

Figure 9-17
Sacramento River Release From Keswick Dam During January Under Baseline and Flexible Purchase Alternative Conditions

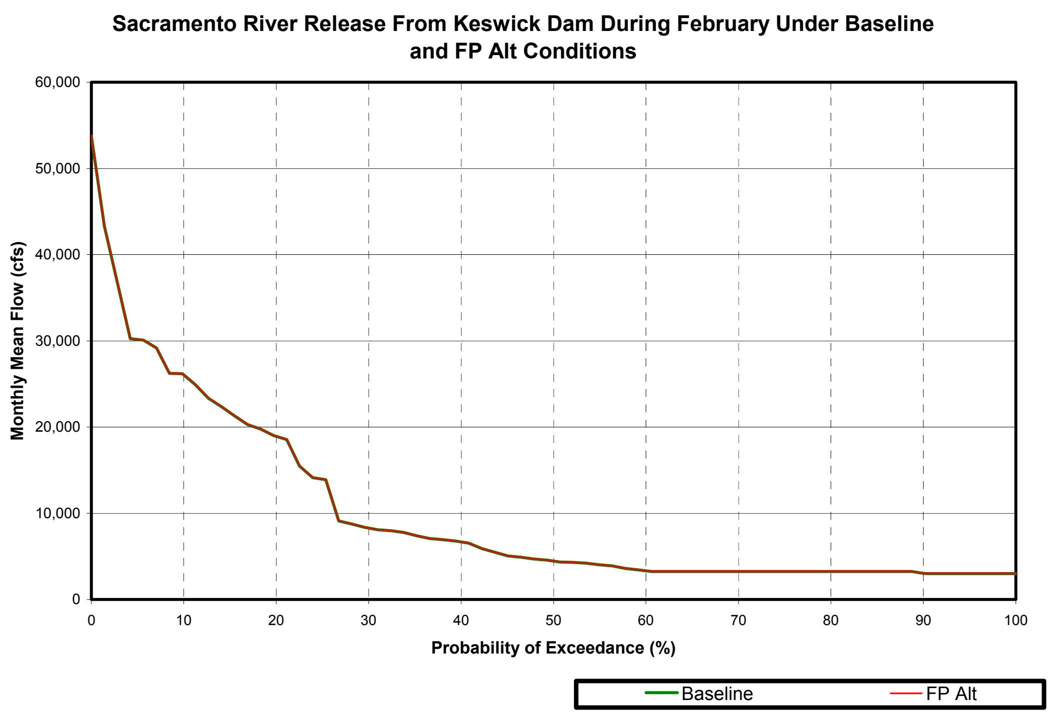

Figure 9-18
Sacramento River Release From Keswick Dam During February Under Baseline and Flexible Purchase Alternative Conditions

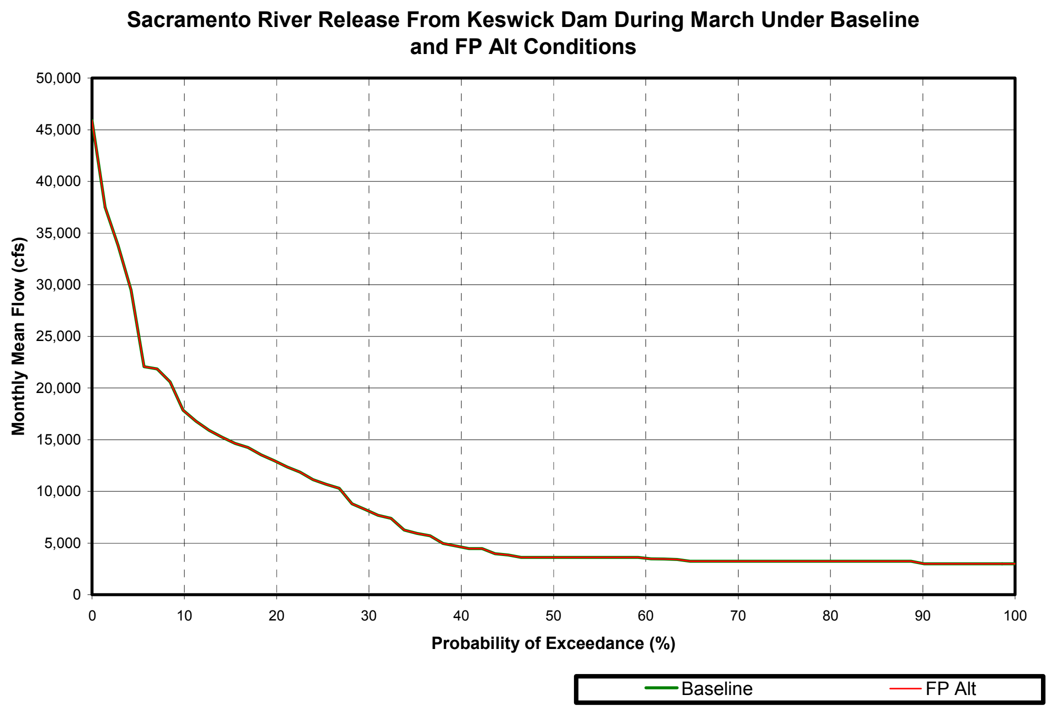

Figure 9-19
Sacramento River Release from Keswick Dam During March Under Baseline and Flexible Purchase Alternative Conditions

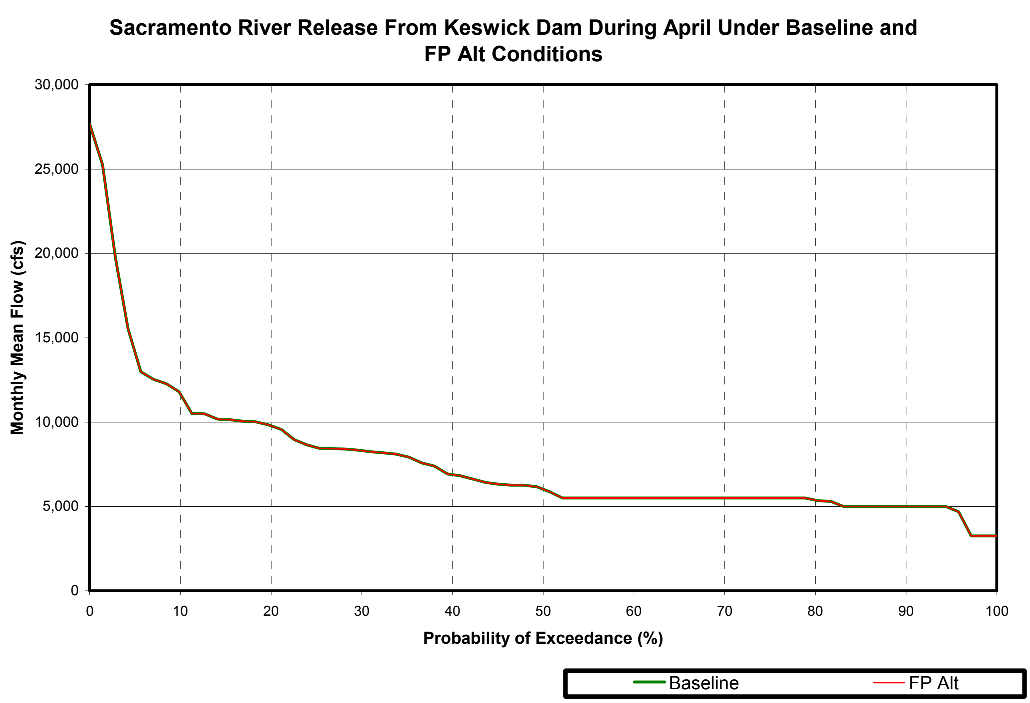

Figure 9-20
Sacramento River Release from Keswick Dam During April Under Baseline and Flexible Purchase Alternative Conditions

Overall, flows in the Sacramento River below Keswick Dam and at Freeport would not differ substantially under the Flexible Purchase Alternative, relative to the Baseline Condition.

Temperature-related Impacts on Juvenile Spring-run Chinook Salmon Rearing and Emigration (December through April)

Modeling associated with the Flexible Purchase Alternative indicates that long-term average water temperatures at Bend Bridge would not change during any month of the December through August period, compared to the Baseline Condition, as shown in Table 9-12. Further, monthly mean water temperatures in the Sacramento River at Bend Bridge under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 345 months simulated for the December through April period. (See Appendix H pgs. 471-475.) Further, the Flexible Purchase Alternative would not result in an increase in the frequency in which monthly mean water temperatures would exceed 65°F for each month of the December through April period. (See Appendix H pgs. 471-475.)

Long-term average water temperatures under the Flexible Purchase Alternative at Jelly's Ferry in the Sacramento River would not differ from those under the Baseline Condition throughout the December through April period, as shown in Table 9-13. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 345 out of the 345 months modeled for the December through April period. (See Appendix H pgs. 459-463.) Further, the Flexible Purchase Alternative would not result in an increase in the frequency in which monthly mean water temperatures would exceed 65°F at Jelly's Ferry in the Sacramento River, relative to the Baseline Condition, for a given month modeled throughout the juvenile rearing and emigration period. (See Appendix H pgs. 459-463.)

Similarly, long-term average water temperatures under the Flexible Purchase Alternative at Freeport in the Sacramento River would decrease by 0.1°F during December, would not change from January through March, and would increase by 0.1°F during April, relative to the Baseline Condition, as shown in Table 9-11. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 345 out of the 345 months modeled for the December through April period. (See Appendix H pgs. 483-487.) Further, the Flexible Purchase Alternative would not result in an increase in the frequency in which monthly mean water temperatures would exceed 65°F at Freeport in the Sacramento River, relative to the Baseline Condition, for a given month modeled throughout the juvenile rearing and emigration period. (See Appendix H pgs. 483-487.)

Overall, the Flexible Purchase Alternative would result in negligible changes in Sacramento River water temperatures at Bend Bridge, Jelly's Ferry, and Freeport throughout the December through April juvenile spring-run Chinook salmon rearing and emigration period. In addition, the frequency in which monthly mean water temperatures at Bend Bridge, Jelly's Ferry, or Freeport would exceed the upper end of the suitable range of water temperatures for juvenile Chinook salmon rearing would not increase under the Flexible Purchase Alternative.

Summary of Impacts on Spring-Run Chinook Salmon in the Sacramento River

In summary, the difference in Sacramento River flows below Keswick Dam and at Freeport during the March through September period that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect attraction, passage, and holding of adult spring-run Chinook salmon immigrating into the Sacramento River. Similarly, changes in flow in the Sacramento River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect spawning, egg incubation, and initial rearing during the August through January period. Slight increases in flow that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile rearing and emigration during the December through April period.

Changes in Sacramento River water temperatures under the Flexible Purchase Alternative during the March through September period would not be of sufficient frequency or magnitude to beneficially or adversely affect adult spring-run Chinook salmon immigration and holding. Potential water temperature changes during the August through January period in the Sacramento River resulting from the implementation of the Flexible Purchase Alternative may affect, but are not likely to adversely affect, adult spring-run Chinook salmon spawning, egg incubation, and initial rearing. Changes in annual early lifestage survival under the Flexible Purchase Alternative would not be of sufficient magnitude to beneficially or adversely impact initial year-class strength of spring-run Chinook salmon in the Sacramento River. Changes in water temperatures under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile spring-run Chinook salmon rearing and emigration.

Overall, the changes in flows and water temperatures in the Sacramento River under the Flexible Purchase Alternative, relative to the baseline, would not be of sufficient frequency or magnitude to beneficially or adversely impact spring-run Chinook salmon. Therefore, impacts on spring-run Chinook salmon in the Sacramento River with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, would be less than significant.

<u>Impacts on Fall-run Chinook Salmon and Steelhead in the Sacramento River</u>

Flow-related Impacts on Adult Fall-run Chinook Salmon/Steelhead Immigration (September through November)

Table 9-9 shows that long-term average flows in the Sacramento River below Keswick Dam would differ by less than 0.8 percent (56 cfs) under the Flexible Purchase

Alternative, compared to the Baseline Condition, during all months of the adult immigration period (September through November). Under the Flexible Purchase Alternative, Sacramento River flows below Keswick Dam would be essentially equivalent to those under the Baseline Condition in 200 out of the 216 months simulated during this period. (See Appendix H pgs. 349-360.)

Long-term average flows under the Flexible Purchase Alternative in the Sacramento River at Freeport would be within one percent of flows under the Baseline Condition in October and November, and would increase by approximately 5 percent in September, relative to the Baseline Condition. (See Table 9-10.) Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 216 out of the 216 months modeled for the September through November period. (See Appendix H pgs. 385-396.)

Temperature-related Impacts on Adult Fall-run Chinook Salmon/Steelhead Immigration (September through November)

Long-term average water temperatures modeled for the Flexible Purchase Alternative would not differ from those under the Baseline Condition at Bend Bridge in the Sacramento River during all months of the September through November adult immigration period, as shown in Table 9-12. At Jelly's Ferry, long-term average water temperatures in the Sacramento River would not differ between the Flexible Purchase Alternative and Baseline Condition during October and November. (See Table 9-13.) In September, long-term average water temperatures at Jelly's Ferry would be 0.1°F greater under the Flexible Purchase Alternative than under the Baseline Condition. Moreover, under the Flexible Purchase Alternative, monthly mean water temperatures in the Sacramento River at Bend Bridge would remain essentially equivalent to those under the Baseline Condition in 205 out of the 207 months included in the analysis. (See Appendix H pgs. 469-480.) Monthly mean water temperatures at Jelly's Ferry under the Flexible Purchase Alternative would remain essentially equivalent to the Baseline Condition in 206 out of the 207 months included in the analysis. (Appendix H pgs. 457-468.)

Long-term average water temperatures under the Flexible Purchase Alternative at Freeport in the Sacramento River would be nearly identical to those under the Baseline Condition throughout the September through November period, as shown in Table 9-11. In fact, long-term average water temperatures under the Flexible Purchase Alternative at Freeport in the Sacramento River would decrease by 0.1°F in September, and would not change in October and November, relative to the Baseline Condition. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 207 out of the 207 months modeled for the September through November period. (See Appendix H pgs. 481-492.) Further, the Flexible Purchase Alternative would not result in an increase in the frequency in which monthly mean water temperatures would exceed 65°F at Freeport in the Sacramento River, relative to the Baseline Condition, for a given month simulated for the adult fall-run Chinook salmon and steelhead immigration period.

Flow-related Impacts on Adult Fall-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (October through February)

Long-term average flows in the Sacramento River below Keswick Dam under the Flexible Purchase Alternative would not differ from flows under the Baseline Condition during all months of the October through February period, as shown in Table 9-9. Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to flows under the Baseline Condition in 360 out of the 360 months simulated for the October through February period. (See Appendix H pgs. 349-353.)

Figure 9-12 through Figure 9-14, Figure 9-17, and Figure 9-21 show exceedance curves for the Sacramento River below Keswick Dam for the October through February period. The basis for development of these exceedance curves was the 1922-1993 period of record. These curves demonstrate that flows under the Flexible Purchase Alternative would be essentially identical to those under the Baseline Condition. Therefore, changes in flow that could potentially reduce the amount of available Chinook salmon spawning habitat would not be expected to occur under the Flexible Purchase Alternative, relative to the Baseline Condition.

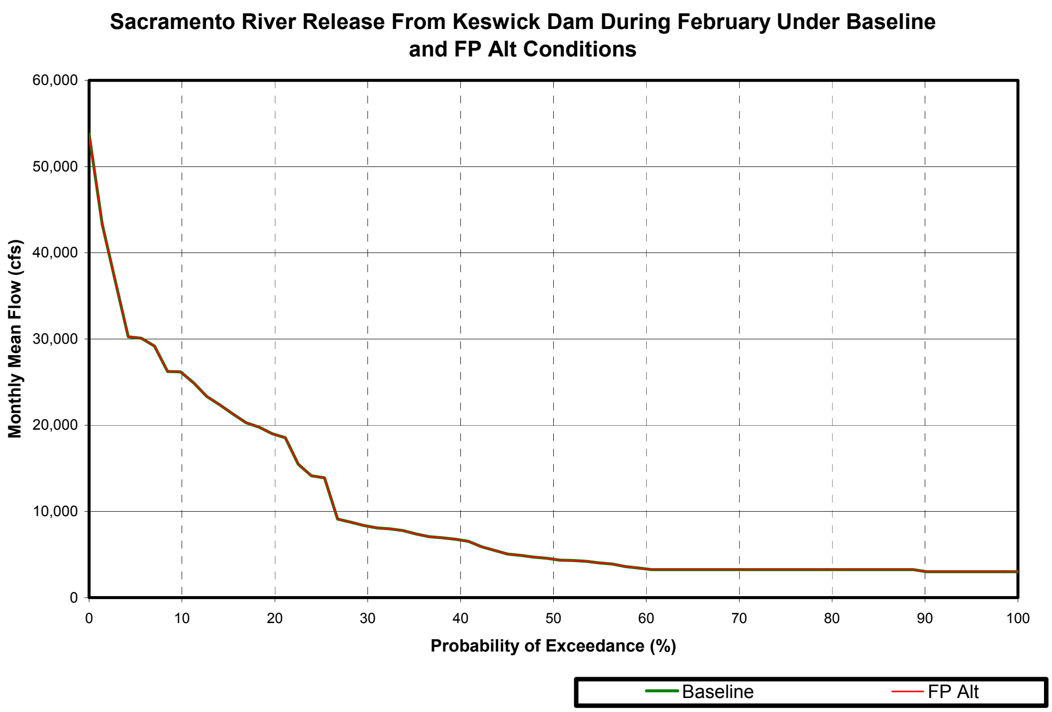

Figure 9-21
Sacramento River Release From Keswick Dam During February Under Baseline and Flexible Purchase Alternative Conditions

Temperature-related Impacts on Adult Fall-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (October through February)

Under the Flexible Purchase Alternative, long-term average water temperatures would not differ from those modeled under the Baseline Condition during the October through February period at Bend Bridge and Jelly's Ferry, as shown in Tables 9-12 and 9-18. In fact, in 345 out of the 345 months included in the analysis, monthly mean water temperatures at these locations under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition. (See Appendix H pgs. 457-461 and 469-473.) In addition, there would not be any additional occurrences in the Sacramento River at Bend Bridge or Jelly's Ferry of monthly mean water temperatures greater than 56°F, relative to the Baseline Condition, in any month simulated for the October through February period. (See Appendix H pgs. 457-461 and 469-473.) Further, water temperatures at Bend Bridge and Jelly's Ferry during December, January, and February would be below 56°F in all 69 years modeled under both the Flexible Purchase Alternative and Baseline Condition. (See Appendix H pgs. 457-461 and 469-473.)

The long-term average annual early lifestage survival for fall-run Chinook salmon in the Sacramento River would be 91.2 percent under the Baseline Condition and 91.1 percent under the Flexible Purchase Alternative. Table 9-16 shows the annual survival estimates for each year of the 69 years modeled. Under the Flexible Purchase Alternative, annual early lifestage survival would not change in 56 of the 69 years simulated, relative to the Baseline Condition. Reductions in annual early lifestage survival of 0.1 to 0.7 percent, relative to the Baseline Condition, would occur in 11 years of the 69-year simulation. In 8 of these years, reductions in survival would be 0.1 percent, relative to the Baseline Condition, and in 3 years, reductions in survival of 0.2 percent, 0.3 percent, and 0.7 percent would occur. In addition, increases in survival of 0.1 percent, relative to the Baseline Condition, would occur in 3 of the 69 years simulated. Potential reductions in annual early lifestage survival could have the greatest impact in years with low survival (dry or critically dry water years, including 1924, 1931, 1932, 1933, 1934, and 1977). However, implementation of the Flexible Purchase Alternative would not result in reductions in simulated annual early lifestage survival in those years, as shown in Table 9-14.

Table 9-16
Sacramento River Salmon Survival – Fall-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	***Baseline Condition Survival (%)***	***Flexible Purchase Alternative Survival (%)***	***Absolute Difference (%)***	***Relative Difference (%)***
1922	95.8	95.8	0.0	0.0
1923	92.9	92.9	0.0	0.0
1924	72.3	72.3	0.0	0.0
1925	78.6	78.6	0.0	0.0
1926	74.9	74.9	0.0	0.0
1927	96.3	96.2	-0.1	-0.1
1928	95.9	95.9	0.0	0.0
1929	83.1	83.1	0.0	0.0
1930	94.1	94.1	0.0	0.0

Table 9-16
Sacramento River Salmon Survival – Fall-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	Baseline Condition Survival (%)	Flexible Purchase Alternative Survival (%)	Absolute Difference (%)	Relative Difference (%)
1931	66.7	66.7	0.0	0.0
1932	61.8	61.8	0.0	0.0
1933	59.9	59.9	0.0	0.0
1934	65.9	65.9	0.0	0.0
1935	80.0	79.9	-0.1	-0.1
1936	80.7	80.1	-0.6	-0.7
1937	96.4	96.4	0.0	0.0
1938	96.7	96.7	0.0	0.0
1939	88.8	88.8	0.0	0.0
1940	96.1	96.1	0.0	0.0
1941	98.4	98.4	0.0	0.0
1942	98.0	98.0	0.0	0.0
1943	95.5	95.5	0.0	0.0
1944	92.7	92.5	-0.2	-0.2
1945	94.8	94.8	0.0	0.0
1946	97.9	97.9	0.0	0.0
1947	93.6	93.6	0.0	0.0
1948	96.0	95.9	-0.1	-0.1
1949	97.8	97.8	0.0	0.0
1950	97.2	97.2	0.0	0.0
1951	97.0	97.0	0.0	0.0
1952	98.2	98.2	0.0	0.0
1953	98.1	98.1	0.0	0.0
1954	96.3	96.3	0.0	0.0
1955	93.5	93.5	0.0	0.0
1956	98.4	98.4	0.0	0.0
1957	95.2	95.3	0.1	0.1
1958	94.5	94.5	0.0	0.0
1959	80.0	80.0	0.0	0.0
1960	93.2	93.2	0.0	0.0
1961	94.2	94.2	0.0	0.0
1962	91.7	91.8	0.1	0.1
1963	93.4	93.1	-0.3	-0.3
1964	92.9	92.9	0.0	0.0
1965	95.1	95.1	0.0	0.0
1966	94.1	94.1	0.0	0.0
1967	95.8	95.8	0.0	0.0
1968	94.6	94.5	-0.1	-0.1
1969	97.5	97.5	0.0	0.0
1970	95.8	95.8	0.0	0.0
1971	97.6	97.6	0.0	0.0
1972	96.0	96.0	0.0	0.0
1973	96.7	96.7	0.0	0.0
1974	97.6	97.6	0.0	0.0
1975	96.7	96.7	0.0	0.0
1976	89.2	89.2	0.0	0.0
1977	66.8	66.8	0.0	0.0
1978	94.3	94.3	0.0	0.0
1979	95.1	95.1	0.0	0.0

Table 9-16
Sacramento River Salmon Survival – Fall-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	Baseline Condition Survival (%)	Flexible Purchase Alternative Survival (%)	Absolute Difference (%)	Relative Difference (%)
1980	96.2	96.2	0.0	0.0
1981	95.7	95.7	0.0	0.0
1982	97.4	97.3	-0.1	-0.1
1983	97.6	97.5	-0.1	-0.1
1984	96.1	96.0	-0.1	-0.1
1985	97.8	97.9	0.1	0.1
1986	96.9	96.8	-0.1	-0.1
1987	94.8	94.8	0.0	0.0
1988	83.0	83.0	0.0	0.0
1989	95.8	95.8	0.0	0.0
1990	81.0	81.0	0.0	0.0
Mean:	91.2	91.1	0.0	0.0
Median:	95.2	95.3	0.0	0.0
Min:	59.9	59.9	-0.6	-0.7
Max:	98.4	98.4	0.1	0.1
Year Counts				
0.0 > X >= -1.0			11	11
-1.0 > X >= -2.0			0	0
-2.0 > X >= -4.0			0	0
-4.0 > X >= -6.0			0	0
X < -6.0			0	0
0.0 < X <= 1.0			3	3
1.0 < X <= 2.0			0	0
2.0 < X <= 4.0			0	0
4.0 < X <= 6.0			0	0
X > 6.0			0	0
No Difference (X = 0.0)			55	55

Flow- and Temperature-related Impacts on Adult Steelhead Immigration, Spawning, and Egg Incubation (December through March)

Monthly mean flows below Keswick Dam and at Freeport in the Sacramento River under the Flexible Purchase Alternative would be essentially equivalent to flows under the Baseline Condition for 288 out of the 288 months simulated for the December through March period. (See Appendix H pgs. 351-354 and 387-390.) Additionally, monthly mean water temperatures under the Flexible Purchase Alternative at Bend Bridge and Jelly's Ferry would be essentially equivalent to water temperatures under the Baseline Condition for 276 of the 276 months included in the analysis. (See Appendix H pgs. 471-474 and 459-462.) Monthly mean water temperatures at Freeport under the Flexible Purchase Alternative would be essentially equivalent to water temperatures under the Baseline Condition in 276 out of the 276 months simulated during the December through March period. (See Appendix H pgs. 483-486.) Under the Flexible Purchase Alternative, the frequency in which water temperatures at Bend Bridge or Jelly's Ferry in the Sacramento River would exceed 56°F would not increase, relative to the Baseline Condition, throughout the December through March period. (See Appendix H pgs. 471-474 and 459-462.)

Steelhead survival cannot be estimated under the Flexible Purchase Alternative or Baseline Condition, because a steelhead mortality model has not been developed for the Sacramento River. However, as discussed in Section 9.2.1.2.1, output from the LSALMON 2 model for late-fall run Chinook salmon can be used as a conservative surrogate for steelhead survival estimates. For late-fall run Chinook salmon in the Sacramento River, the long-term average annual early lifestage survival would be 99.3 percent under both the Baseline Condition and Flexible Purchase Alternative. Table 9-17 shows the annual survival estimates for late-fall-run Chinook salmon in the Sacramento River for the 69 years modeled. Substantial increases or decreases in survival would not occur in any individual year of the 69-year simulation, relative to the Baseline Condition. In 67 out of the 69 years modeled, there would be no difference in annual early lifestage survival of late-fall-run Chinook salmon between the Flexible Purchase Alternative and the Baseline Condition. In the two years in which changes in annual early lifestage survival would occur, there would be one reduction in survival of 0.1 percent, as well as one increase in survival of 0.1 percent, relative to the Baseline Condition. Thus, decreases in late-fall run Chinook salmon survival under the Flexible Purchase Alternative would be negligible, relative to the Baseline Condition.

Table 9-17
Sacramento River Salmon Survival – Late-fall-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	***Baseline Condition Survival (%)***	***Flexible Purchase Alternative Survival (%)***	***Absolute Difference (%)***	***Relative Difference (%)***
1922	99.7	99.7	0.0	0.0
1923	99.0	99.0	0.0	0.0
1924	99.2	99.2	0.0	0.0
1925	99.1	99.1	0.0	0.0
1926	98.2	98.2	0.0	0.0
1927	99.9	99.9	0.0	0.0
1928	99.4	99.4	0.0	0.0
1929	97.4	97.4	0.0	0.0
1930	99.3	99.3	0.0	0.0
1931	98.6	98.6	0.0	0.0
1932	96.7	96.7	0.0	0.0
1933	96.9	96.9	0.0	0.0
1934	96.6	96.7	0.1	0.1
1935	98.3	98.3	0.0	0.0
1936	97.3	97.3	0.0	0.0
1937	99.7	99.7	0.0	0.0
1938	99.4	99.3	-0.1	-0.1
1939	98.5	98.5	0.0	0.0
1940	99.5	99.5	0.0	0.0
1941	99.9	99.9	0.0	0.0
1942	99.9	99.9	0.0	0.0
1943	99.7	99.7	0.0	0.0
1944	99.8	99.8	0.0	0.0
1945	99.8	99.8	0.0	0.0
1946	99.7	99.7	0.0	0.0
1947	99.2	99.2	0.0	0.0

Table 9-17
Sacramento River Salmon Survival – Late-fall-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	Baseline Condition Survival (%)	Flexible Purchase Alternative Survival (%)	Absolute Difference (%)	Relative Difference (%)
1948	99.9	99.9	0.0	0.0
1949	99.3	99.3	0.0	0.0
1950	99.6	99.6	0.0	0.0
1951	99.7	99.7	0.0	0.0
1952	99.9	99.9	0.0	0.0
1953	100.0	100.0	0.0	0.0
1954	99.9	99.9	0.0	0.0
1955	99.6	99.6	0.0	0.0
1956	99.8	99.8	0.0	0.0
1957	99.7	99.7	0.0	0.0
1958	97.3	97.3	0.0	0.0
1959	96.7	96.7	0.0	0.0
1960	99.8	99.8	0.0	0.0
1961	99.7	99.7	0.0	0.0
1962	99.5	99.5	0.0	0.0
1963	99.4	99.4	0.0	0.0
1964	99.9	99.9	0.0	0.0
1965	99.7	99.7	0.0	0.0
1966	99.5	99.5	0.0	0.0
1967	99.8	99.8	0.0	0.0
1968	99.7	99.7	0.0	0.0
1969	99.9	99.9	0.0	0.0
1970	99.6	99.6	0.0	0.0
1971	99.9	99.9	0.0	0.0
1972	99.8	99.8	0.0	0.0
1973	99.2	99.2	0.0	0.0
1974	99.7	99.7	0.0	0.0
1975	99.8	99.8	0.0	0.0
1976	98.9	98.9	0.0	0.0
1977	98.6	98.6	0.0	0.0
1978	99.7	99.7	0.0	0.0
1979	99.6	99.6	0.0	0.0
1980	99.9	99.9	0.0	0.0
1981	99.4	99.4	0.0	0.0
1982	99.5	99.5	0.0	0.0
1983	99.9	99.9	0.0	0.0
1984	99.7	99.7	0.0	0.0
1985	99.4	99.4	0.0	0.0
1986	99.8	99.8	0.0	0.0
1987	99.8	99.8	0.0	0.0
1988	99.2	99.2	0.0	0.0
1989	99.6	99.6	0.0	0.0
1990	98.9	98.9	0.0	0.0
Mean:	99.3	99.3	0.0	0.0
Median:	99.6	99.6	0.0	0.0
Min:	96.6	96.7	-0.1	-0.1
Max:	100.0	100.0	0.1	0.1
Year Counts				
0.0 > X >= -1.0			1	1
> X >= -2.0			0	0
> X >= -4.0			0	0

Table 9-17 Sacramento River Salmon Survival – Late-fall-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions				
Water Year	Baseline Condition Survival (%)	Flexible Purchase Alternative Survival (%)	Absolute Difference (%)	Relative Difference (%)
> X >= -6.0			0	0
X < -6.0			0	0
< X <= 1.0			1	1
< X <= 2.0			0	0
< X <= 4.0			0	0
< X <= 6.0			0	0
X > 6.0			0	0
No Difference (X = 0.0)			67	67

Overall, there would be no detectable change to monthly mean flows or water temperatures in the upper or lower Sacramento River under the Flexible Purchase Alternative, relative to the Baseline Condition.

Flow-related Impacts on Juvenile Fall-run Chinook Salmon and Steelhead Rearing and Emigration (February through June)

Under the Flexible Purchase Alternative, long-term average flows below Keswick Dam would not differ from flow under the Baseline Condition during the February through June period. (See Table 9-9.) In 360 out of the 360 months simulated, monthly mean flows below Keswick Dam under the Flexible Purchase Alternative would be essentially equivalent to flows under the Baseline Condition. (See Appendix H pgs. 353-357.) Flow exceedance curves for the Sacramento River below Keswick Dam during the February through June period are shown in Figures 9-18 through 9-20 and Figures 9-22 and 9-23. The basis for development of these exceedance curves was the 1922-1993 period of record. The flow exceedance curves indicate that flows in the Sacramento River below Keswick Dam under the Flexible Purchase Alternative would be nearly identical to flows under the Baseline Condition.

Long-term average flows under the Flexible Purchase Alternative in the Sacramento River at Freeport would be within 2 percent of flows under the Baseline Condition from February through June. (See Table 9-10.) Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 360 out of the 360 months modeled for the February through June period. (See Appendix H pgs. 389-393.) Exceedance curves for the Sacramento River flows at Freeport (Figure 9-24 through 9-28) indicate that flows under the Flexible Purchase Alternative would be nearly identical to slightly increased, relative to those under the Baseline Condition, throughout the February through June period. The basis for development of these exceedance curves was the 1922-1993 period of record.

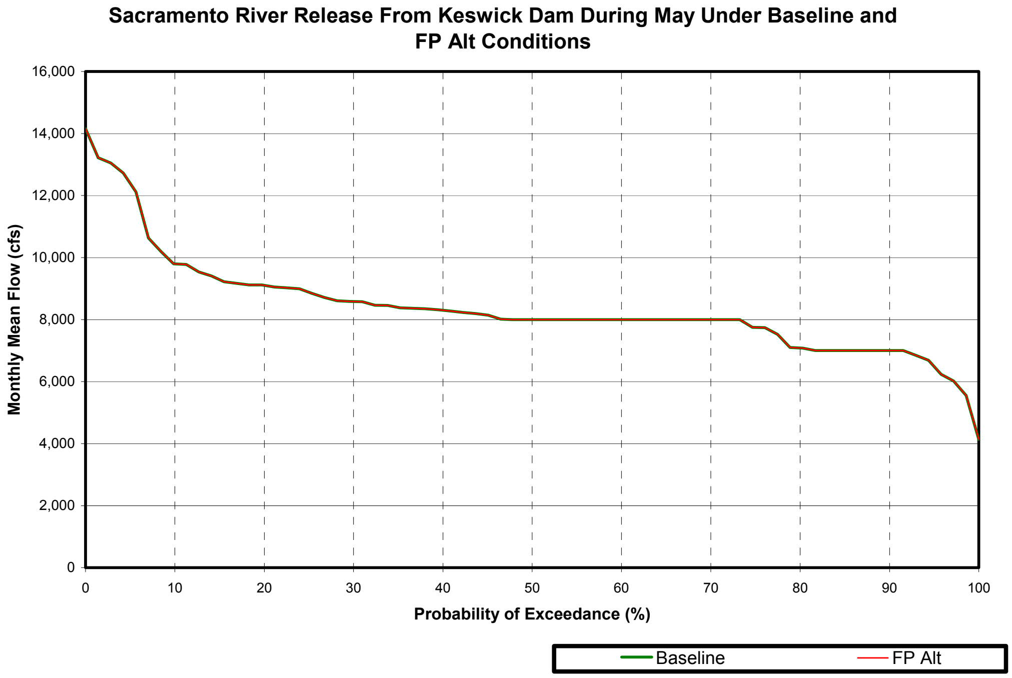

Figure 9-22
Sacramento River Release From Keswick Dam During May Under Baseline and Flexible Purchase Alternative Conditions

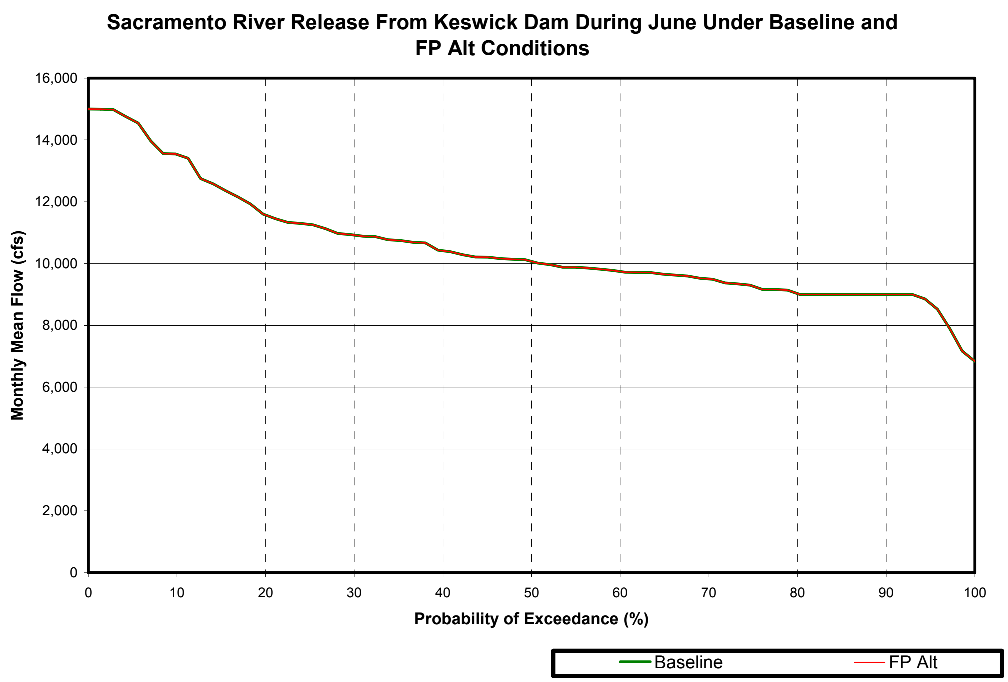

Figure 9-23
Sacramento River Release From Keswick Dam During June Under Baseline and Flexible Purchase Alternative Conditions

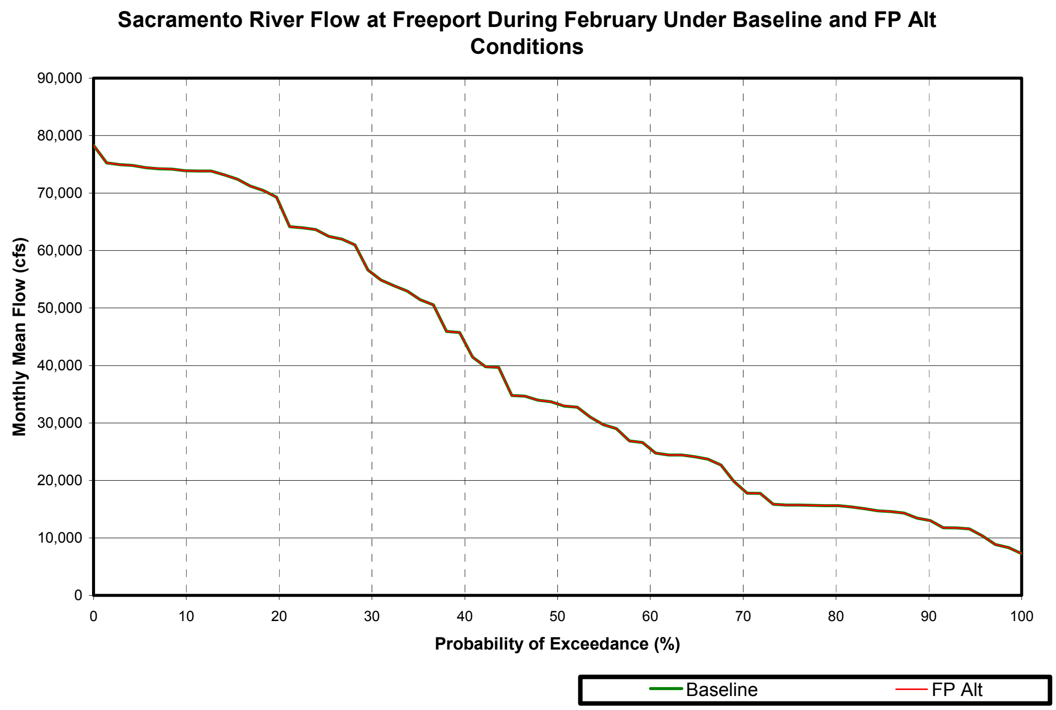

Figure 9-24
Sacramento River Flow at Freeport During February Under Baseline and Flexible Purchase Alternative Conditions

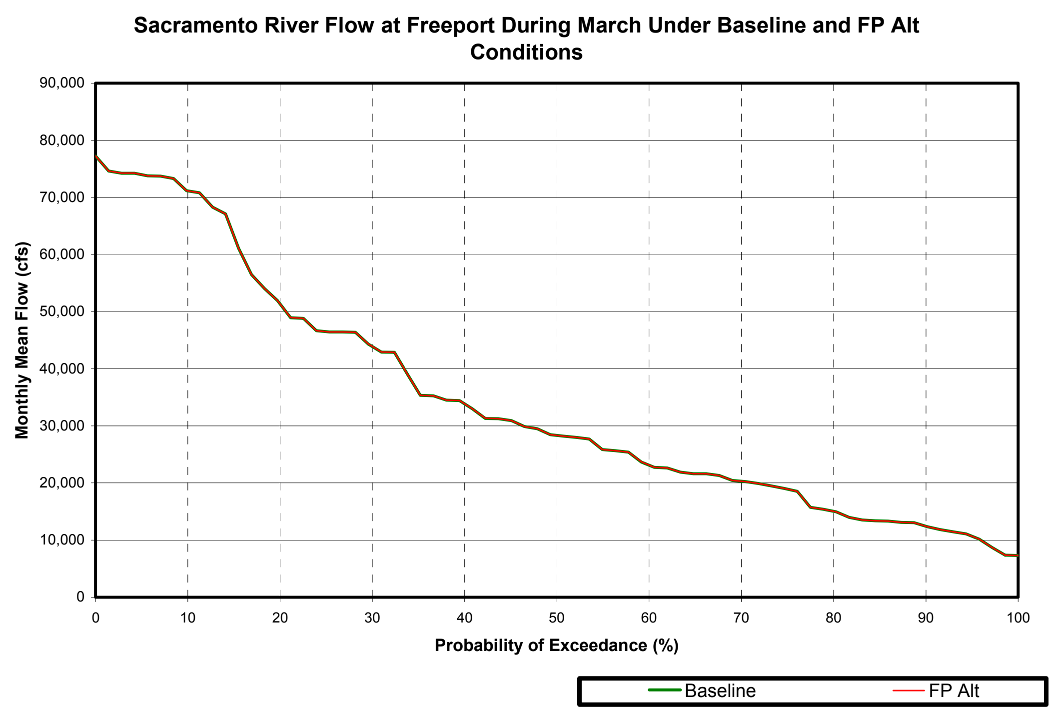

Figure 9-25
Sacramento River Flow at Freeport During March Under Baseline and Flexible Purchase Alternative Conditions

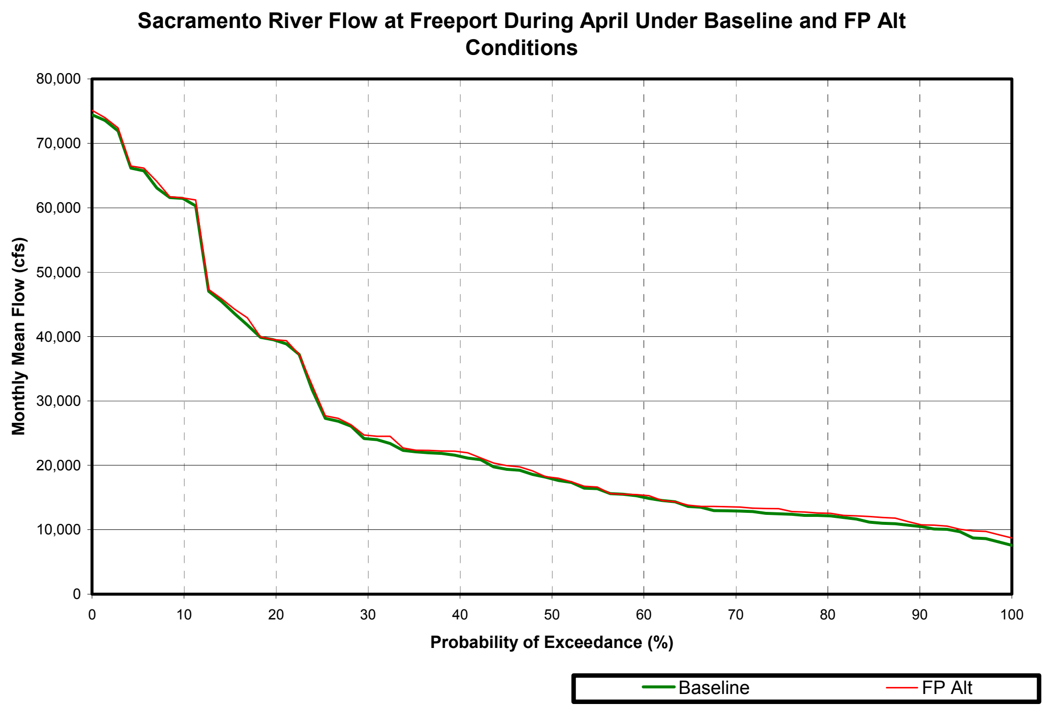

Figure 9-26
Sacramento River Flow at Freeport During April
Under Baseline and Flexible Purchase Alternative Conditions

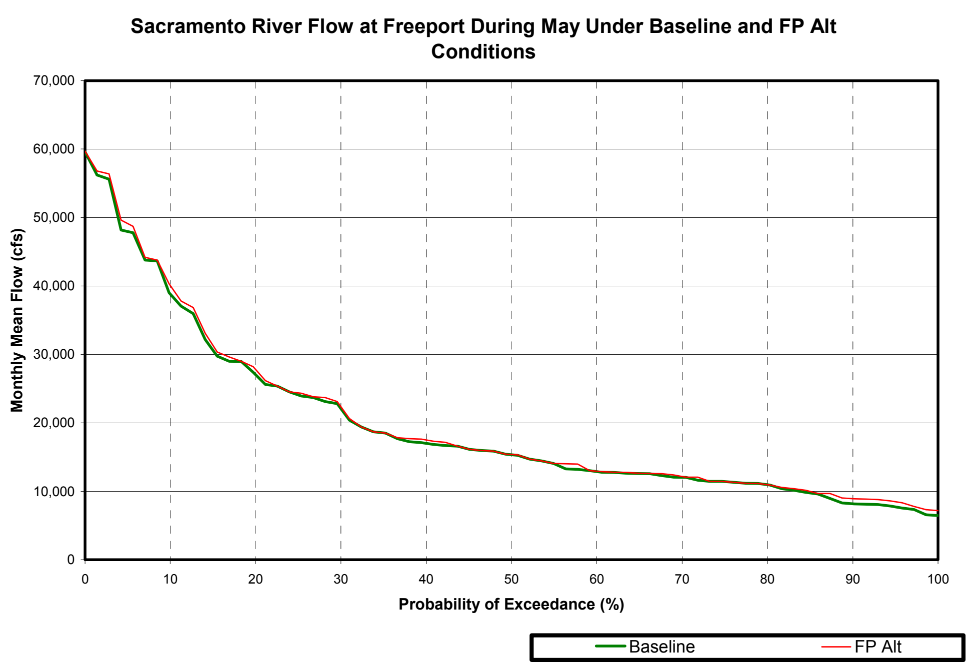

Figure 9-27
Sacramento River Flow at Freeport During May
Under Baseline and Flexible Purchase Alternative Conditions

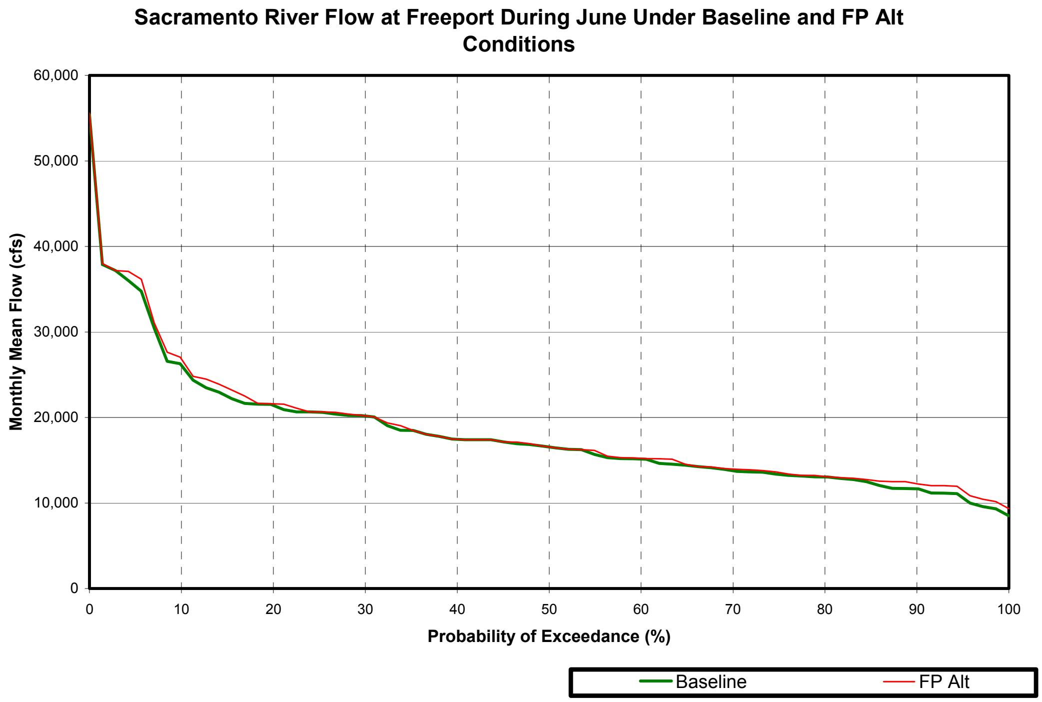

Figure 9-28
Sacramento River Flow at Freeport During June
Under Baseline and Flexible Purchase Alternative Conditions

Temperature-related Impacts on Juvenile Fall-run Chinook Salmon and Steelhead Rearing and Emigration (February through June)

Modeling associated with the Flexible Purchase Alternative indicates that simulated long-term average water temperatures at Bend Bridge would not change during any month of the February through June period, compared to the Baseline Condition, as shown in Table 9-12. Monthly mean water temperatures in the Sacramento River at Bend Bridge under the Flexible Purchase Alternative would not increase during any of the 345 months simulated for the February through June period. (See Appendix H pgs. 473-477.) Further, there would not be any additional occurrences under the Flexible Purchase Alternative in which water temperatures would be above 65°F at Bend Bridge, relative to the Baseline Condition. (Appendix H pgs. 473-477.)

Long-term average water temperatures under the Flexible Purchase Alternative at Jelly's Ferry in the Sacramento River would not differ from those under the Baseline Condition throughout the February through June period, as shown in Table 9-13. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 345 out of the 345 months modeled for the February through June period. (See Appendix H pgs. 461-465.) In addition, the Flexible Purchase Alternative would not result in an increase in the frequency in which monthly mean water temperatures would exceed 65°F at Jelly's Ferry in the Sacramento River, relative to the Baseline Condition, for a given month modeled throughout the juvenile rearing and emigration period. (See Appendix H pgs. 461-465.)

Long-term average water temperatures under the Flexible Purchase Alternative at Freeport in the Sacramento River would not change during February and March, and would increase by 0.1°F during April, May, and June, relative to the Baseline Condition. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 345 out of the 345 months modeled for the February through June period. (See Appendix H pgs. 485-489.) Further, the Flexible Purchase Alternative would not result in any measurable occurrences in which monthly mean water temperatures would exceed 65°F at Freeport in the Sacramento River, relative to the Baseline Condition, for all months simulated throughout the juvenile rearing and emigration period. (See Appendix H pgs. 485-489.)

Overall, changes in Sacramento River water temperatures at Bend Bridge, Jelly's Ferry, and Freeport under the Flexible Purchase Alternative throughout the February through June period would be negligible, relative to the Baseline Condition. There would be no increase in the frequency of water temperatures greater than 65°F at Bend Bridge, Jelly's Ferry, or Freeport.

Flow-related Impacts on Over-Summer Juvenile Steelhead Rearing (July through September)

Under the Flexible Purchase Alternative, long-term average flows in the Sacramento River below Keswick Dam would decrease by less than 0.2 percent for a given month of the July through September period, relative to the Baseline Condition. (See Table 9-9.) Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 212 out of the 216 months simulated. (See Appendix H pgs. 358-360.)

Long-term average flows under the Flexible Purchase Alternative in the Sacramento River at Freeport would increase by approximately 5 to 18 percent during the July through September period, relative to the Baseline Condition. (See Table 9-10.) Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 216 out of the 216 months modeled for the July through September period. (See Appendix H pgs. 394-396.) Freeport flows under the Flexible Purchase Alternative would be greater than flows under the Baseline Condition in nearly every month modeled for the July through September period.

Temperature-related Impacts on Over-summer Juvenile Steelhead Rearing (July through September)

Long-term average water temperatures under the Flexible Purchase Alternative at Bend Bridge, Jelly's Ferry, and Freeport would be within 0.1°F of long-term average water temperatures under the Baseline Condition during July, August, and

September. (Refer to Tables 9-12, 9-13, and 9-11, respectively.) Water temperatures at Bend Bridge would be essentially equivalent to those under the Baseline Condition in 205 out of the 207 months simulated for this three-month period. (See Appendix H pgs. 478-480.) At Jelly's Ferry, Sacramento River water temperatures under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 206 of the 207 months simulated for the July through September period. (See Appendix H pgs. 466-468.) Monthly mean water temperatures at Freeport under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 207 out of the 207 months included in the analysis. (See Appendix H pgs. 490-492.) Furthermore, the Flexible Purchase Alternative would not result in additional occurrences of water temperatures greater than 65°F during any month simulated for the July through September period at Bend Bridge, Jelly's Ferry, or Freeport in the Sacramento River, relative to the Baseline Condition. (See Appendix H pgs. 478-480, 466-468, and 490-492.) Overall, potential changes in water temperature that may occur under the Flexible Purchase Alternative would be negligible, relative to the Baseline Condition.

Flow-related Impacts on Fall/Winter Juvenile Steelhead Rearing (October through January)

Under the Flexible Purchase Alternative, long-term average flows in the Sacramento River below Keswick Dam would not decrease in any month of the October through January period, relative to the Baseline Condition. (See Table 9-9.) Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in all of the 288 months simulated. (See Appendix H pgs. 349-352.)

Long-term average flows under the Flexible Purchase Alternative in the Sacramento River at Freeport would increase by no more than 0.7 percent during the October through January period, relative to the Baseline Condition. (See Table 9-10.) Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in all of the 288 months modeled for the October through January period. (See Appendix H pgs. 385-388.)

Temperature-related Impacts on Fall/Winter Winter Juvenile Steelhead Rearing (October through January)

Long-term average water temperatures under the Flexible Purchase Alternative at Bend Bridge, Jelly's Ferry, and Freeport would be essentially equivalent during all months of the October through January period (Tables 9-12, 9-13, and 9-11, respectively), relative to the Baseline Condition. Water temperatures at Bend Bridge would be essentially equivalent to those under the Baseline Condition in all of the 276 months simulated for this four-month period. (See Appendix H pgs. 469-472.) At Jelly's Ferry, Sacramento River water temperatures under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 276 months simulated for the October through January period. (See

Appendix H pgs. 457-460.) Monthly mean water temperatures at Freeport under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 276 months included in the analysis. (See Appendix H pgs. 481-484.) Overall, potential changes in water temperature that may occur under the Flexible Purchase Alternative would be negligible, relative to the Baseline Condition.

Summary of Impacts on Fall-Run Chinook Salmon and Steelhead in the Sacramento River

In summary, potential changes in flow in the Sacramento River under the Flexible Purchase Alternative during the September through November period would not be of sufficient frequency or magnitude to beneficially or adversely affect adult fall-run Chinook salmon immigration. Similarly, changes in flows under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact fall-run Chinook salmon spawning, egg incubation, and initial rearing during the October through February period. Slight increases in flow that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile fall-run Chinook salmon rearing and emigration during the February through June period.

Changes in water temperature in the Sacramento River under the Flexible Purchase Alternative during the September through November period would not be of sufficient frequency or magnitude to beneficially or adversely affect adult fall-run Chinook salmon immigration. Changes in annual early lifestage survival under the Flexible Purchase Alternative would not be of sufficient magnitude to beneficially or adversely impact initial year-class strength. Changes in water temperature under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact spawning, egg incubation, and initial rearing during the October to February period. Changes in water temperature that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile fall-run Chinook salmon rearing and emigration during the February through June period.

Potential changes in flow in the Sacramento River under the Flexible Purchase Alternative during the September through November period would not be of sufficient frequency or magnitude to beneficially or adversely affect adult steelhead immigration. Flow related changes under the Flexible Purchase Alternative during the December through March period would not be of sufficient frequency or magnitude to beneficially or adversely impact adult steelhead immigration, spawning, and egg incubation. Slight increases in flow that would occur in the Sacramento River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile steelhead rearing, including over-summer and fall/winter rearing, and emigration.

Changes in water temperature in the Sacramento River under the Flexible Purchase Alternative during the September through November period would not be of sufficient frequency or magnitude to beneficially or adversely affect adult steelhead immigration. Changes in annual early lifestage survival under the Flexible Purchase Alternative would not be of sufficient magnitude to beneficially or adversely impact initial year-class strength of steelhead in the Sacramento River. Water temperature related changes under the Flexible Purchase Alternative during the December through March period would not be of sufficient frequency or magnitude to beneficially or adversely impact adult steelhead immigration, spawning, and egg incubation. Negligible changes in water temperature that would occur in the Sacramento River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile steelhead rearing, including over-summer and fall/winter rearing, and emigration.

Overall, the changes in flows and water temperatures in the Sacramento River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impacts on fall-run Chinook salmon. Therefore, impacts on fall-run Chinook salmon in the Sacramento River with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, would be less than significant.

Similarly, the changes in flows and water temperatures in the Sacramento River under the Flexible Purchase Alternative, relative to the Baseline Condition, would not be of sufficient frequency or magnitude to beneficially or adversely impact steelhead. Therefore, impacts on steelhead in the Sacramento River with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, would be less than significant.

Impacts on Late-fall-run Chinook Salmon in the Sacramento River

Flow-related Impacts on Adult Late-fall-run Chinook Salmon Immigration and Holding (October through April)

Table 9-9 shows that long-term average flows in the Sacramento River below Keswick Dam under the Flexible Purchase Alternative would not differ from flows under the Baseline Condition, during all months of the adult immigration period (October through April). In all 504 months simulated in this period, flows in the Sacramento River below Keswick Dam would be essentially equivalent to flows under the Baseline Condition. (See Appendix H pgs. 349-355.)

Long-term average flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would not differ from flows under the Baseline Condition during December through March, and would increase by approximately 0.1 to 1.9 percent in April, October and November, relative to the Baseline Condition. (See Table 9-10.) Monthly mean flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 504 out of the 504 months modeled for October through April. (See Appendix H pgs. 385-391.)

Temperature-related Impacts on Adult Late-fall-run Chinook Salmon Immigration and Holding (October through April)

Long-term average water temperatures in the Sacramento River modeled for the Flexible Purchase Alternative would not differ from those under the Baseline Condition at the Bend Bridge and Jelly's Ferry during all months of the October through April adult immigration period, as shown in Tables 9-12 and 9-13. Moreover, under the Flexible Purchase Alternative, water temperatures in the Sacramento River at Bend Bridge would remain essentially equivalent to those under the Baseline Condition in all of the 483 months included in the analysis. (See Appendix H pgs. 469-475.) Similarly, monthly mean water temperatures at Jelly's Ferry under the Flexible Purchase Alternative would remain essentially equivalent to those simulated under the Baseline Condition in all of the 483 months included in the analysis. (See Appendix H pgs. 457-463.)

October through April long-term average water temperatures in the Sacramento River at Freeport under the Flexible Purchase Alternative would be within 0.1°F of water temperatures under the Baseline Condition. (See Table 9-11.) In fact, long-term average water temperatures under the Flexible Purchase Alternative would not differ from those under the Baseline Condition in October, November, January, February, and March, and would decrease and increase by 0.1°F in December and April, respectively, relative to the Baseline Condition. Further, monthly mean water temperatures in the Sacramento River at Freeport under the Flexible Purchase Alternative would be essentially equivalent to water temperatures under the Baseline Condition in all of the 483 months modeled for the October through April period. (See Appendix H pgs. 486-492.)

Flow-related Impacts on Adult Late-fall-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (December through April)

Long-term average flows in the Sacramento River below Keswick Dam under the Flexible Purchase Alternative would not differ from flows under the Baseline Condition during all months of the December through April period, as shown in Table 9-9. In all the 360 months simulated during this period, Sacramento River monthly mean flows below Keswick Dam would be essentially equivalent to flows under the Baseline Condition. (See Appendix H pgs. 351-355.)

Figure 9-14, Figure 9-15, and Figure 9-29 show exceedance curves for the Sacramento River below Keswick Dam for the December through April period. The basis for development of these exceedance curves was the 1922-1993 period of record. These curves demonstrate that flows under the Flexible Purchase Alternative would be similar to those under the Baseline Condition at all flow ranges. The Flexible Purchase Alternative would not be expected to result in reductions in flows during the December through April spawning period, relative to the Baseline Condition.

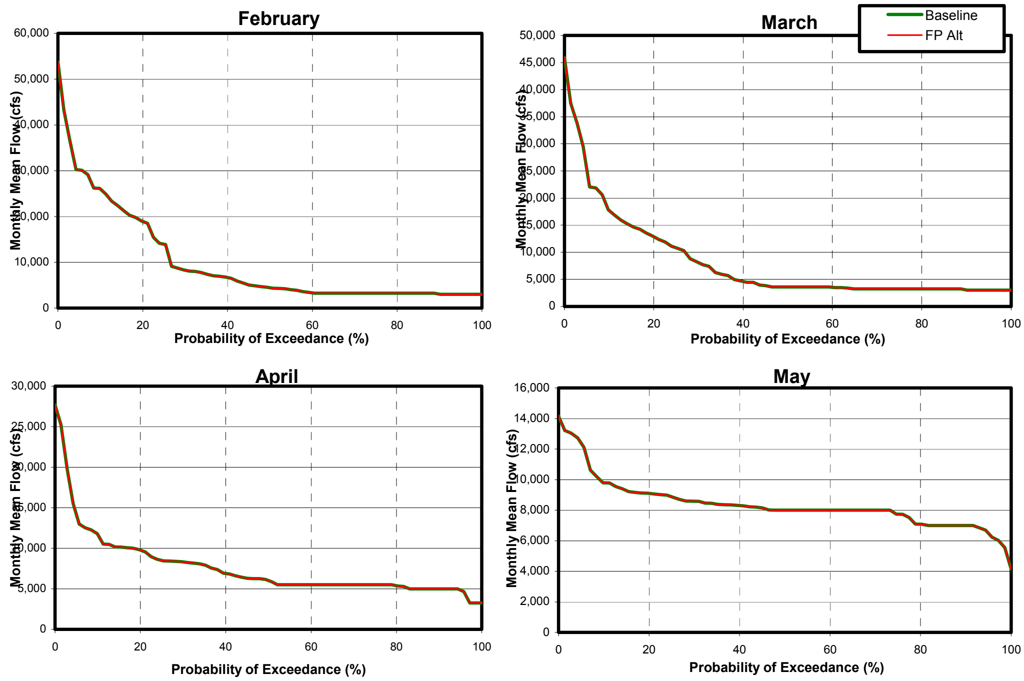

Figure 9-29
Sacramento River Release From Keswick Dam
Under Baseline and Flexible Purchase Alternative Conditions
February through May

Temperature-related Impacts on Adult Late-fall-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (December through April)

Under the Flexible Purchase Alternative, long-term average water temperatures would not differ from those under the Baseline Condition during the December through April period at Bend Bridge and Jelly's Ferry, as shown in Tables 9-12 and Table 9-13. In fact, in all of the 345 months included in the analysis, monthly mean water temperatures at Bend Bridge and Jelly's Ferry, respectively, would be essentially equivalent to those under the Baseline Condition. (See Appendix H pgs. 471-475 and 459-463.) Further, there would not be any additional occurrences of water temperatures above 56°F under the Flexible Purchase Alternative, relative to the Baseline Condition, at either Bend Bridge or Jelly's Ferry. (See Appendix H pgs. 471-475 and 459-463.)

The long-term average annual early lifestage survival for late-fall-run Chinook salmon in the Sacramento River would be 99.3 percent under both the Baseline Condition and Flexible Purchase Alternative. Table 9-17 shows the annual survival estimates for late-fall-run Chinook salmon in the Sacramento River for the 69 years modeled. Substantial increases or decreases in survival would not occur in any individual year of the 69-year simulation, relative to the Baseline Condition. In 67 out of the 69 years modeled, there would be no difference in annual early lifestage survival of late-fall-run Chinook salmon between the Flexible Purchase Alternative and the Baseline

Condition. In the 2 years in which changes in survival would occur, there would be a relative decrease in survival of 0.1 percent and a relative increase in survival of 0.1 percent, relative to the Baseline Condition. Therefore, changes in annual early lifestage survival under the Flexible Purchase Alternative would not be of sufficient magnitude to result in adverse effects on initial year-class strength of late fall-run Chinook salmon in the Sacramento River.

Flow-related Impacts on Juvenile Late-fall-run Chinook Salmon Rearing and Emigration (April through October)

Under the Flexible Purchase Alternative, long-term average flows in the Sacramento River below Keswick Dam would not differ by greater than 0.9 percent or less than 0.8 percent from flows modeled under the Baseline Condition during the April through October period. (See Table 9-9.) In 468 out of the 504 months simulated, flows below Keswick Dam under the Flexible Purchase Alternative would be essentially equivalent to flows under the Baseline Condition. (See Appendix H pgs. 349, 355-360.) Flow exceedance curves during the April through October period are shown for the Sacramento River below Keswick Dam in Figure 9-29, Figure 9-30 and Figure 9-31. The basis for development of these exceedance curves was the 1922-1993 period of record. The flow exceedance curves indicate that flows below Keswick Dam under the Flexible Purchase Alternative would be nearly identical to flows under the Baseline Condition. Therefore, flows modeled under the Flexible Purchase Alternative would not be likely to result in adverse effects on long-term juvenile late-fall-run Chinook salmon rearing and emigration.

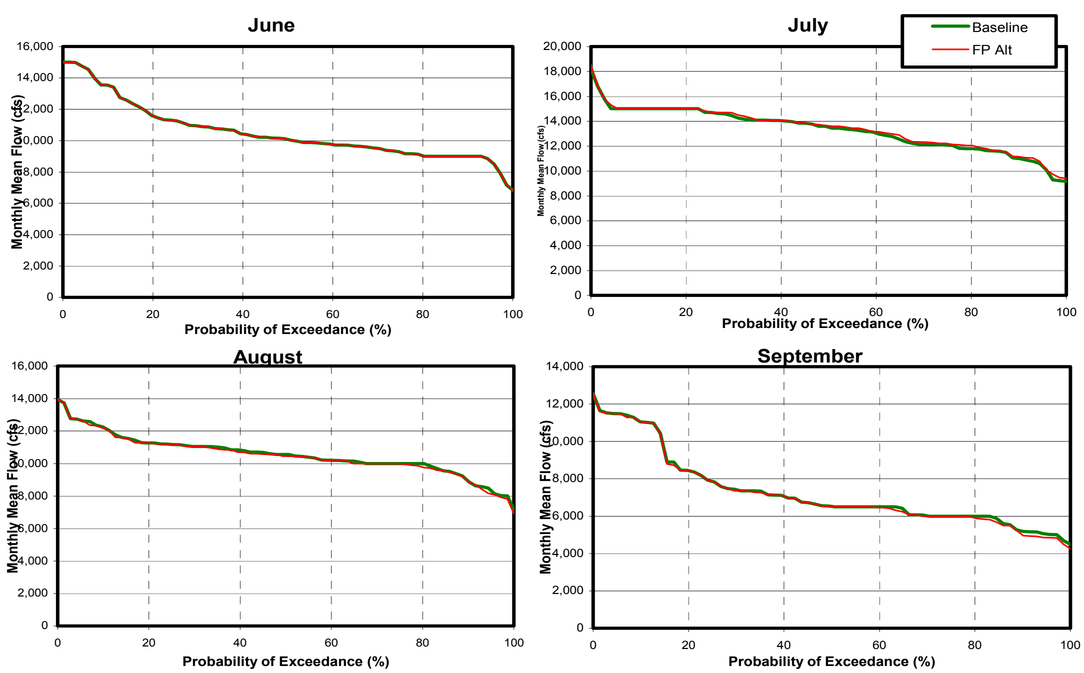

Figure 9-30
Sacramento River Release From Keswick Dam
Under Baseline and Flexible Purchase Alternative Conditions
June Through September

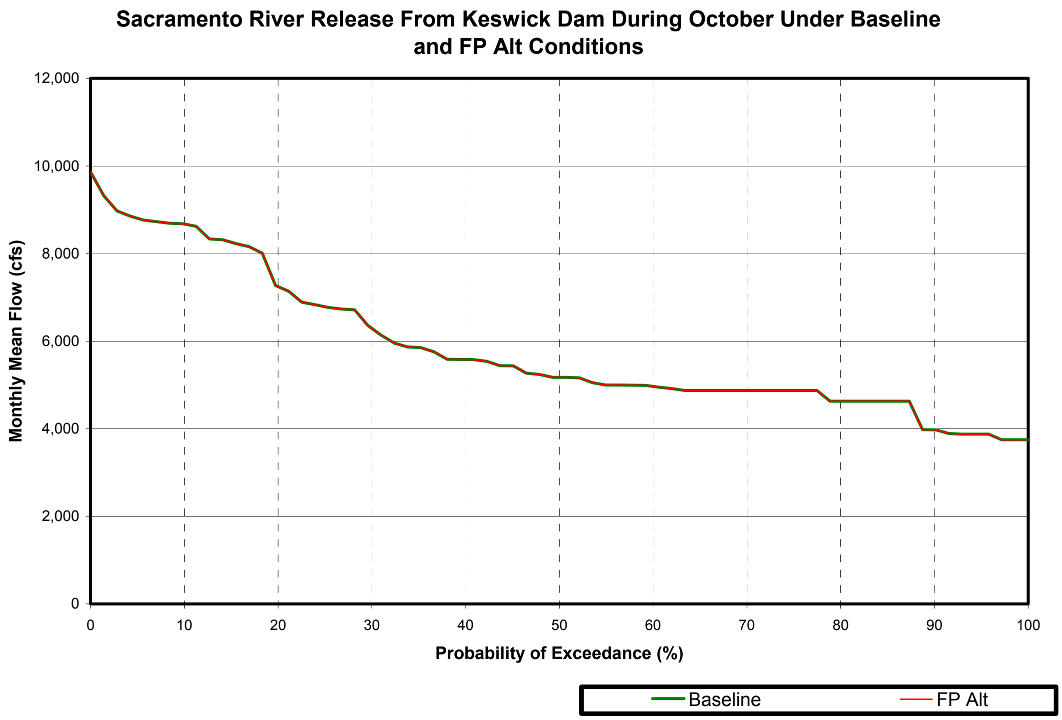

Figure 9-31
Sacramento River Release From Keswick Dam During October Under Baseline and Flexible Purchase Alternative Conditions

Long-term average flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would increase by 17.7 percent in July, 15.7 percent in August, and 9.7 percent in September, relative to the Baseline Condition. During April through June and October, long-term average temperatures under the Flexible Purchase Alternative would not differ greater than 6.8 percent compared to the Baseline Condition. (Refer to Table 9-10.) Monthly mean flows in the Sacramento River at Freeport under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in all of the 504 months modeled for the April through October period. (See Appendix H pgs. 385, 391-396.) Overall, flows in the Sacramento River below Keswick Dam and at Freeport would not differ substantially under the Flexible Purchase Alternative, relative to the Baseline Condition.

Temperature-related Impacts on Juvenile Late-fall-run Chinook Salmon Rearing and Emigration (April through October)

Modeling associated with the Flexible Purchase Alternative indicates that long-term average water temperatures at Bend Bridge would not change during any month of the April through October period, compared to the Baseline Condition, as shown in Table 9-12. Monthly mean water temperatures in the Sacramento River at Bend Bridge would be essentially equivalent to or less than those under to the Baseline

Condition in 481 of the 483 months of the April through October period. (See Appendix H pgs. 469, 475-480.) Further, the Flexible Purchase Alternative would not result in an increase in the frequency in which monthly mean water temperatures would exceed 65°F for each month of the April through October period. (See Appendix H pgs. 469, 475-480.)

Long-term average water temperatures under the Flexible Purchase Alternative at Jelly's Ferry in the Sacramento River would increase by 0.1°F in September and would not change during the remaining months of the April through October late fall-run Chinook salmon juvenile rearing and emigration period, as shown in Table 9-13. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 482 out of the 483 months modeled for the April through October period. (See Appendix H pgs. 457, 463-468.) Further, the Flexible Purchase Alternative would not result in an increase in the frequency in which monthly mean water temperatures would exceed 65°F at Jelly's Ferry in the Sacramento River, relative to the Baseline Condition, for a given month simulated for the juvenile rearing and emigration period. (See Appendix H pgs. 457, 463-468.)

Similarly, long-term average water temperatures under the Flexible Purchase Alternative at Freeport in the Sacramento River would increase by 0.1°F in April, May, and June, would decrease by 0.1°F in August and September, and would not change during November, as shown in Table 9-11. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 483 months modeled for the April through October period. (See Appendix H pgs. 481, 487-492.) In addition, there would be no measurable increase in the frequency in which monthly mean water temperatures at Freeport would be above 65°F, relative to the Baseline Condition.

Overall, the Flexible Purchase Alternative would result in negligible changes in Sacramento River water temperatures at Bend Bridge, Jelly's Ferry, and Freeport throughout the April through October juvenile late-fall-run Chinook salmon rearing and emigration period.

Summary of Impacts on Late-fall-run Chinook Salmon in the Sacramento River

In summary, the difference in Sacramento River flows below Keswick Dam and at Freeport that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect attraction, passage, and holding of adult late-fall-run Chinook salmon immigrating into the Sacramento River during the October through April period. Similarly, changes in flow in the Sacramento River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact spawning, egg incubation, and initial rearing during the December through April period. Changes in flow that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile late-fall-run Chinook salmon rearing and emigration during the April through October period.

Changes in Sacramento River water temperatures under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect adult late-fall-run Chinook salmon immigration and holding during the October through April period. Potential water temperature changes in the Sacramento River resulting from the implementation of the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact spawning, egg incubation, and initial rearing during the December through April period. Changes in annual early lifestage survival under the Flexible Purchase Alternative would not be of sufficient magnitude to beneficially or adversely impact initial year-class strength of late-fall-run Chinook salmon in the Sacramento River. Changes in water temperatures under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile late-fall-run Chinook salmon rearing and emigration during the April through October period.

Overall, the changes in flows and water temperatures in the Sacramento River under the Flexible Purchase Alternative, relative to the Baseline Condition, would not be of sufficient frequency or magnitude to beneficially or adversely impact late-fall-run Chinook salmon. Therefore, impacts on late-fall-run Chinook salmon in the Sacramento River with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, would be less than significant.

Impacts on Splittail in the Sacramento River

Under the Flexible Purchase Alternative, long-term average flows at Freeport during the period of February through May would be within 2 percent of flows under the Baseline Condition, as shown in Table 9-10. In all of the 288 months simulated for this period, monthly mean flows would be essentially equivalent to or greater than flows under the Baseline Condition. (See Appendix H pgs. 389-392.) Below Keswick Dam, long-term average flows under the Flexible Purchase Alternative and the Baseline Condition would be identical throughout the February through May period, as shown in Table 9-9. Monthly mean flows below Keswick Dam under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 288 months simulated for the February through May period. (See Appendix H pgs. 353-356.) Therefore, flow changes under the Flexible Purchase Alternative would not be expected to reduce the availability of submerged habitat for splittail spawning, relative to the Baseline Condition.

During the February through May period, monthly mean water temperatures at Freeport would not rise above 68°F, the upper end of the reported preferred range for splittail spawning, more frequently as a result of the Flexible Purchase Alternative, relative to the Baseline Condition. (See Appendix H pgs. 485-488.) Similarly, monthly mean water temperatures at Jelly's Ferry in the Sacramento River would not rise above 68°F as a result of the Flexible Purchase Alternative. (See Appendix H pgs. 461-464.) Similarly, monthly mean water temperatures at Bend Bridge under the Flexible

Purchase Alternative would not rise above 68°F more frequently than under the Baseline Condition. (See Appendix F pgs. 473-476.)

Overall, potential flow and water temperature changes resulting from the implementation of the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact splittail spawning. Therefore, impacts on splittail in the Sacramento River under the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on American Shad in the Sacramento River

Table 9-10 shows that long-term average flows in the Sacramento River at Freeport would not differ from long-term average flows under the Baseline Condition in May and June. Similarly, monthly mean flows under the Flexible Purchase Alternative during May and June would be essentially equivalent to those under the Baseline Condition in all of the 144 months simulated for this period. (See Appendix H pgs. 392-393.) Thus, implementation of the Flexible Purchase Alternative would not be likely to result in reductions in flows at Freeport during May or June that could potentially reduce the number of adult shad attracted into the river.

The number of years that monthly mean water temperatures at Freeport in May and June would be within the reported preferred range for American shad spawning of 60°F to 70°F would not change measurably under the Flexible Purchase Alternative, relative to the Baseline Condition. (See Appendix H pgs. 488-489.) Therefore, the frequency with which suitable water temperatures for American shad spawning would occur would not decrease under the Flexible Purchase Alternative, relative to the Baseline Condition.

As shown in Table 9-9, long-term average flows below Keswick Dam in the Sacramento River would not differ from long-term average flows under the Baseline Condition in May and June. Similarly, monthly mean flows under the Flexible Purchase Alternative during May and June would be essentially equivalent to those under the Baseline Condition in all of the 144 months simulated for this period. (Refer to Appendix H pgs. 356-357.) Thus, implementation of the Flexible Purchase Alternative would not be likely to result in reductions in flows below Keswick Dam during May or June that could potentially reduce the number of adult shad attracted into the river.

Monthly mean water temperatures would be below the reported preferred range for American shad spawning of 60°F to 70°F under the Baseline Condition or Flexible Purchase Alternative in all of the 138 months simulated for the May through June period at both Bend Bridge and Jelly's Ferry. (Refer to Appendix H pgs. 464-465 and 476-477). Therefore, the Flexible Purchase Alternative would not result in a change in the frequency of upper Sacramento River water temperatures within the reported preferred range for American shad spawning.

Overall, changes in flows and water temperatures in the upper and lower Sacramento River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact American shad attraction and spawning. Therefore, impacts on American shad in the Sacramento River under the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

<u>Impacts on Striped Bass in the Sacramento River</u>

Table 9-10 shows that long-term average flows in the Sacramento River at Freeport would not differ from long-term average flows under the Baseline Condition in May and June. Similarly, monthly mean flows under the Flexible Purchase Alternative during May and June would be essentially equivalent to those under the Baseline Condition in all of the 144 months simulated for this period [Appendix H pgs. 392-393]. Below Keswick Dam, long-term average flows in the upper Sacramento River under the Flexible Purchase Alternative would not differ from long-term average flows under the Baseline Condition during the May through June period, as shown in Table 9-9. Similarly, monthly mean flows under the Flexible Purchase Alternative during May and June would be essentially equivalent to those under the Baseline Condition in all of the 144 months simulated for this period. (Refer to Appendix H pgs. 356-357).

The frequency of monthly mean water temperatures in the Sacramento River at Freeport within the reported preferred range for striped bass spawning and initial rearing (59°F to 68°F) would not change measurably under the Flexible Purchase Alternative, relative to the Baseline Condition, during the May through June period [Appendix H pgs. 488-489]. At Bend Bridge and Jelly's Ferry, monthly mean water temperatures in the upper Sacramento River would be below 59°F in all of the 138 months simulated for the May through June period under the Baseline Condition and Flexible Purchase Alternative. (Refer to Appendix H. pgs. 464-465 and 476-477.) Therefore, the frequency in which suitable water temperature s would occur for striped bass spawning and initial rearing in Sacramento River would not change under the Flexible Purchase Alternative, relative to the Baseline Condition.

Overall, changes in flows and water temperatures in the upper and lower Sacramento River would not be of sufficient frequency or magnitude to beneficially or adversely impact striped bass spawning and initial rearing. Therefore, impacts on striped bass in the Sacramento River under the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Butte Creek

Implementation of the Flexible Purchase Alternative has the potential to reduce agricultural return flows in Butte Creek, downstream of the Western Canal Siphon (Butte Creek Siphon), primarily from July through September.

Agricultural return flows are often characterized as warmer and of lower water quality than ambient stream receiving waters. If that is the case with agricultural return flows to Butte Creek, then a reduction in the volume of low quality water entering the river could potentially represent a beneficial effect to Chinook salmon, steelhead, and Sacramento splittail. However, the water quality in agricultural return flows may be suitable for the various lifestages of these species (refer to Section 9.1, Affected Environment/Existing Conditions), therefore flow reductions have been evaluated to determine potential effects.

<u>Impacts on Spring-run Chinook Salmon in Butte Creek</u>

Spring-run Chinook salmon adult holding, spawning, embryo incubation, fry emergence, and juvenile rearing in Butte Creek is reported to occur upstream of the Western Canal Siphon (CDFG 1998; Butte Creek Watershed Conservancy 2003). Therefore, reduced flows downstream of the Western Canal Siphon only have the potential to affect fish migrating through this area. Adult spring-run Chinook salmon upstream migration in Butte Creek reportedly extends from mid-February though July, with peak migration during May (CDFG 1998). Potential agricultural return flow reductions could be expected to occur at, or after, the end of the adult upstream migration period. In addition to upstream migrating adult spring-run Chinook salmon, juveniles migrating out of Butte Creek must pass through the area downstream of the Western Canal Siphon. However, the majority of juvenile spring-run Chinook salmon out-migration is reported to occur during December and January, with some emigration continuing through May (CDFG 1998). Some spring-run Chinook salmon in Butte Creek reportedly emigrate as yearlings from October to February, with peak yearling emigration occurring during November and December (CDFG 1998). Peak juvenile and yearling spring-run Chinook salmon outmigration periods do not coincide with potential agricultural return flow reductions. Although juvenile and yearling spring-run Chinook salmon outmigration may occur during the period of potentially reduced agricultural return flows (July through September), as shown in Table 9-1, implementation of conservation measures will avoid potential impacts related to flow reductions in Butte Creek.

In summary, potential reductions in agricultural return flow in Butte Creek under the Flexible Purchase Alternative would not occur during the appropriate time period to beneficially or adversely impact adult spring-run Chinook salmon immigration or juvenile spring-run Chinook salmon emigration. Overall, implementation of the Flexible Purchase Alternative represents a less-than-significant impact on spring-run Chinook salmon in Butte Creek.

<u>Impacts on Fall-run Chinook Salmon in Butte Creek</u>

Fall-run Chinook salmon adult spawning, embryo incubation, fry emergence, and juvenile rearing in Butte Creek is reported to occur upstream of the Western Canal Siphon (USFWS 2000; Butte Creek Watershed Conservancy 2003). Therefore, reduced flows downstream of the Western Canal Siphon, primarily from July through September, only have the potential to affect fish migrating through this area. Adult fall-run Chinook salmon upstream migration in Butte Creek reportedly extends from late-September through October (USFWS 2000; Butte Creek Watershed Conservancy 2003). Potential agricultural return flow reductions could be expected to occur before, or up to, the onset of adult fall-run Chinook salmon upstream immigration period. In addition to upstream migrating adult fall-run Chinook salmon, juveniles migrating out of Butte Creek must pass through the area downstream of the Western Canal Siphon. However, the majority of juvenile fall-run Chinook salmon out-migration is reported to occur during December through March (USFWS 2000; Butte Creek Watershed Conservancy 2003). Some fall-run Chinook salmon in Butte Creek reportedly emigrate from April to June (USFWS 2000; Butte Creek Watershed Conservancy 2003). The juvenile fall-run Chinook salmon out-migration periods do not coincide with the period of potential agricultural return flow reductions.

In summary, potential reductions in agricultural return flow in Butte Creek under the Flexible Purchase Alternative would not occur during the appropriate time period to beneficially or adversely impact adult fall-run Chinook salmon immigration or juvenile fall-run Chinook salmon emigration. Overall, implementation of the Flexible Purchase Alternative represents a less-than-significant impact on fall-run Chinook salmon in Butte Creek.

Impacts on Late-fall-run Chinook Salmon in Butte Creek

Late-fall-run Chinook salmon adult spawning, embryo incubation, fry emergence, and juvenile rearing in Butte Creek is reported to occur upstream of the Western Canal Siphon (USFWS 2000; Butte Creek Watershed Conservancy 2003). Therefore, reduced flows downstream of the Western Canal Siphon, primarily from July through September, only have the potential to affect fish migrating through this area. Adult late fall-run Chinook salmon upstream migration in Butte Creek reportedly extends from December through February (USFWS 2000; Butte Creek Watershed Conservancy 2003). Potential agricultural return flow reductions could be expected to occur before the onset of the adult late-fall-run Chinook salmon upstream migration period. In addition to upstream migrating adult late fall-run Chinook salmon, juveniles migrating out of Butte Creek must pass through the area downstream of the Western Canal Siphon. However, the majority of juvenile late fall-run Chinook salmon outmigration is reported to occur during April through June (USFWS 2000; Butte Creek Watershed Conservancy 2003). The juvenile late fall-run Chinook salmon outmigration period does not coincide with the period of potential agricultural return flow reductions.

In summary, potential reductions in agricultural return flow in Butte Creek under the Flexible Purchase Alternative would not occur during the appropriate time period to beneficially or adversely impact adult late-fall-run Chinook salmon immigration or juvenile late-fall-run Chinook salmon emigration. Overall, implementation of the Flexible Purchase Alternative represents a less-than-significant impact on late-fall-run Chinook salmon in Butte Creek.

Impacts on Steelhead in Butte Creek

Steelhead adult spawning, embryo incubation, and fry emergence is reported to occur in locations similar to spring-run Chinook salmon spawning in Butte Creek, which occur upstream of the Western Canal Siphon. In addition, steelhead spawning, embryo incubation, and fry emergence has been reported in Little Butte Creek (USFWS 2000; Butte Creek Watershed Conservancy 2003). Because steelhead spawning locations are similar to spring-run Chinook salmon spawning locations and because spring-run Chinook rearing is reported to occur in proximity to spawning (refer to Section 9.1, Affected Environment/Existing Conditions), it is likely that steelhead rearing also occurs in proximity to these spawning areas, all of which are upstream of the Western Canal Siphon. Therefore, reduced flows downstream of the Western Canal Siphon, primarily from July through September, only have the potential to affect fish migrating through this area, an would not affect steelhead rearing upstream of the siphon. Adult steelhead upstream migration in Butte Creek reportedly extends from late-fall though winter (USFWS 2000; Butte Creek Watershed Conservancy 2003). Potential agricultural return flow reductions could be expected to occur before the onset of the adult steelhead upstream migration period. In addition to upstream migrating adult steelhead, juveniles migrating out of Butte Creek must pass through the area downstream of the Western Canal Siphon. However, the majority of juvenile steelhead out-migration is reported to occur during March through June (USFWS 2000; Butte Creek Watershed Conservancy 2003). Some steelhead in Butte Creek reportedly emigrate as yearlings from September through March (USFWS 2000; Butte Creek Watershed Conservancy 2003). The juvenile and yearling steelhead out-migration periods do not coincide with the period of potential agricultural return flow reductions.

In summary, potential reductions in agricultural return flow in Butte Creek under the Flexible Purchase Alternative would not occur during the appropriate time period to beneficially or adversely impact adult steelhead immigration or juvenile steelhead emigration. Overall, implementation of the Flexible Purchase Alternative represents a less-than-significant impact on steelhead in Butte Creek.

Impacts on Sacramento Splittail in Butte Creek

During normal flow conditions, Butte Creek water is not diverted into the Sacramento River through the Butte Slough Outfall gates near Colusa and therefore flows through the Sutter Bypass, entering the Sacramento River via the Sacramento Slough southeast of the community of Knights Landing (Butte Creek Watershed Conservancy 2003). Within the Sutter Bypass, Butte Creek water flows through the East and West borrow pits, which are excavated channels on either side of the Sutter Bypass. It has been reported that flooded lands of the Sutter Bypass are an important spawning and nursery area for Sacramento splittail (USFWS 2000). Records indicate that most spawning takes place from February through April (USFWS 1995). Splittail have not been reported to spawn in these conveyance canals, but if they do, potential reductions in agricultural return flows could be expected to occur after the cessation of splittail spawning. Therefore, potential agricultural return flow reductions to Butte

Creek under the Flexible Purchase Alternative represent a less-than-significant impact on Sacramento splittail.

9.2.5.1.2 Feather River Area of Analysis

EWA acquisition of Oroville-Wyandotte ID stored reservoir water would alter surface water elevations in Sly Creek and Little Grass Valley reservoirs from November until refill. EWA acquisition of Oroville-Wyandotte ID stored reservoir water would alter surface water elevations in Lake Oroville from the November prior to the transfer until the following September. EWA acquisition of Feather River contractor water via groundwater substitution and crop idling would alter summer surface water elevations in Lake Oroville. EWA acquisition of Feather River contractor water via groundwater substitution and crop idling would alter Feather River flows below Lake Oroville, relative to the Baseline Condition.

The analysis of potential impacts on the fisheries resources in the Feather River Basin includes an assessment of the warmwater and coldwater fisheries of Little Grass Valley and Sly Creek reservoirs, Lake Oroville, and an assessment of fisheries resources of the lower Feather River below Lake Oroville. For lower Feather River fisheries resources, flow- and temperature-related impacts are discussed separately by species and lifestage. Organizationally, flow- and temperature-related impacts on fall-run Chinook salmon and steelhead are discussed together, followed by impact discussions for splittail, American shad, and striped bass.

<u>Impacts on Little Grass Valley and Sly Creek Reservoir Warmwater Fisheries</u>

Table 9-18 and Table 9-19 provide monthly median storage, elevation, and elevation changes for Little Grass Valley and Sly Creek reservoirs, respectively. Hydrologic conditions under the Flexible Purchase Alternative would result in reductions in the median water surface elevation of Little Grass Valley Reservoir of 2 feet in April and 6 feet in November, relative to the Baseline Condition, during the warmwater fish juvenile rearing period of April through November. At Sly Creek Reservoir, hydrologic conditions under the Flexible Purchase Alternative also would result in reductions in the median water surface elevation of 2 feet in April and 8 feet in November, relative to the Baseline Condition, during the April through November juvenile rearing period. Changes in water surface elevation of Little Grass Valley and Sly Creek reservoirs would result in corresponding changes in the availability of littoral habitat containing submerged vegetation. Such shallow, nearshore waters containing physical structure are important to producing and maintaining strong year-classes of warmwater fishes. Reductions in median end-of-month water surface elevation of Little Grass Valley and Sly Creek reservoirs under the Flexible Purchase Alternative would not be anticipated to result in substantial reductions in the amount of habitat potentially available to warmwater fishes for spawning and/or rearing, because large reductions in water surface elevation would occur outside of April and May, the primary months of the spawning and initial rearing period.

In addition, the Flexible Purchase Alternative could alter the rates by which water surface elevation in Little Grass Valley and Sly Creek reservoirs change, relative to the Baseline Condition. Table 9-18 and Table 9-19 indicate that the magnitude of monthly reservoir drawdown would not be greater under the Flexible Purchase Alternative than under the Baseline Condition during the warmwater fish-spawning period of March through June Reservoir. Further, it is anticipated that reductions in water surface elevation of greater than 9 feet msl per month during the warmwater fish-spawning period of March through June, which could potentially result in nest dewatering events, would not occur more frequently under the Flexible Purchase Alternative than under the Baseline Condition.

Table 9-18
Little Grass Valley Reservoir Monthly Median Storage, Elevation, and Elevation Change, Under Baseline and Flexible Purchase Alternative Conditions

	Storage				Elevation			Elevation Change		
Month	Baseline (TAF)	FP Alt (TAF)	Diff (TAF)	Diff (%)	Baseline (ft msl)	FP Alt (ft msl)	Diff (ft msl)	Baseline (ft msl)	FP Alt (ft msl)	Diff (ft msl)
Oct	52	52	0	0	5018	5018	0	-5	-5	0
Nov	50	44	-6	-12	5015	5010	-6	-2	-8	-6
Dec	50	38	-12	-24	5016	5004	-12	1	-6	-6
Jan	57	48	-10	-17	5022	5013	-9	6	9	3
Feb	63	55	-7	-11	5027	5021	-6	5	7	3
Mar	70	65	-5	-7	5033	5029	-4	6	8	2
Apr	76	73	-2	-3	5037	5035	-2	4	6	2
May	86	86	0	0	5044	5044	0	7	9	2
Jun	86	86	0	0	5044	5044	0	0	0	0
Jul	76	76	0	0	5037	5037	0	-7	-7	0
Aug	66	66	0	0	5029	5029	0	-8	-8	0
Sep	58	58	0	0	5023	5023	0	-6	-6	0

Based on median monthly storage and flow over the historical record from 1970 to 2001.
FP Alt = Flexible Purchase Alternative; Diff = Difference

Table 9-19
Sly Creek Reservoir Monthly Median Storage, Elevation, and Elevation Change Under Baseline and Flexible Purchase Alternative Conditions

	Storage				Elevation			Elevation Change		
Month	Baseline (TAF)	FP Alt (TAF)	Diff (TAF)	Diff (%)	Baseline (ft msl)	FP Alt (ft msl)	Diff (ft msl)	Baseline (ft msl)	FP Alt (ft msl)	Diff (ft msl)
Oct	22	22	0	0	3438	3438	0	-10	-10	0
Nov	21	18	-3	-12	3434	3425	-8	-4	-12	-8
Dec	19	14	-5	-27	3427	3410	-18	-7	-16	-9
Jan	27	23	-4	-15	3453	3441	-12	26	32	6
Feb	36	33	-3	-8	3476	3468	-8	23	27	4
Mar	48	46	-2	-4	3504	3500	-4	29	32	3
Apr	55	54	-1	-2	3521	3519	-2	17	19	2
May	62	62	0	0	3536	3536	0	15	17	2
Jun	58	58	0	0	3525	3525	0	-10	-10	0
Jul	48	48	0	0	3504	3504	0	-21	-21	0
Aug	33	33	0	0	3469	3469	0	-35	-35	0
Sep	25	25	0	0	3447	3447	0	-22	-22	0

Based on median monthly storage and flow over the historical record from 1970 to 2001.
FP Alt = Flexible Purchase Alternative; Diff = Difference

In summary, the Flexible Purchase Alternative is not likely to result in substantial changes in the availability of littoral habitat at Little Grass Valley or Sly Creek reservoirs, and thus, would not likely beneficially or adversely affect warmwater fish rearing. The Flexible Purchase Alternative does not increase the frequency of potential nest dewatering events in Little Grass Valley or Sly Creek reservoirs, and thus, would not adversely affect long-term warmwater fish nesting success.

Therefore, under the Flexible Purchase Alternative, impacts on Little Grass Valley and Sly Creek reservoirs warmwater fisheries would be less than significant, relative to the Baseline Condition.

Impacts on Little Grass Valley and Sly Creek Reservoir Coldwater Fisheries

Hydrologic conditions under the Flexible Purchase Alternative would result in a decrease in median storage of up to 6 TAF, or 12 percent, at Little Grass Valley Reservoir during the April through November period, relative to the Baseline Condition, as shown in Table 9-18. At Sly Creek Reservoir, hydrologic conditions under the Flexible Purchase Alternative would result in a decrease in median storage of up to 3 TAF, or 12 percent, during the April through November period, relative to the Baseline Condition. (See Table 9-19.) Anticipated reductions in reservoir storage would not be expected to adversely affect the reservoir's coldwater fisheries because: 1) coldwater habitat would remain available within the reservoir during all months of all years, 2) physical habitat availability is not believed to be among the primary factors limiting coldwater fish populations, and 3) anticipated seasonal reductions in storage would not be expected to adversely affect the primary prey species utilized by coldwater fish. Further, given the overall storage capacity of Little Grass Valley and Sly Creek reservoirs (94.7 TAF and 65.7 TAF, respectively), such changes in storage represent only a small proportion of each reservoir's total volume. Therefore, changes in end-of-month storage at Little Grass Valley and Sly Creek reservoirs under the Flexible Purchase Alternative represent a less-than-significant impact on coldwater fish resources.

Impacts on Lake Oroville Warmwater Fisheries

Hydrologic conditions under the Flexible Purchase Alternative would result in slight differences in the long-term average end-of-month water surface elevation of Lake Oroville during the warmwater juvenile fish-rearing period of April through November. As shown in Table 9-20, long-term average end-of-month water surface elevation under the Flexible Purchase Alternative would not change during April and September, would increase by 2 feet and 3 feet msl, respectively, during May and June, and would decrease by 4 feet and 3 feet msl, respectively, during July and August, relative to the Baseline Condition. Monthly mean end-of-month water surface elevation at Lake Oroville would be essentially equivalent to or greater than the Baseline Condition for 474 months of the 576 months included in the analysis. (See Appendix H pgs. 580-591.)

Changes in water surface elevation in Lake Oroville during the April through November period would result in corresponding changes in the availability of reservoir littoral habitat containing submerged vegetation (willows and button brush). Such shallow, nearshore waters containing physical structure are important to producing and maintaining strong year-classes of warmwater fish annually. The small and infrequent reduction in the water surface elevation that would occur under the Flexible Purchase Alternative would not be of sufficient magnitude to substantially reduce the amount of available littoral habitat and, thus, long-term average initial year-class strength of the warmwater fish populations.

Table 9-20
Long-term Average Oroville Reservoir End of Month Elevation Under Baseline and Flexible Purchase Alternative Conditions

Month	Average Elevation[1] (feet msl)		
	Baseline	Flexible Purchase Alternative	Difference
Mar	840	840	0
Apr	857	857	0
May	864	866	2
Jun	849	852	3
Jul	825	821	-4
Aug	794	791	-3
Sep	782	782	0
Oct	775	775	0
Nov	780	780	0
Dec	791	791	0

[1] Based on 72 years modeled.

In addition, the Flexible Purchase Alternative could alter the extent to which water surface elevations in Lake Oroville change during each month of the primary warmwater fish-spawning period (March through June). As discussed in Section 9.2.1.1.1, adverse effects on spawning from nest dewatering are assumed to have the potential to occur when reservoir elevation decreases by more than nine feet within a given month. Modeling results, shown in Table 9-21, indicate that the frequency with which potential nest dewatering events could occur in Lake Oroville would remain the same or be less under the Flexible Purchase Alternative, compared to the Baseline Condition, during any month of the March through June spawning period (two fewer occurrences in May and three fewer occurrences in June).

In summary, the Flexible Purchase Alternative is not likely to result in substantial changes in the availability of littoral habitat at Lake Oroville, and thus, would not likely beneficially or adversely affect warmwater fish rearing. The Flexible Purchase Alternative does not increase the frequency of potential nest dewatering events in Lake Oroville, and thus, would not adversely affect long-term warmwater fish nesting success. In fact, implementation of the Flexible Purchase Alternative would potentially beneficially affect warmwater fish spawning by reducing the number of potential nest dewatering events, relative to the baseline. Overall, under the Flexible Purchase Alternative, impacts on Lake Oroville warmwater fisheries would be less than significant, relative to the Baseline Condition.

Table 9-21 Long-term Average Surface Elevation and Number of Years with Elevation Decrease Greater than 9 feet in Oroville Reservoir Under Baseline and Flexible Purchase Alternative Conditions					
Month	**Average Reservoir Surface Elevation[1] (feet msl)**			**No. Years[1] w/Monthly Elevation Decrease During Month > 9 ft**	
	Baseline	**Flexible Purchase Alternative**	**Difference**	**Baseline**	**FP Alt**
Mar	840	840	0	2	2
Apr	857	857	0	3	3
May	864	866	2	9	7
Jun	849	852	3	50	47

[1] Based on 72 years modeled.

Impacts on Lake Oroville Coldwater Fisheries

Long-term average end-of-month storage under the Flexible Purchase Alternative would not change in April, September, October, and November, would increase by 17 TAF or 0.6 percent in May, 39 TAF or 1.4 percent in June, and would decrease 50 TAF or 2.0 percent in July, 26 TAF or 1.2 percent in August, and 2 TAF or 0.1 percent in September relative to the Baseline Condition, during the period when the reservoir thermally stratifies (April through November). (Refer to Table 9-22). Lake Oroville monthly mean end-of-month storage under the Flexible Purchase Alternative would be essentially equivalent to or greater than the Baseline Condition for 483 of the 576 months for November. (See Appendix H pgs. 121-122 and 127-132.) Anticipated reductions in reservoir storage that would occur under the Flexible Purchase Alternative would not be expected to adversely affect the reservoir's coldwater fisheries because: 1) coldwater habitat would remain available within the reservoir during all months of all years; 2) physical habitat availability is not believed to be among the primary factors limiting coldwater fish populations; and 3) anticipated seasonal reductions in storage would not be expected to adversely affect the primary prey species utilized by coldwater fish. Therefore, potential impacts on Lake Oroville coldwater fisheries under the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Table 9-22 Long-term Average Oroville Reservoir End of Month Storage Under Baseline and Flexible Purchase Alternative Conditions				
Month	**Average Storage[1] (TAF)**		**Difference**	
	Baseline	**Flexible Purchase Alternative**	**(TAF)**	**(%)[2]**
Apr	2953	2953	0	0.0
May	3056	3073	17	0.6
Jun	2849	2888	39	1.4
Jul	2557	2507	-50	-2.0
Aug	2218	2192	-26	-1.2
Sep	2105	2103	-2	-0.1
Oct	2047	2047	0	0.0
Nov	2099	2099	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Impacts on Spring-run Chinook Salmon in the Lower Feather River

Flow-related Impacts on Adult Spring-run Chinook Salmon Immigration and Holding (March through August)

Long-term average flows in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would not differ in March, and would be up to 29 percent greater than flows under the Baseline Condition during April through August, as shown in Table 9-23. Monthly mean flows below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 425 out of the 432 months included in the analysis for March through August. (See Appendix H pgs. 897-902.)

Table 9-23
Long-term Average Flow Below the Thermalito Afterbay Outlet Under Baseline and Flexible Purchase Alternative Conditions

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	2441	2509	68	2.8
Nov	2301	2315	14	0.6
Dec	3984	3989	5	0.1
Jan	5005	5007	2	0.0
Feb	5930	5931	1	0.0
Mar	6144	6146	2	0.0
Apr	3416	3734	318	9.3
May	3826	3969	143	3.7
Jun	5084	5192	108	2.1
Jul	5896	7210	1314	22.3
Aug	4434	5737	1303	29.4
Sep	1600	1977	377	23.6

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Long-term average flows at the mouth of the Feather River under the Flexible Purchase Alternative would not differ in March, and would be up to 35 percent greater than flows under the Baseline Condition during April through August, as shown in Table 9-24. Monthly mean flows at the mouth of the Feather River under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 430 out of the 432 months included in the analysis for March through August. (See Appendix H pgs. 873-878.)

Temperature-related Impacts on Adult Spring-run Chinook Salmon Immigration and Holding (March through August)

Long-term average water temperatures in the Feather River below the Fish Barrier Dam under the Flexible Purchase Alternative would not differ from those under the Baseline Condition during the March through August period, as shown in Table 9-25. Monthly mean water temperatures below the Fish Barrier Dam under the Flexible

Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 414 months included in the analysis. (See Appendix H pgs. 945-950.)

Table 9-24
Long-term Average Flow at the Feather River Mouth Under Baseline and Flexible Purchase Alternative Conditions

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	3284	3352	68	2.1
Nov	3482	3496	14	0.4
Dec	6227	6232	5	0.1
Jan	11355	11357	2	0.0
Feb	13096	13097	1	0.0
Mar	13182	13184	2	0.0
Apr	9518	9836	318	3.3
May	7735	7877	142	1.8
Jun	7647	7755	108	1.4
Jul	6311	8497	2186	34.6
Aug	4881	6512	1631	33.4
Sep	3404	3852	498	13.2

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Below the Thermalito Afterbay Outlet, long-term average water temperatures under the Flexible Purchase Alternative during the March through August period would be identical to those under the Baseline Condition, as shown in Table 9-26. Monthly mean water temperatures would remain essentially equivalent to those under the Baseline Condition in 413 of the 414 months simulated for the March through August adult spring-run Chinook salmon immigration and holding period. (See Appendix H pgs. 921-926.)

At the mouth of the Feather River, long-term average water temperatures under the Flexible Purchase Alternative would increase 0.1°F, 0.1°F, and 0.2°F during the months of April, May, and June, respectively, as shown in Table 9-27. By contrast, long-term average water temperatures would decrease 0.4°F and 0.5°F during August and September, respectively, with the implementation of the Flexible Purchase Alternative, and would not change during July. Monthly mean water temperatures at the mouth of the Feather River during the March through August period would remain essentially equivalent to or less than those under the Baseline Condition in 382 of the 414 months included in the analysis. (See Appendix H pgs. 933-938.) There would be 19 and 6 occurrences during May and June, respectively, in which water temperatures would increase by greater than 0.3°F, relative to the Baseline Condition. By contrast, during August and September, when long-term average water temperatures would be higher than those during May and June, numerous decreases in monthly mean water temperatures would occur. In August, there would be 30 months in which decreases in monthly mean water temperatures of greater than 0.3°F would occur, and in September, there would be 49 months with temperature decreases of greater than 0.3°F.

Table 9-25
Long-term Average Water Temperature in the Feather River Below the Fish Barrier Dam Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	54.0	54.0	0.0
Nov	52.4	52.4	0.0
Dec	48.0	48.0	0.0
Jan	46.0	46.0	0.0
Feb	47.1	47.1	0.0
Mar	49.0	49.0	0.0
Apr	51.0	51.0	0.0
May	55.3	55.3	0.0
Jun	57.4	57.4	0.0
Jul	61.6	61.6	0.0
Aug	60.8	60.8	0.0
Sep	56.5	56.5	0.0

[1] Based on 69 years modeled.

Table 9-26
Long-term Average Water Temperature in the Feather River Below the Thermalito Afterbay Outlet Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	59.6	59.6	0.0
Nov	53.0	53.0	0.0
Dec	46.4	46.4	0.0
Jan	45.3	45.3	0.0
Feb	49.0	49.0	0.0
Mar	52.7	52.7	0.0
Apr	57.0	57.0	0.0
May	62.4	62.4	0.0
Jun	66.2	66.2	0.0
Jul	70.1	70.1	0.0
Aug	69.2	69.2	0.0
Sep	64.7	64.7	0.0

[1] Based on 69 years modeled.

Table 9-27
Long-term Average Water Temperature at the Mouth of the Feather River Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	61.3	61.3	0.0
Nov	52.4	52.4	0.0
Dec	45.9	45.9	0.0
Jan	45.3	45.3	0.0
Feb	49.6	49.6	0.0
Mar	54.2	54.2	0.0
Apr	59.8	59.9	0.1
May	65.5	65.6	0.1
Jun	70.0	70.2	0.2
Jul	73.6	73.6	0.0
Aug	72.2	71.8	-0.4
Sep	69.7	69.2	-0.5

[1] Based on 69 years modeled.

Flow-Related Impacts on Adult Spring-run Chinook Salmon Spawning and Egg Incubation (August through November)

Long-term average flows in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be up to 29 percent greater than flows under the Baseline Condition in August, September, and October, and would be essentially equivalent in November and December, as shown in Table 9-23. Monthly mean flows below the Thermalito Afterbay Outlet would be essentially equivalent to or greater than flows under the Baseline Condition in 288 of the 288 months included in the analysis. (See Appendix H pgs. 892, 902-903.)

Figures 9-32 through 9-35 show exceedance curves for below the Thermalito Afterbay Outlet in the lower Feather River for August through November. The basis for development of these exceedance curves was the 1922-1993 period of record. These curves demonstrate that flows under the Flexible Purchase Alternative would be equivalent to or greater than flows under the Baseline Condition.

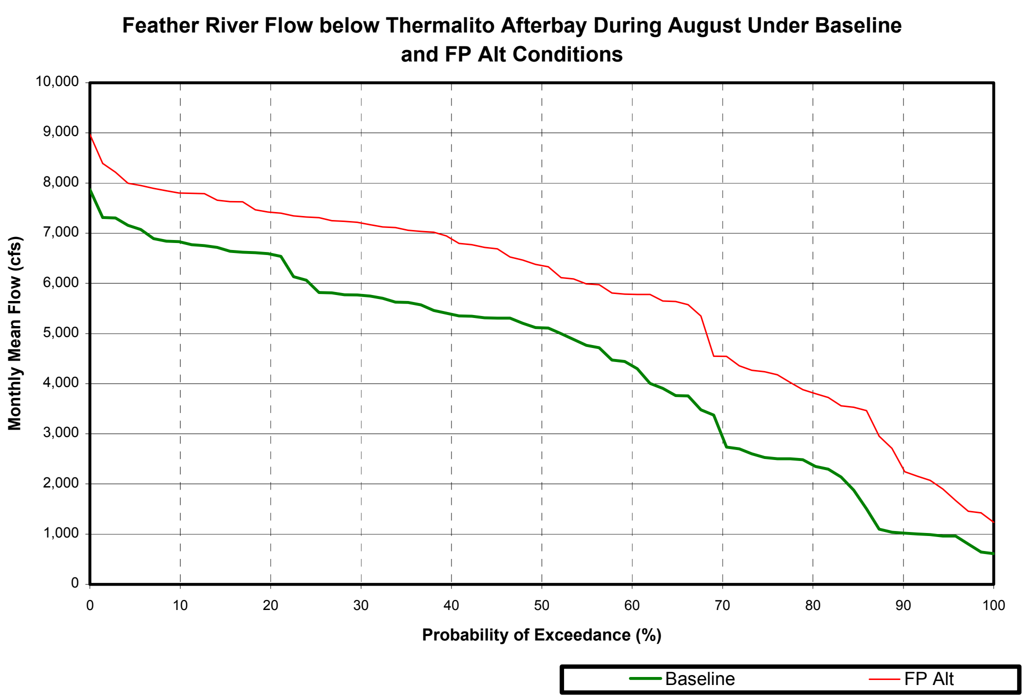

Figure 9-32
Feather River Flow Below Thermalito Afterbay During August Under Baseline and Flexible Purchase Alternative Conditions

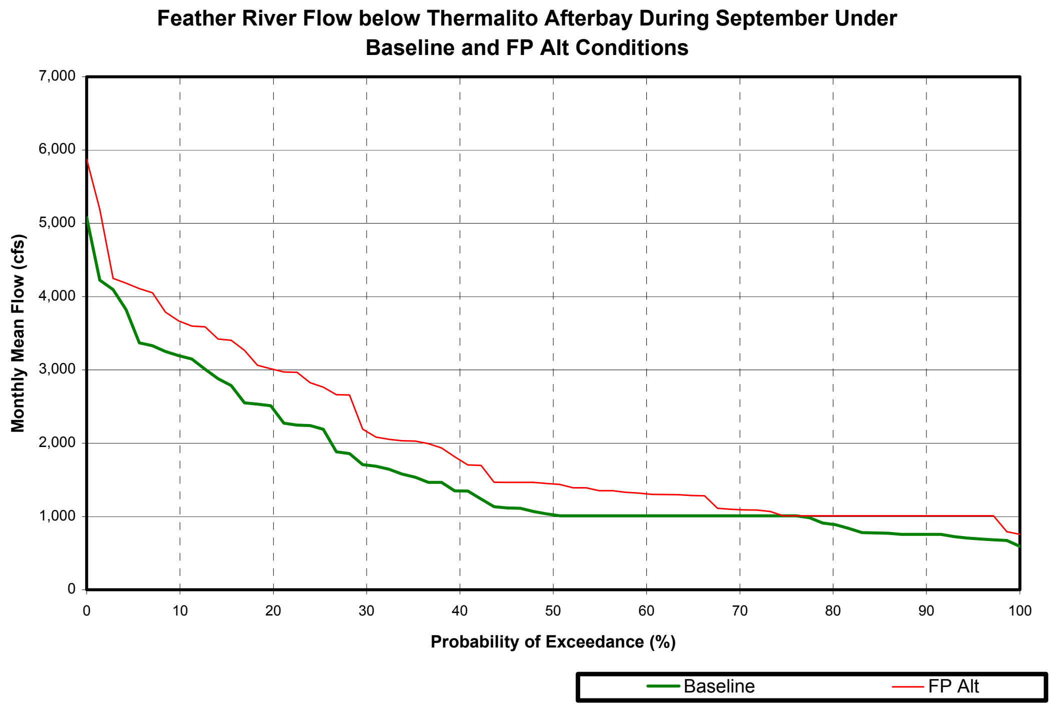

Figure 9-33
Feather River Flow Below Thermalito Afterbay During September Under Baseline and Flexible Purchase Alternative Conditions

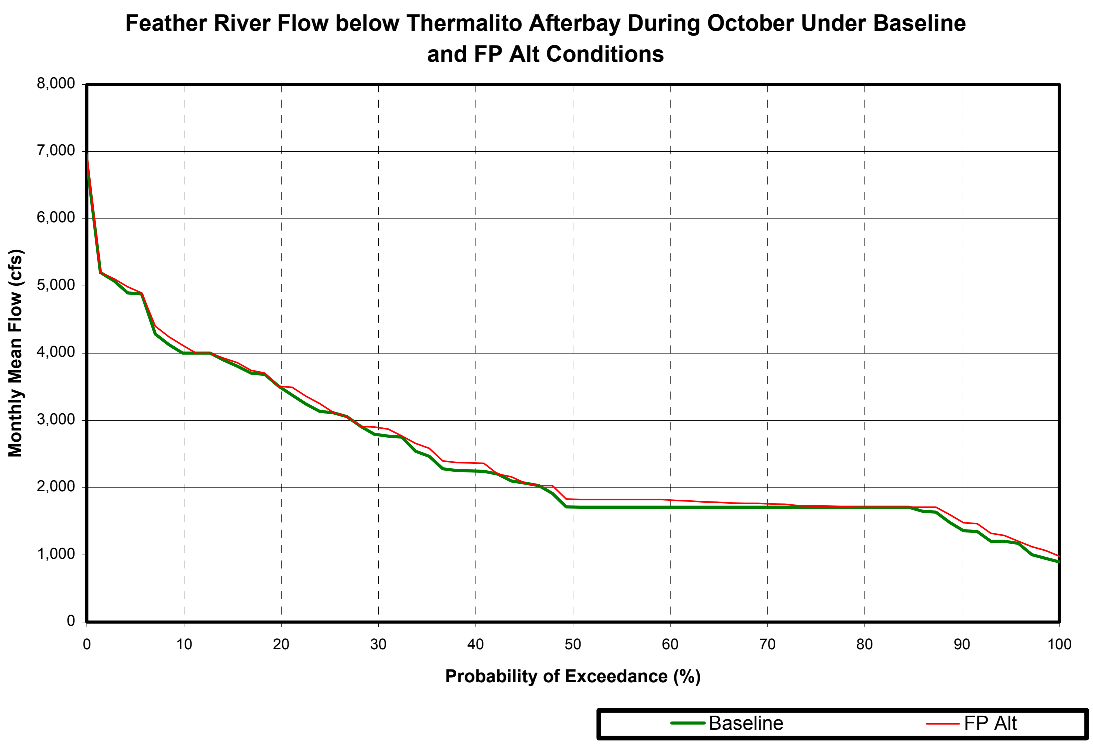

Figure 9-34
Feather River Flow Below Thermalito Afterbay During October Under Baseline and Flexible Purchase Alternative Conditions

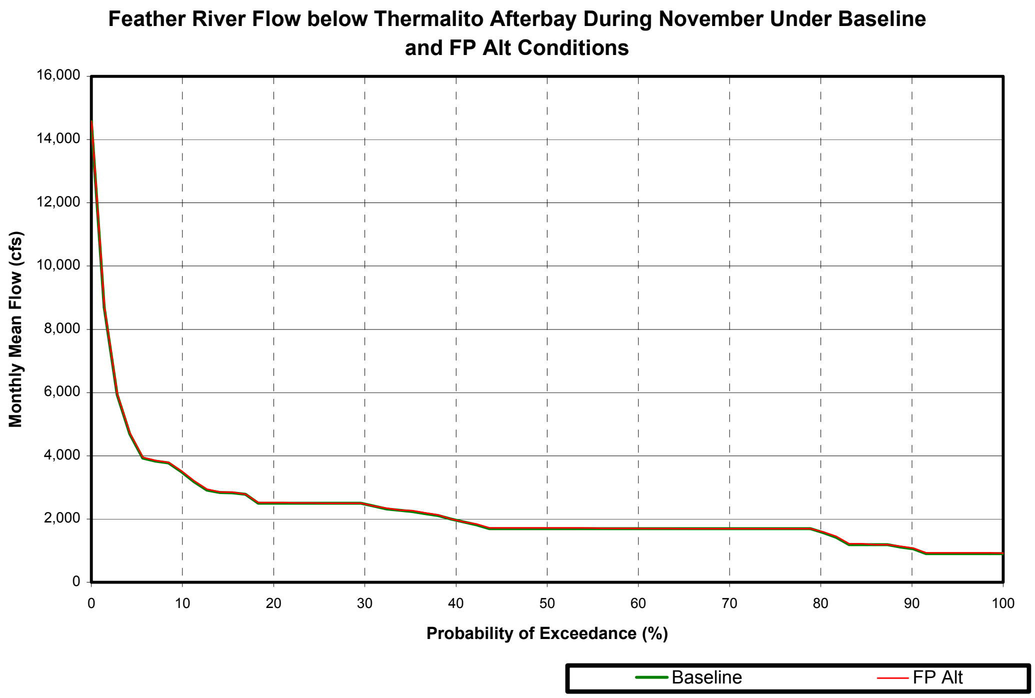

Figure 9-35
Feather River Flow Below Thermalito Afterbay During November Under Baseline and Flexible Purchase Alternative Conditions

These findings indicate that the Flexible Purchase Alternative could: 1) increase flows below Thermalito Afterbay for all flows relative to the Baseline Condition during August; 2) equal or increase flows below Thermalito Afterbay for all flows relative to the Baseline Condition during September; 3) equal or slightly increase flows below Thermalito Afterbay for all flows relative to the Baseline Condition during October; and 4) equal flows below Thermalito Afterbay for all flows relative to the Baseline Condition during November.

Temperature-related Impacts on Adult Spring-run Chinook Salmon Spawning and Egg Incubation (August through November)

Under the Flexible Purchase Alternative, long-term average water temperatures below the Fish Barrier Dam and below the Thermalito Afterbay Outlet would be identical to those under the Baseline Condition during the August through October period below the Fish Barrier Dam and below the Thermalito Afterbay Outlet, as shown in Table 9-25 and Table 9-26, respectively. In fact, in all of the 276 months included in the analysis, monthly mean water temperatures at these locations under the Flexible Purchase Alternative would be essentially equivalent to water temperatures under the Baseline Condition. (See Appendix H pgs. 916-927 and 940-951.) Further, there would not be any additional occurrences of water temperatures greater than 56°F under the Flexible Purchase Alternative, relative to the Baseline Condition, below the Fish Barrier Dam and below the Thermalito Afterbay Outlet.

Flow-related Impacts on Juvenile Spring-run Chinook Salmon Rearing and Emigration (November through June)

Long-term average flows in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be up to 9 percent greater during the November through June juvenile spring-run Chinook salmon rearing and emigration period, relative to the Baseline Condition, as shown in Table 9-23. Monthly mean flows below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 576 of the 576 months included in the analysis for November through June. (Refer to Appendix H pgs. 893-900.)

Long-term average flows at the mouth of the Feather River under the Flexible Purchase Alternative would be up to three percent greater during the November through June juvenile spring-run Chinook salmon rearing and emigration period relative to the Baseline Condition. (Refer to Table 9-24.) Monthly mean flows at the mouth of the Feather River under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 576 of the 576 months included in the analysis for November through June. (Refer to Appendix H pgs. 869-876.)

Temperature-related Impacts on Juvenile Spring-run Chinook Salmon Rearing and Emigration (November through June)

Long-term average water temperatures under the Flexible Purchase Alternative below the Fish Barrier Dam would be identical to those under the Baseline Condition during the November through June period, as shown in Table 9-25. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 552 months simulated for the November through June period. (See Appendix H pgs. 941-948.) Monthly mean water temperatures would not be greater than 65°F in any month simulated for the November through June period under both the Flexible Purchase Alternative and the Baseline Condition. (See Appendix H pgs. 941-948.) Therefore, implementation of the Flexible Purchase Alternative would not result in water temperatures above 65°F below the Fish Barrier Dam during the juvenile spring-run Chinook salmon rearing and emigration period.

Below the Thermalito Afterbay Outlet, long-term average water temperatures under the Flexible Purchase Alternative would be identical to those under the Baseline Condition throughout the November through June juvenile spring-run Chinook salmon rearing and emigration period, as shown in Table 9-26. Monthly mean water temperatures in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 552 months included in the analysis. (See Appendix H pgs. 917-924.) In addition, the Flexible Purchase Alternative would not result in an increase in the frequency in which monthly mean water temperatures below the Thermalito Afterbay Outlet would be greater than 65°F, relative to the Baseline Condition.

At the mouth of the Feather River, long-term average water temperatures under the Flexible Purchase Alternative would remain unchanged from November through March, and would increase by 0.1°F, 0.1°F, and 0.2°F during April, May, and June, respectively, as shown in Table 9-27. Monthly mean water temperatures in the Feather River at the mouth would be essentially equivalent to those under the Baseline Condition in 525 of the 552 months simulated for the November through June period. (See Appendix H pgs. 929-936.) However, there would only be one additional occurrence in which monthly mean water temperatures under the Flexible Purchase Alternative would be greater than 65°F, relative to the Baseline Condition.

Summary of Impacts on Spring-Run Chinook Salmon in the Feather River

In summary, the difference in flows below the Thermalito Afterbay Outlet and at the mouth of the Feather River that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect attraction, passage, and holding of adult spring-run Chinook salmon during the March through August period. Similarly, the difference in flows below the Thermalito Afterbay Outlet and at the mouth of the Feather River that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect spawning and egg incubation during the August through November period. Changes in flow that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile rearing and emigration during the November through June period.

Changes in Feather River water temperatures under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect adult spring-run Chinook salmon immigration and holding during the March through August period. Similarly, potential water temperature changes in the Feather River resulting from the implementation of the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact spawning and egg incubation during the August through November period. Changes in water temperatures under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile rearing and emigration during the November through June period.

Overall, the changes in flows and water temperatures in the Feather River under the Flexible Purchase Alternative, relative to the Baseline Condition, would not be of sufficient frequency or magnitude to beneficially or adversely impact spring-run Chinook salmon. Therefore, impacts on spring-run Chinook salmon in the Feather

River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on Fall-run Chinook Salmon and Steelhead in the Lower Feather River

Flow-related Impacts on Adult Fall-run Chinook Salmon/Steelhead Immigration (September through January)

Table 9-24 shows that long-term average flows at the mouth of the Feather River under the Flexible Purchase Alternative would be up to 13 percent greater during September through January relative to the Baseline Condition. Monthly mean flows at the mouth of the Feather River under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 360 of the 360 months included in the analysis for September through January. (See Appendix H pgs. 868-871, 879.)

Long-term average flows below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be up to 24 percent greater during September through January relative to the Baseline Condition, as shown in Table 9-23. Monthly mean flows below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 360 of the 360 months included in the analysis for September through January. (See Appendix H pgs. 892-895, 903.)

Temperature-related Impacts on Adult Fall-run Chinook Salmon/Steelhead Immigration (September through January)

Under the Flexible Purchase Alternative, long-term average water temperatures at the mouth of the Feather River would decrease by 0.5°F in September, relative to the Baseline Condition, and would remain unchanged in the remaining months of the September through January period, as shown in Table 9-27. Moreover, under the Flexible Purchase Alternative, monthly mean water temperatures at the mouth of the Feather River would remain essentially equivalent to or less than those under the Baseline Condition in all of the 345 months included in the analysis. (See Appendix H pgs. 928-933, 939.)

Long-term average water temperatures below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be identical those under the Baseline Condition during the September through January period, as shown in Table 9-26. Monthly mean water temperatures below the Thermalito Afterbay Outlet would remain essentially equivalent to those under the Baseline Condition in all of the 345 months simulated for the September through January period. (See Appendix H pgs. 916-919, 927.)

Flow-related Impacts on Adult Fall-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (October through February)

Under the Flexible Purchase Alternative, long-term average flows in the Feather River below the Thermalito Afterbay Outlet would be 3 percent greater in October and essentially equivalent during November through February relative to the Baseline Condition, as shown in Table 9-23. Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 360 of the 360 months included in the analysis for October through February. (See Appendix H pgs. 892-896.)

Temperature-related Impacts on Adult Fall-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (October through February)

Under the Flexible Purchase Alternative, long-term average water temperatures in the Feather River below the Fish Barrier Dam would not differ from those under the Baseline Condition during the October through February period, as shown in Table 9-25. In fact, in all of the 345 months included in the analysis, monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to water temperatures under the Flexible Purchase Alternative. (See Appendix H pgs. 940-944.) Moreover, implementation of the Flexible Purchase Alternative would not result in additional occurrences in which water temperatures during the October through February period would be above 56°F, relative to the Baseline Condition. (See Appendix H pgs. 940-944.)

Below the Thermalito Afterbay Outlet, long-term average water temperatures would not differ from those under the Baseline Condition during the October through February period, as shown in Table 9-26. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 345 months included in the analysis. (See Appendix H pgs. 916-920.) In addition, there would not be any additional occurrences in which water temperatures would be greater than 56°F under the Flexible Purchase Alternative, relative to the Baseline Condition, during any month of the October through February period. (See Appendix H pgs. 916-920.)

Flow-related Impacts on Adult Steelhead Spawning and Egg Incubation (December through April)

Table 9-23 shows that long-term average flows in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be up to 9 percent greater than flows under the Baseline Condition during the December through April adult steelhead spawning and egg incubation period. Further, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 360 of the 360 months included in the analysis for December through April. (See Appendix H pgs. 894-898.)

Temperature-related Impacts on Adult Steelhead Spawning and Egg Incubation (December through April)

Long-term average water temperatures below the Fish Barrier Dam under the Flexible Purchase Alternative would not differ from those under the Baseline Condition during the December through April period, as shown in Table 9-25. In addition, monthly mean water temperatures below the Fish Barrier Dam would be essentially equivalent to those under the Baseline Condition for all of the 345 months included in the analysis. (See Appendix H pgs. 942-946.) Moreover, implementation of the Flexible Purchase Alternative would not result in monthly mean water temperatures below the Fish Barrier Dam greater than 56°F, relative to the Baseline Condition, in any month simulated for the December through April period.

Below the Thermalito Afterbay Outlet, long-term average water temperatures under the Flexible Purchase Alternative throughout the December through April period would be identical to those under the Baseline Condition, as shown in Table 9-23. In addition, monthly mean water temperatures below the Thermalito Afterbay Outlet would be essentially equivalent to those under the Baseline Condition for all of the 345 months included in the analysis. (See Appendix H pgs. 918-922.) Further, there would be no additional occurrences in which water temperatures below Thermalito Afterbay would be greater than 56°F, relative to the Baseline Condition, for all of the 69 years modeled.

Flow-related Impacts on Juvenile Fall-run Chinook Salmon and Steelhead Rearing and Emigration (February through June)

Long-term average flows in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be up to 9 percent or greater than flows under the Baseline Condition during February through June. (Refer to Table 9-23.) Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition included in the analysis for February through June. (See Appendix H pgs. 896-900.)

Flow exceedance curves for February through June in the Feather River below the Thermalito Afterbay are shown in Figures 9-36 through 9-40. The basis for development of these exceedance curves was the 1922-1993 period of record. These curves indicate that flows in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be essentially equivalent o or slightly greater than flows under the Baseline Condition.

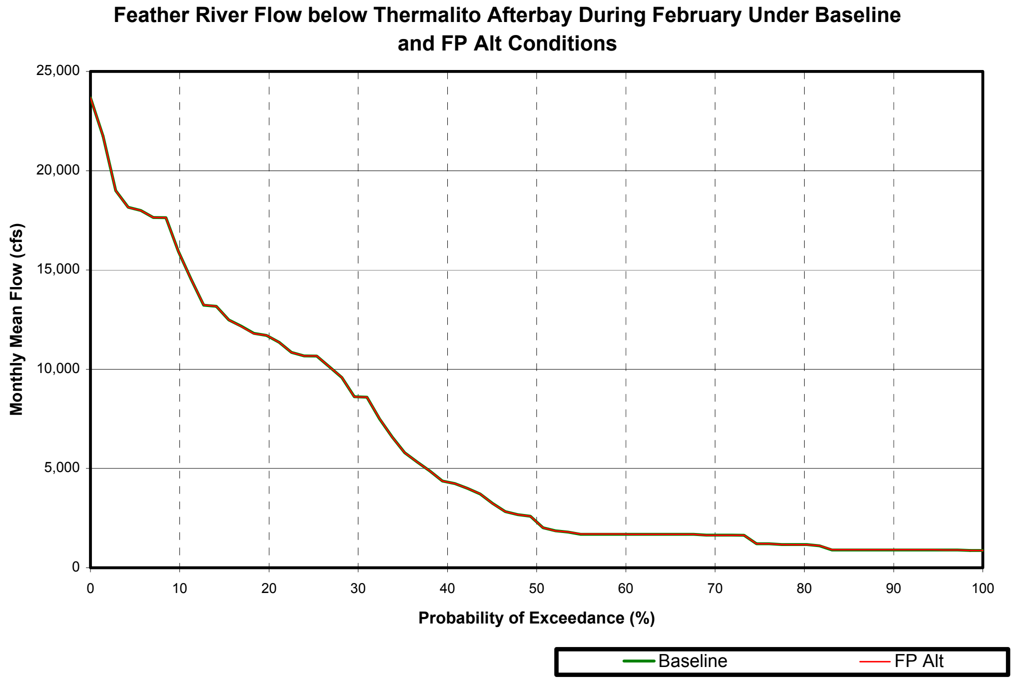

Figure 9-36
Feather River Flow Below Thermalito Afterbay During February Under Baseline and Flexible Purchase Alternative Conditions

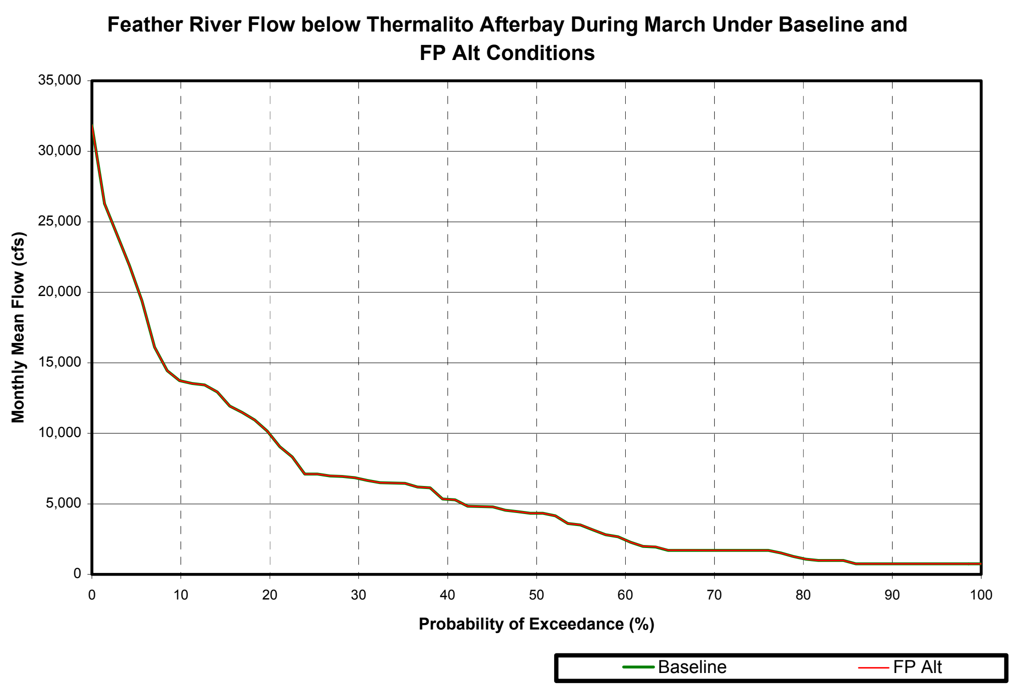

Figure 9-37
Feather River Flow Below Thermalito Afterbay During March Under Baseline and Flexible Purchase Alternative Conditions

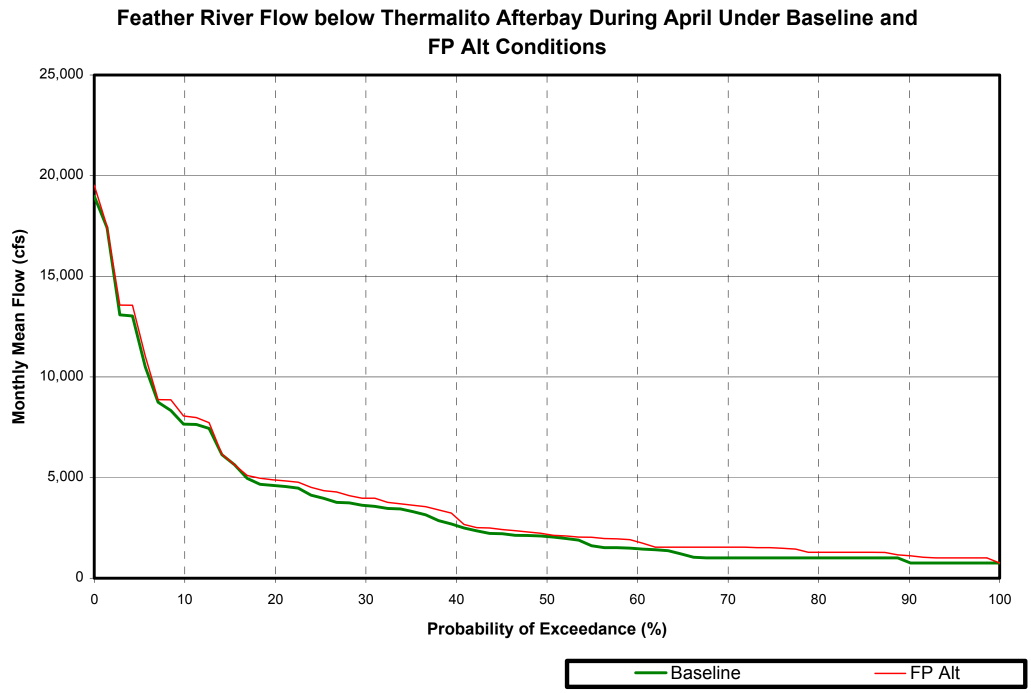

Figure 9-38
Feather River Flow Below Thermalito Afterbay During April Under Baseline and Flexible Purchase Alternative Conditions

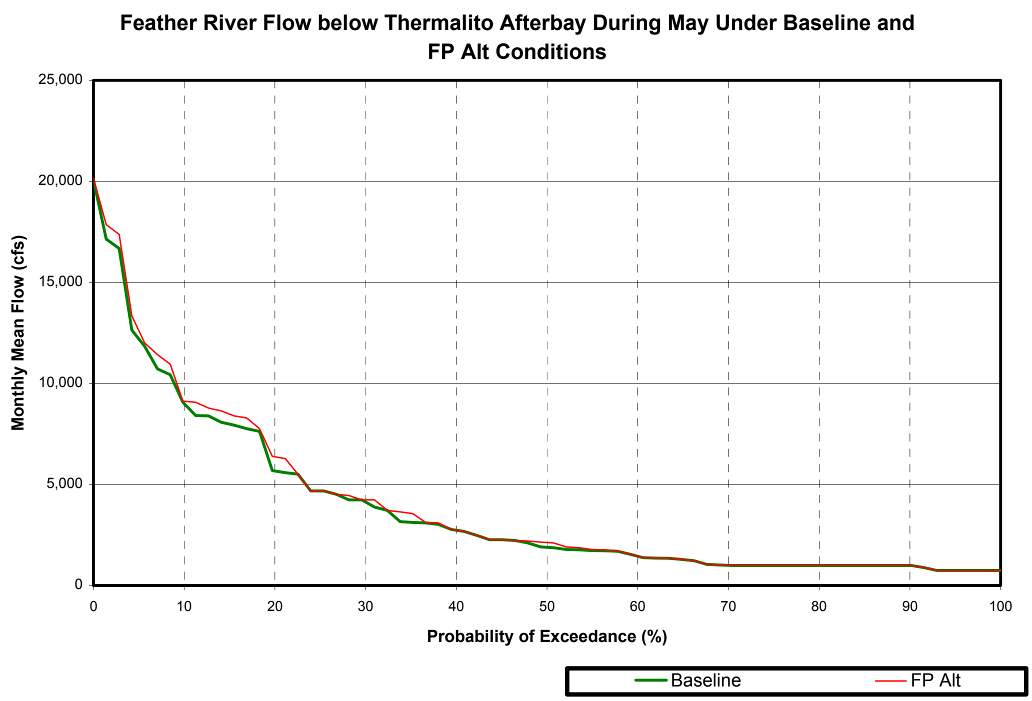

Figure 9-39
Feather River Flow Below Thermalito Afterbay During May Under Baseline and Flexible Purchase Alternative Conditions

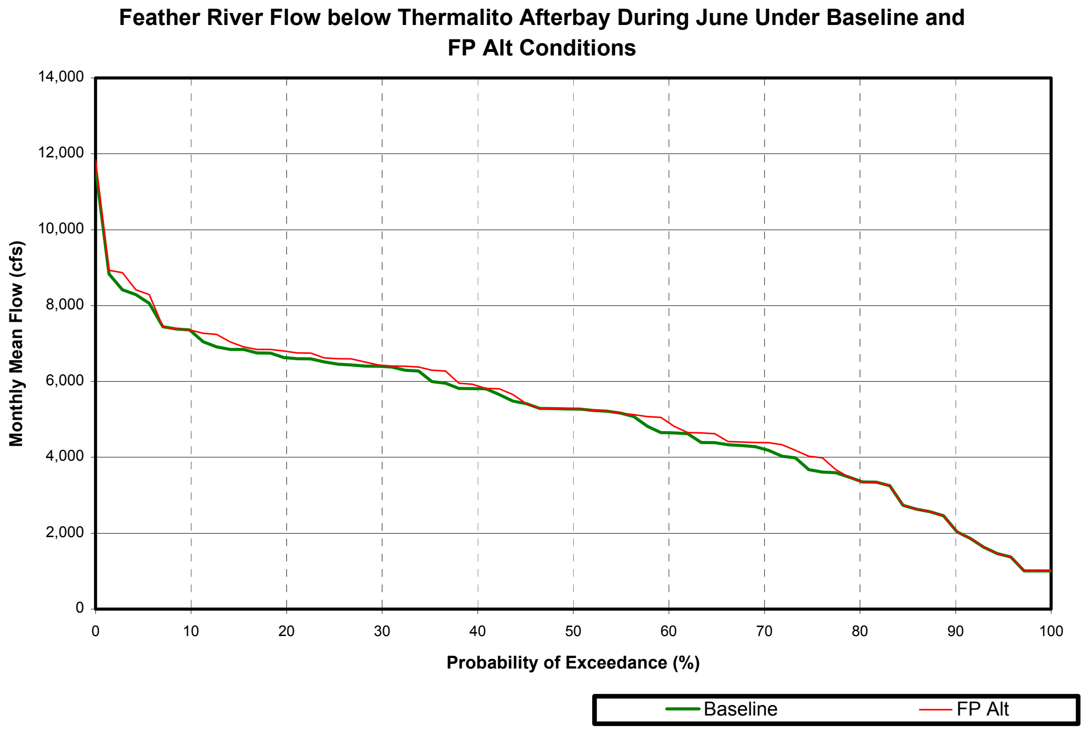

Figure 9-40
Feather River Flow Below Thermalito Afterbay During June Under Baseline and Flexible Purchase Alternative Conditions

Long-term average flows at the mouth of the Feather River under the Flexible Purchase Alternative would be up to 3 percent greater than flows under the Baseline Condition during February through June. (Refer to Table 9-24.) Further, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 360 of the 360 months included in the analysis for February through June. (Refer to Appendix H pgs. 872-876.)

Temperature-related Impacts on Juvenile Fall-run Chinook Salmon and Steelhead Rearing and Emigration (February through June)

Modeling associated with the Flexible Purchase Alternative indicates that the long-term average water temperatures in the lower Feather River below the Fish Barrier Dam would not differ during any month of the February through June period, relative to the Baseline Condition, as shown in Table 9-25. Monthly mean water temperatures in the Feather River below the Fish Barrier Dam would be essentially equivalent to those under the Baseline Condition in all of the 345 months simulated for the February through June period. (Refer to Appendix H pgs. 944-948.) In addition, monthly mean water temperatures under the Flexible Purchase Alternative and Baseline Condition would be below 65°F for each month simulated for the February through June period. Therefore, there would be no additional occurrences during February through June in which monthly mean water temperatures in the Feather River below the Fish Barrier

Dam under the Flexible Purchase Alternative would exceed 65°F, relative to the Baseline Condition.

NOAA Fisheries temperature criteria for daily water temperatures (less than 65°F) in the Low Flow Channel of the Feather River are applicable during June of the juvenile fall-run Chinook salmon and steelhead rearing and emigration period (NMFS 2001). As described in the Section 9.2.1.2.2 of the Assessment Methods, this analysis is based on monthly mean water temperatures due to modeling limitations. Therefore, this analysis evaluates the potential for monthly mean water temperatures to exceed NOAA Fisheries temperature criteria for the Feather River below the Fish Barrier Dam. As described above, the Flexible Purchase Alternative would not result in an increase in the frequency in which water temperatures would be above 65°F below the Fish Barrier Dam in the Low Flow Channel, relative to the Baseline Condition. Therefore, the Flexible Purchase Alternative would not exceed the NOAA Fisheries temperature criteria for the Feather River, relative to the Baseline Condition.

Below the Thermalito Afterbay Outlet, long-term average water temperatures under the Flexible Purchase Alternative would not differ from those under the Baseline Condition during any month of the February through June period, as shown in Table 9-26. Further, monthly mean water temperatures under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 345 months simulated for the February through June period and there would be no additional occurrences in which monthly mean water temperatures below the Thermalito Afterbay Outlet would be above 65°F, relative to the Baseline Condition.

Modeling associated with the Flexible Purchase Alternative indicates that long-term average water temperatures at the mouth of the Feather River would not change, relative to the Baseline Condition, during February and March, and would increase by up to 0.2°F during April, May, and June, as shown in Table 9-27. Monthly mean water temperatures under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 318 of the 345 months included in the analysis. (See Appendix H pgs. 932-936.) However, the frequency in which monthly mean water temperatures at this location would exceed 65°F would increase by one measurable occurrence under the Flexible Purchase Alternative, relative to the Baseline Condition.

Overall, water temperatures under the Flexible Purchase Alternative in the Feather River below the Fish Barrier Dam and below the Thermalito Afterbay Outlet would be unchanged, relative to the Baseline Condition, and would change slightly during April, May and June at the Feather River mouth. However, implementation of the Flexible Purchase Alternative would not result in additional exceedances of NOAA Fisheries water temperature criteria for the Low Flow Channel in the lower Feather River.

Flow-related Impacts on Over-summer Juvenile Steelhead Rearing (July through September)

Long-term average flows in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be between 22 percent and 29 percent greater than flows under the Baseline Condition during July through September. (See Table 9-23.) Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 209 of the 216 months included in the analysis. (See Appendix H pgs. 901-903.)

Long-term average flows at the mouth of the Feather River under the Flexible Purchase Alternative would be between 13 percent and 35 percent greater than flows under the Baseline Condition during July through September. (See Table 9-24.) Monthly mean flows would be essentially equivalent to or greater than flows under the Baseline Condition in 216 of the 216 months included in the analysis for July through September. (See Appendix H pgs. 877-879.)

Temperature-related Impacts on Over-summer Juvenile Steelhead Rearing (July through September)

Under the Flexible Purchase Alternative, long-term average water temperatures in the lower Feather River below the Fish Barrier Dam would not differ during any month of the July through September period, relative to the Baseline Condition, as shown in Table 9-25. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 207 months simulated for the July through September period. (See Appendix H pgs. 949-951.) In addition, the Flexible Purchase Alternative would not result in additional occurrences during the July through September period in which monthly mean water temperatures in the Feather River below the Fish Barrier Dam would be above 65°F, relative to the Baseline Condition.

NOAA Fisheries temperature criteria for daily water temperatures (less than 65°F) in the Low Flow Channel of the Feather River are applicable during July through September of the over-summer juvenile steelhead-rearing period (NMFS 2001). As described in Section 9.2.1.2.2 of the Assessment Methods, this analysis is based on monthly mean water temperatures due to modeling limitations. Therefore, this analysis evaluates the potential for monthly mean water temperatures to exceed NOAA Fisheries temperature criteria for the Feather River below the Fish Barrier Dam. As described above, the Flexible Purchase Alternative would not result in an increase in the frequency in which water temperatures would be above 65°F below the Fish Barrier Dam throughout the July through September period, relative to the Baseline Condition. Therefore, the Flexible Purchase Alternative would not be expected to result in an increase in the frequency in which monthly mean water temperatures exceed the NOAA Fisheries temperature criteria for the Feather River, relative to the Baseline Condition.

Modeling associated with the Flexible Purchase Alternative indicates that long-term average water temperatures in the lower Feather River below the Thermalito Afterbay Outlet would not change during any month of the July through September period, relative to the Baseline Condition, as shown in Table 9-26. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 207 months simulated for the July through September period. (See Appendix H pgs. 925-927.) Further, there would be no additional occurrences during the July through September period in which monthly mean water temperatures below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be above 65°F, relative to the Baseline Condition.

At the mouth of the Feather River, implementation of the Flexible Purchase Alternative would result in no change in long-term average water temperatures in July, and reductions in long-term average water temperatures of 0.4°F and 0.5°F in August and September, respectively. (Refer to Table 9-27.) Monthly mean water temperatures under the Flexible Purchase Alternative at the mouth of the Feather River would be essentially equivalent to those under the Baseline Condition in 202 of the 207 months simulated for the July through September period. (See Appendix H pgs. 937-939.) Additionally, the Flexible Purchase Alternative would not result in an increase in the frequency of water temperatures above 65°F at the mouth of the Feather River, relative to the Baseline Condition.

Flow-related Impacts on Fall/Winter Juvenile Steelhead Rearing (October through January)

Long-term average flows in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be no more than 2.8 percent greater than flows under the Baseline Condition during October through January. (Refer to Table 9-23.) Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in all of the 288 months included in the analysis. (Refer to Appendix H pgs. 892-895.)

Long-term average flows at the mouth of the Feather River under the Flexible Purchase Alternative would be no more than 2.1 percent greater than flows under the Baseline Condition during October through January. (Refer to Table 9-24.) Monthly mean flows would be essentially equivalent to or greater than flows under the Baseline Condition in all of the 288 months included in the analysis for October through January. (Refer to Appendix H pgs. 868-871.)

Temperature-related Impacts on Fall/Winter Juvenile Steelhead Rearing (October through January)

Under the Flexible Purchase Alternative, long-term average water temperatures in the lower Feather River below the Fish Barrier Dam would not differ during any month of the October through January period, relative to the Baseline Condition, as shown in Table 9-25. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline

Condition in all of the 276 months simulated for the October through January period. (Refer to Appendix H pgs. 940-943.)

Modeling associated with the Flexible Purchase Alternative indicates that long-term average water temperatures in the lower Feather River below the Thermalito Afterbay Outlet would not change during any month of the October through January period, relative to the Baseline Condition, as shown in Table 9-26. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 276 months simulated for the October through January period. (Refer to Appendix H pgs. 916-919.)

At the mouth of the Feather River, implementation of the Flexible Purchase Alternative would result in no change in long-term average water temperatures in any month of the October through January period. (Refer to Table 9-27.) Monthly mean water temperatures under the Flexible Purchase Alternative at the mouth of the Feather River would be essentially equivalent to those under the Baseline Condition in all of the 276 months simulated for the October through January period. (Refer to Appendix H pgs. 928-931.)

Summary of Impacts on Fall-run Chinook Salmon and Steelhead in the Feather River

In summary, potential changes in flow in the Feather River under the Flexible Purchase Alternative during the September through January period would not be of sufficient frequency or magnitude to beneficially or adversely affect adult fall-run Chinook salmon immigration. Similarly, changes in flows under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact spawning, egg incubation, and initial rearing during the October through February period. Changes in flow that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile rearing and emigration during the February through June period.

Changes in water temperature in the Feather River under the Flexible Purchase Alternative during the September through January period would not be of sufficient frequency or magnitude to beneficially or adversely affect adult fall-run Chinook salmon immigration. Similarly, changes in water temperature under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact spawning, egg incubation, and initial rearing during the October through February period. Changes in water temperature that would occur under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile rearing and emigration during the February through June period.

Potential changes in flow in the Feather River under the Flexible Purchase Alternative during the September through January period would not be of sufficient frequency or magnitude to beneficially or adversely affect adult steelhead immigration. Flow related changes under the Flexible Purchase Alternative during the December through April period would not be of sufficient frequency or magnitude to beneficially or adversely impact adult steelhead spawning and egg incubation. Changes in flow that would occur in the Feather River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile steelhead rearing, including over-summer and fall/winter rearing, and emigration during the February through June, July through September, and October through January periods.

Changes in water temperature in the Feather River under the Flexible Purchase Alternative during the September through January period would not be of sufficient frequency or magnitude to beneficially or adversely affect adult steelhead immigration. Water temperature changes under the Flexible Purchase Alternative during the December through March period would not be of sufficient frequency or magnitude to beneficially or adversely impact adult steelhead spawning and egg incubation. Changes in water temperature that would occur in the Feather River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile steelhead rearing, including over-summer and fall/winter rearing and emigration during the February through June, July through September, and October through January periods.

Overall, the changes in flows and water temperatures in the Feather River under the Flexible Purchase Alternative, relative to the baseline, would not be of sufficient frequency or magnitude to beneficially or adversely impact fall-run Chinook salmon. Therefore, impacts on fall-run Chinook salmon in the Feather River with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, would be less than significant.

Similarly, the changes in flows and water temperatures in the Feather River under the Flexible Purchase Alternative, relative to the baseline, would not be of sufficient frequency or magnitude to beneficially or adversely impact steelhead. Therefore, impacts on steelhead in the Feather River with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, would be less than significant.

Impacts on Splittail in the Feather River

Splittail spawning occurs primarily at the mouth of the Feather River in areas of submerged vegetation. Long-term average flows at the mouth of the Feather River under the Flexible Purchase Alternative would be up to 3 percent greater than flows under the Baseline Condition during February through May, as shown in Table 9-24. Monthly mean flows at the mouth of the Feather River under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows those under the Baseline Condition in 288 of the 288 months included in the analysis for February through May. (Refer to Appendix H pgs. 872-875.)

During the February through May period, long-term average water temperatures under the Flexible Purchase Alternative at the mouth of the Feather River would not change during February and March, and would increase by 0.1°F in both April and May, as shown in Table 9-27. Monthly mean water temperatures would exceed 68°F, the upper end of the reported preferred range for splittail spawning, in one additional month under the Flexible Purchase Alternative, relative to the Baseline Condition during the February through May period. (Refer to Appendix H pgs. 932-935.) Thus, there would be slight changes in water temperatures under the Flexible Purchase Alternative, relative to the Baseline Condition.

Overall, potential flow and water temperature changes in the Feather River resulting from the implementation of the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact splittail spawning. Therefore, impacts on splittail in the Feather River under the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

<u>Impacts on American Shad in the Feather River</u>

Table 9-24 shows that long-term average flows at the mouth of the Feather River under the Flexible Purchase Alternative would be 1.8 percent greater during May and 1.4 percent greater during June, relative to the Baseline Condition. Monthly mean flows at the mouth of the Feather River under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 144 of the 144 months included in the analysis for the May through June spawning period. (Refer to Appendix H pgs. 875-876.)

Long-term average flows below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be 3.7 percent greater during May and 2.1 percent greater during June relative tot he the Baseline Condition, as shown in Table 9-23. Monthly mean flows at this location under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 144 of the 144 months included in the analysis for May through June. (Refer to Appendix H pgs. 899-900.) The reported preferred range for American shad spawning is 60°F to 70°F. Implementation of the Flexible Purchase Alternative would not result in a change in the frequency of monthly mean water temperatures below the Fish Barrier Dam or below the Thermalito Afterbay Outlet within the reported preferred range for American shad spawning, relative to the Baseline Condition. (Refer to Appendix H pgs. 923-924 and 947-948.) At the mouth of the Feather River, there would be three fewer occurrences of water temperatures within the reported preferred range for American shad spawning under the Flexible Purchase Alternative, relative to the Baseline Condition. (Refer to Appendix H pgs. 935-936.) The frequency of monthly mean water temperatures within this range would remain unchanged under the Flexible Purchase Alternative below the Fish Barrier Dam and below the Thermalito Afterbay Outlet.

Overall, changes in flows and water temperatures in the Feather River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact American shad attraction and spawning. Therefore, impacts on American shad in the Feather River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on Striped Bass in the Feather River

Under the Flexible Purchase Alternative, long-term average flows at the mouth of the Feather River would be 1.8 percent greater during May and 1.4 percent greater during June, relative to the Baseline Condition, as shown in Table 9-24. Monthly mean flows at the mouth of the Feather River under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 144 of the 144 months included in the analysis for the May through June spawning period. (Refer to Appendix H pgs. 875-876.)

Table 9-23 shows that long-term average flows in the Feather River below the Thermalito Afterbay Outlet under the Flexible Purchase Alternative would be 3.7 percent greater during May and 2.1 percent greater during June. Monthly mean flows at this location under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in 144 of the 144 months included in the analysis for May through June. (Refer to Appendix H pgs. 899-900.) Thus, reductions in flows would not occur under the Flexible Purchase Alternative.

The reported preferred range for striped bass spawning and initial rearing is 59°F to 68°F. Implementation of the Flexible Purchase Alternative would not result in a change in the frequency of monthly mean water temperatures within this range below the Fish Barrier Dam or below the Thermalito Afterbay Outlet. (Refer to Appendix H pgs. 923-924 and 947-948.) At the mouth of the Feather River, there would be one less occurrence of water temperatures within the reported preferred range for striped bass spawning under the Flexible Purchase Alternative, relative to the Baseline Condition (Refer to Appendix H pgs. 935-936.) The frequency of monthly mean water temperatures within this range would remain unchanged under the Flexible Purchase Alternative below the Fish Barrier Dam and below the Thermalito Afterbay Outlet. Overall, changes in flows and water temperatures in Feather River would not be of sufficient frequency or magnitude to beneficially or adversely impacts striped bass spawning and initial rearing. Therefore, impacts on striped bass in the Sacramento River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

9.2.5.1.3 Yuba River Area of Analysis

EWA acquisition of Yuba County WA water via groundwater substitution would alter Yuba River flows during April through June. EWA acquisition of Yuba County WA water via groundwater substitution and crop idling would alter water surface elevations in New Bullards Bar Reservoir during April through June, relative to the Baseline Condition. EWA *acquisition of Yuba County WA stored reservoir water would alter surface water elevations from July until refill at New Bullards Bar Reservoir.*

Impacts on New Bullards Bar Reservoir Warmwater Fisheries

Table 9-28 provides monthly median storage, elevation, and elevation changes for New Bullards Bar Reservoir. Hydrologic conditions under the Flexible Purchase Alternative could result in reductions of up to 27 feet msl in the median water surface elevation of New Bullards Bar Reservoir, relative to the Baseline Condition, during the April through November period, when warmwater fish rearing may be expected. Water surface elevation is typically correlated with the availability of littoral habitat (submerged vegetation) associated with the shoreline of reservoirs. Such shallow, nearshore waters containing physical structure are important to producing and maintaining strong year-classes of warmwater fishes.

Changes in water surface elevation of New Bullards Bar Reservoir would not result in corresponding changes in the availability of littoral habitat, as would be typical of several other reservoirs, for many reasons. New Bullards Bar Reservoir is a deep, steep-sloped reservoir created from the flooding of a tall, strongly sloped canyon. Because of its deep nature, the amount of littoral habitat typically available at New Bullards Bar Reservoir does not change substantially throughout the period of reservoir drawdown. Areas of potentially submerged littoral habitat important for escape cover for young-of-the-year warmwater fish rearing are typically exposed early in the period of reservoir drawdown (by summer). Consequently, littoral habitat is typically not available in summer, when escape cover would be utilized by rearing young-of-the-year warmwater fish species.

Table 9-28
New Bullards Bar Reservoir Monthly Median Storage, Elevation, and Elevation Change Under Baseline and Flexible Purchase Alternative Conditions

Month	Storage				Elevation			Elevation Change		
	Base (TAF)	FP Alt (TAF)	Diff (TAF)	Diff (%)	Base (ft msl)	FP Alt (ft msl)	Diff (ft msl)	Base (ft msl)	FP Alt (ft msl)	Diff (ft msl)
Oct	544	446	-98	-18	1838	1812	-27	-16	-19	-3
Nov	546	449	-98	-18	1839	1812	-26	1	1	0
Dec	532	442	-90	-17	1835	1810	-25	-4	-2	1
Jan	593	578	-15	-3	1850	1847	-3	15	36	22
Feb	649	649	0	0	1862	1862	0	12	15	3
Mar	735	735	0	0	1878	1878	0	16	16	0
Apr	774	788	14	2	1884	1886	2	6	9	2
May	879	908	28	3	1899	1902	3	15	16	1
Jun	917	960	43	5	1903	1908	5	5	6	1
Jul	825	820	-5	-1	1892	1891	-1	-12	-17	-5
Aug	713	660	-52	-7	1874	1864	-10	-18	-27	-9
Sep	614	514	-100	-16	1855	1831	-24	-19	-34	-14

Based on median monthly storage and flow over the historical record from 1970 to 2001.
FP Alt = Flexible Purchase Alternative
Diff = Difference

The Flexible Purchase Alternative could alter the rates by which water surface elevation in New Bullards Bar Reservoir change, relative to the Baseline Condition. As discussed in Section 9.2.1.1.1, adverse effects on warmwater fish spawning from nest dewatering are assumed to have the potential to occur when reservoir water surface elevation decreases by more than nine feet within a given month during the March-June warmwater fish-spawning period. Reductions in median water surface elevation between months at New Bullards Bar Reservoir, under the Flexible Purchase Alternative or the Baseline Condition, would not occur during the March through June spawning period, as shown in Table 9-28. Under the Flexible Purchase Alternative, the magnitude of monthly drawdown is not expected to exceed nine feet during the March through June spawning period.

In summary, because of New Bullards Bar Reservoir's unique bathymetric profile, reductions in surface water elevation resulting from implementing the Flexible Purchase Alternative is not likely to result in substantial changes in the availability of littoral habitat at New Bullards Bar Reservoirs. Thus, implementation of the Flexible Purchase Alternative would not likely adversely affect warmwater fish rearing in Bullards Bar Reservoir. The Flexible Purchase Alternative does not increase the frequency of potential nest dewatering events in New Bullards Bar Reservoir, and thus, would not adversely affect long-term warmwater fish nesting success. Therefore, under the Flexible Purchase Alternative, impacts on New Bullards Bar Reservoirs warmwater fisheries would be less than significant, relative to the Baseline Condition.

Impacts on New Bullards Bar Reservoir Coldwater Fisheries

Hydrologic conditions under the Flexible Purchase Alternative would result in a reduction in median storage of up to 100 TAF, or 16 percent, at New Bullards Bar Reservoir during the April through November period, relative to the Baseline Condition, as shown in Table 9-28. Changes in New Bullards Bar Reservoir storage under the Flexible Purchase Alternative would not be expected to result in significant impacts on coldwater fish resources, relative to the Baseline Condition, because New Bullards Bar Reservoir is a deep, steep-sloped reservoir with ample coldwater pool reserves. Throughout the period of operations of New Bullards Bar Reservoir (1969 – present), which encompasses the most extreme critically dry year on record, the coldwater pool in New Bullards Bar Reservoir has not been depleted. In fact, since 1993, coldwater pool availability in New Bullards Bar has been sufficient to accommodate year-round utilization of the lower river outlets at the direction provided by CDFG in order to provide the coldest water possible to the lower Yuba River. Therefore, anticipated reductions in reservoir storage would not be expected to adversely affect the reservoir's coldwater fisheries because: 1) coldwater habitat would remain available within the reservoir during all months of all years; 2) physical habitat availability is not believed to be among the primary factors limiting coldwater fish populations; and 3) anticipated seasonal reductions in storage would not be expected to adversely affect the primary prey species utilized by coldwater fish. Therefore, changes in end-of-month storage at New Bullards Bar Reservoir under the

Flexible Purchase Alternative represent a less-than-significant effect to coldwater fisheries, relative to the Baseline Condition.

Impacts on Yuba River Fisheries Resources

The analysis used to evaluate potential impacts of the EWA Program on the Yuba River Basin varies from that used for other river systems in the Area of analysis. Modeled streamflow data for the baseline and Flexible Purchase Alternative conditions, similar to that utilized in the analyses of EWA potential effects on other rivers, is not available for the Yuba River. The Yuba River HEC 5 operations model data consists only of input to flows at the confluence of the Yuba and Feather rivers. Thus, mean monthly flows for the Yuba River are not provided as part of the CALSIM II simulation outputs. Changes in flow due to Yuba River-specific EWA actions such as crop idling and ground water substitution were incorporated, when appropriate, to adjust the flows at the mouth of the Yuba River. Additionally, a water temperature model has not yet been developed for the Yuba River Basin; therefore, mean monthly water temperatures cannot be calculated and used as the basis for determining temperature-related impacts on fisheries resources within the Yuba River. However, water transfer issues and the health of aquatic resources in the Yuba River Basin have received a high level of scrutiny over the past few years. Information derived from recent monitoring has been used to analyze potential effects and describe ongoing efforts within the Yuba River Basin that are being employed to protect aquatic resources while also meeting other beneficial uses.

Recent historical flows in the Yuba River below Englebright Dam during June through October, the typical time period for water transfers, have ranged from approximately 600 to 2,500 cfs. Historical data suggests that, without EWA water transfer, flows below Englebright Reservoir range from approximately 1,000 to 1,800 cfs during June, July, and most of August. Streamflows range from approximately 500 to 900 cfs in late August and early September, and remain relatively constant at 600 to 900 cfs for October and November. At the onset of the wet season, unregulated winter storm and snowmelt flows primarily affect lower Yuba River hydrology. Without EWA water transfers, flows below Daguerre Point Dam range from approximately 245 to 800 cfs in June, and from 100 to 250 cfs during July, August, and September. Flows below Daguerre Point Dam in the first two weeks in October are approximately 320 to 400 cfs, and increase to 400 to 500 cfs for the last two weeks of October through the time period in the winter when runoff from winter storms significantly affects river flows.

Two transfer scenarios, referred to as the maximum transfer scenario and the minimum transfer scenario, are discussed for the Yuba River as part of potential EWA actions. Potential EWA operations may reflect the maximum or minimum transfer scenarios, or any gradient of water transfer between the two. Under all scenarios, the majority of the water transfer is expected to occur during July and August. In some years water transfer may begin as early as June depending on current instream conditions in the Yuba River, Delta conditions, and the SWP's ability to pump the water south of the Delta. Releases in September and October would be scheduled to provide fishery benefits in the lower Yuba River in addition to water delivery. Potential fisheries benefits of the water transfer may include: 1) increased spawning habitat availability for spring-run and fall-run Chinook salmon; 2) increased flows and possibly reduced water temperatures for juvenile steelhead rearing; and 3) minimal flow changes while transitioning to the fall instream flow spawning requirements.

Water transfers under all scenarios could affect Lake Oroville water levels. Lake Oroville water levels would be affected if DWR releases stored water to compensate for reduced flows to the Delta during the period when New Bullards Bar Reservoir is being refilled to account for the amount of evacuated storage resulting from the transfer. The need for increased releases from Lake Oroville resulting from reduced releases from New Bullards Bar Reservoir (reduced Yuba River outflow) would only occur under particular hydrologic conditions.

Under the maximum transfer scenario of the Flexible Purchase Alternative, the proposed transfer of 185 TAF to the EWA program is expected to take place mainly in July and August, with some water potentially released in June and between September 1 and October 31 to provide fishery benefits on the lower Yuba River, in addition to delivery of water. During late June, July, and August, streamflow would be relatively constant at up to 1,200 to 1,500 cfs above Yuba River instream flow and diversion delivery requirements.

Under the minimum transfer scenario of the Flexible Purchase Alternative, the expected amount of water to be transferred to EWA is 30 TAF. As with the maximum transfer, the delivery of this water would take place mainly in July and August, with some water released in June and between September 1 and October 31. During late June, July, and August, flow rates would be relatively constant at up to 500 cfs above Yuba River instream flow and diversion delivery requirements. Flow increases of 500 cfs would be realized only if the entire water transfer allotment were to be delivered in one month.

Recent Water Transfer History

The Yuba River is one of many Central Valley rivers that have been utilized in water transfer projects for a number of years. In 2001, the Yuba County WA and other local water agencies initiated water transfers from New Bullards Bar Reservoir through the Yuba River in order to satisfy a variety of downstream needs. The total water transfer consisted of approximately 172 TAF of water, including 114,052 AF utilized by DWR. The water transfers occurred approximately between July 1, 2001 and October 14, 2001. Over a few days in early July, flows were increased by about 1,200 cfs in the lower Yuba River and were generally sustained through late August when ramping down began.

Yuba River water transfers occurred again during 2002. Observations and discussions regarding flow and water temperature patterns and coincident fish behavior (e.g., juvenile steelhead downstream movement and adult Chinook salmon immigration) during the 2001 water transfers prompted Yuba County WA, NOAA Fisheries, USFWS, CDFG, and non-governmental organizations (NGO) representatives to collaboratively develop a rigorous monitoring and evaluation plan for the 2002 water transfers. Yuba County WA transferred a total of 162,050 acre-feet of water for downstream needs (157,050 AF allocated to DWR, and 5 TAF to the Contra Costa Water District) from about mid-June through mid-September 2002. The 2002 water transfers were characterized by the lack of a definitive ramping-up period. Instead, the relatively high flows that occurred during the spring were sustained until initiation of the water transfers. Relatively stable flows were maintained through mid-August, when a ramping down period began which extended to mid-September.

An evaluation of the numerous variables (e.g., ambient air temperature, cloud cover, diversion rates), which may have influenced instream water temperatures, has not yet been conducted, however, changes in Yuba River water temperatures were observed coincident with both the 2001 and 2002 water transfers. For example, in 2001, water temperatures at Highway 70 dropped from 73.4°F on July 3 to 62.6°F on July 8, subsequent to the commencement of the water transfer. Water temperatures at this site remained around 61°F until flows were reduced in late August, at which time the water temperatures increased coincident with flow reduction (CDFG unpublished data). A less dramatic change in water temperature was associated with the onset of the 2002 water transfer, compared to that in 2001, likely due to the higher sustained flow and the absence of a dramatic flow increase at the start of the transfer period.

Anadromous Salmonids in the Yuba River

The Yuba River provides habitat for three salmonid ESUs: Central Valley steelhead and Central Valley spring- and fall-run Chinook salmon. Since the timing of the life history events of each fish is different, at any given time water transfer operations could potentially affect different lifestages (e.g., adult immigration, spawning and incubation, and juvenile rearing and emigration) of the various salmonids and their habitat (e.g., spawning and rearing habitat). Both races of adult Chinook salmon immigrate to their spawning grounds in the Yuba River during the water transfer period. The immigration of adult steelhead in the lower Yuba River has been reported to occur from August through March, with peak immigration from October through February (CDFG 1991). Therefore, the adult immigration of Chinook salmon is more likely to be affected by Yuba County WA water transfers than is steelhead immigration. Juvenile fall-run Chinook salmon are believed to emigrate shortly after emergence (Moyle 2002) and thus are not likely to be subjected to water transfer river conditions. Juvenile steelhead often rear in the lower Yuba River for one year or more, and juvenile spring-run Chinook salmon also may exhibit some extended rearing in the river. Consequently, over-summering juvenile steelhead and some juvenile spring-run Chinook salmon may be subject to potential impacts associated with Yuba River water transfers.

The primary issues of concern regarding the water transfers are the potential associations between the water transfer and: 1) the downstream movement of juvenile salmonids; and 2) the attraction of non-native adult Chinook salmon into the Yuba River.

Evaluating the potential impacts associated with changes in flows during the summer months in the lower Yuba River must take into account: 1) that the Yuba County WA has embarked upon a cooperative process with the resource agencies in order to implement water transfers in the most fish-friendly manner possible; and 2) the development and implementation of monitoring and evaluation studies associated with the water transfers in order to more definitively evaluate potential impacts. For the past few years the public resource management agencies (CDFG, NOAA Fisheries, and USFWS) and non-governmental organizations such as the California Sportfishing Protection Alliance (CSPA) have discussed and collaborated on the water transfer timing, magnitude, and other resource management issues.

Potential Water Transfer-related Effects on Juvenile Salmonid Movement in the Yuba River

Juvenile Chinook salmon are not likely to be affected by Yuba County WA water transfers, as they usually spend very little time in their natal river before emigrating in large numbers as small fry during the winter (CDFG 2000). Most of the remaining juvenile Chinook salmon emigrate in the spring (April through June) as smolts. Recent CDFG unpublished catch data collected between November 24, 1999 and June 30, 2000, and between November 1, 2001 and March 31, 2002 by a rotary screw-trap (RST) in the lower Yuba River (located at Hallwood Blvd., approximately seven miles upstream from the Feather River) show that more than 97 percent of the juvenile Chinook salmon caught by the RST during the surveying season (November 1 through July 1) had been caught by April 1. Therefore, flow changes associated with Yuba County WA water transfers to the EWA are not expected to adversely affect juvenile Chinook salmon rearing.

Because juvenile steelhead rear in the Yuba River year-round, water transfers during the summer and early fall may potentially affect their behavior. Beginning approximately July 1, 2001, water transfers increased flows in the lower Yuba River over a few days by about 1,200 cfs. On July 8, 2001, a week subsequent to the start of the 2001 water transfers, the daily catch of the CDFG RST, located at Hallwood Blvd., increased from less than ten young-of-the-year (YOY) steelhead juveniles per day, to more than 450 YOY per day (CDFG, unpublished data). The next week, daily catches decreased to about 190 YOY per day. In the following weeks, while the transfers were continuing, daily catches decreased further, but still surpassed catches prior to the water transfers. For example, the average RST daily catch was 39 YOY per day for the period July 15 through August 31, while the average prior to the initiation of the water transfers (May 1 through June 30) was three YOY per day. Increased observations of juvenile steelhead at the RST during the water transfers suggest that a large, rapid increase in flow, similar to that which characterized the 2001 water transfer, may stimulate downstream movement of juvenile steelhead.

The relationship between a rapid increase in flow and a large influx in the number of juvenile steelhead captured at the trap may indicate the stimulation of downstream movement of juvenile steelhead, possibly over Daguerre Point Dam into the lower Yuba River, or indeed, into the lower Feather River, by the water transfer. Downstream movement may transport juvenile steelhead into less suitable habitat, particularly in the lower Feather River, where temperatures are much higher than those in the Yuba River. The potential movement of juvenile steelhead over Daguerre Point Dam restricts subsequent rearing to those areas downstream of Daguerre Point Dam because juvenile steelhead are not able to readily pass back upstream of Daguerre Point Dam. Conditions downstream of Daguerre Point Dam may or may not be suitable for juvenile steelhead rearing during the post-water transfer period, depending on several factors including post-transfer flow and air temperature.

Cooler water temperatures are likely associated with the relatively high flows of the water transfers, particularly between Daguerre Point Dam and the mouth of the Yuba River. The decreased water temperatures likely associated with these higher flows would potentially improve juvenile steelhead rearing habitat quality in the river downstream. However, when water transfers cease and flows are reduced to the early fall minimum flow requirements, a coincident increase in water temperature may expose juvenile steelhead that were transported downstream of Daguerre Point Dam to less suitable rearing conditions. Additional monitoring may help resolve the frequency and importance of this effect.

Yuba County WA, working together with the public trust resource management agencies, developed an instream flow release schedule associated with the 2002 water transfer that did not include a rapid increase in flow, or correspondingly rapid decrease in water temperature when the transfer began. Rather, the flows were held relatively constant in the late spring and then gradually increased up to the sustained summer flow. Preliminary RST information at the Hallwood Blvd. location in 2002 indicates that a large peak in downstream movement of juvenile steelhead observed in 2001 did not occur in 2002. Downstream movement of juvenile steelhead during the water transfers may be associated with the rate of flow increase from the water transfer, rather than the eventual maximum flow or a response to water temperature change. However, careful monitoring of the movements of juvenile steelhead under different environmental conditions (e.g., different water year types) with and without water transfers will be required to assess potential relationships between fish movement patterns and water transfers. Providing flow patterns similar to those in 2002 can likely minimize undesirable downstream movement of steelhead. Overall, the flow changes during Yuba County WA water transfers to the EWA are not expected to adversely affect juvenile Chinook salmon and steelhead rearing in the Yuba River.

Potential Water Transfer-related Effects on Attraction of Non-native Adult Chinook Salmon in the Yuba River

Chinook salmon straying is fairly common in Central Valley streams, and throughout the entire Chinook salmon distribution. However, introducing non-native Chinook salmon (especially of hatchery origin) at high rates may be detrimental to the overall well-being of self-sustaining natural Chinook salmon populations, such as those in the Yuba River.

Monitoring efforts in 2001 and 2002, water transfer years, confirmed a few Chinook salmon of hatchery origin ascended the fish ladders at Daguerre Point Dam in the lower Yuba River during both the water transfer and non-transfer periods. Chinook salmon of hatchery origin have also been observed ascending the Yuba River in non-transfer years (CDFG, unpublished data).

In 2001, the immigration of adult Chinook salmon was monitored at the fish ladders of Daguerre Point Dam from March 1 through July 31 (CDFG, unpublished data). During July, after the initiation of the 2001 water transfers, five out of the 11 salmon trapped at the ladders had clipped adipose fins, indicating hatchery origins for these fish. In the four months of trapping prior to the beginning of the 2001 water transfers, no adipose fin-clipped Chinook salmon were observed at the ladders. The observed fin-clipped Chinook salmon certainly came from other river basins, because there are no hatchery releases or tagging programs in the lower Yuba River. Conclusions based upon the above observations in the month of July during the 2001 water transfer season may not accurately characterize the overall effects of the 2001 water transfers on the attraction of non-native Chinook salmon in the Yuba River because: 1) the sample size is small; 2) the sampling period reflects only the first of the 3.5 month water transfer period; and 3) the sampling period reflects only the initial portion of the immigration period of Chinook salmon in the Yuba River, which likely peaks in September.

The annual adult salmon escapement survey in the Yuba River recovered a relatively high number of adipose fin-clipped Chinook salmon in 2001 compared to previous years (S. Theis 2002). However, this observation alone does not necessarily implicate the water transfer as the cause of the increased incidence of adipose fin-clipped Chinook salmon. The record high escapement of hatchery Chinook salmon in the Feather River in 2001 may explain the increased number of adipose fin-clipped Chinook salmon observed in the Yuba River (PFMC 2003).

A change in operation protocol avoided a rapid increase of flows, and corresponding decrease in water temperatures, during the 2002 water transfer. Also, a study specifically designed to address the concerns of increased straying due to water transfers was implemented during the 2002 water transfer. The results of the 2002 monitoring effort are described below.

In 2002, the immigration rates, calculated for fish passing Daguerre Point Dam, for unclipped and clipped adult Chinook salmon suggest that the relatively high water transfer flows or cool water temperatures did not attract non-native salmon immigrants. An increased immigration rate during the water transfer period, compared to the non-transfer period, would suggest that additional flows from the water transfer were attracting non-native fish into the Yuba River. The immigration rate for unclipped Chinook salmon during the post-water transfer period was five times higher than during the water transfer period itself (0.32683 and 1.63623 fish per hour, respectively). The immigration rate for adipose fin-clipped Chinook salmon during the post-water transfer period was 23 times higher than during the water transfer period itself (0.00627 and 0.1449 fish per hour, respectively). The much greater immigration rates, during both the water transfer and post-water transfer periods, for unclipped adult Chinook salmon relative to clipped adult salmon probably reflects the general lack of a significant hatchery influence on the lower Yuba River. Similarly, an increased immigration rate, during the post-water transfer period compared to water transfer period, for clipped adult salmon probably reflects the independency of water transfers and non-native adult salmon attraction. Although the exact time at which adult Chinook salmon entered the lower Yuba River is uncertain, the increase in the number of adult Chinook salmon passing Daguerre Point Dam in the latter part of the monitoring period most likely reflects the adult upstream migration lifestage periodicity expected for fall-run Chinook salmon.

Also, preliminary analyses of an extensive data set incorporating spawning stock escapement estimates and coded wire tag (CWT) recoveries incorporating recent years indicates that a low rate of straying occurs in the lower Yuba River (S. Cramer 2002).

Overall, the flow changes associated with Yuba County WA water transfers to the EWA are not expected to adversely affect adult salmonid immigration in the Yuba River. However, the potential interactions between run timing and the water transfers need to be evaluated with more years of adult Chinook salmon immigration data from water transfer and non-water transfer years, during various hydrologic and climatic conditions (SWRI and Jones & Stokes 2003) to provide more definitive results. The issue of salmon straying in Central Valley rivers is a topic of paramount importance and quantitative information is needed valley-wide, including the Yuba River.

Collaborative Monitoring Efforts in the Yuba River

It is anticipated that Yuba County WA will continue to work collaboratively and cooperatively with the resource agencies to implement appropriate monitoring and evaluation programs, on an annual basis, associated with water transfers. The results will be used to evaluate water transfers in the Yuba River and to develop and implement operational scenarios to avoid impacts on the salmonid populations within the Area of analysis. The study results also may be utilized in other investigations to help assess the impacts of water transfers on salmonids in California.

Summary of Water Transfer-related Impacts on Central Valley Spring- and Fall-run Chinook Salmon and Central Valley Steelhead in the Yuba River

Based on the above findings, potential flow and water temperature-related effects on anadromous salmonids in the lower Yuba River resulting from water transfers are expected to be less than significant. Flows are expected to increase and water temperatures are expected to decrease during water transfer years, relative to non-water transfer years; however, these changes are not expected to result in potentially adverse impacts on the various anadromous salmonid lifestages occurring coincident with the water transfer period (steelhead juvenile rearing and Chinook salmon upstream migration) in the Yuba River.

Management efforts in the Yuba River Basin are addressing the potential impacts of water transfers, particularly the downstream movement of juvenile steelhead and the attraction of non-indigenous fish. The magnitude of the flow increase resulting from the water transfer is not expected to result in an increase of downstream movement of juvenile steelhead. Preliminary data suggest that the magnitude and rate of change in flow, not the flow itself, may be associated with the potential downstream movement of juvenile steelhead in the lower Yuba River. Yuba County WA and the public trust resource management agencies are working together to avoid rapid increases in flow during water transfers, and to schedule gradual increases up to the sustained summer flows. Straying of non-natal fish into the lower Yuba River also has been recognized as a potential impact; however, this is a concern throughout the Central Valley and there is still a considerable amount of uncertainty as to the specific causes and factors that trigger fish to move into non-natal streams. Further efforts have been identified to expand CWT analyses in the Central Valley that may help better characterize the extent of adult salmon straying in the lower Yuba River.

The Yuba County WA and management agencies responsible for managing the Yuba River Basin are continuing to work towards understanding these processes. As part of these ongoing efforts, water transfer strategies have been carefully designed, implemented, and monitored to avoid adverse impacts on juvenile and adult anadromous salmonids. Based on preliminary data analyses and a continued commitment to the 2002 water transfer implementation strategy and to monitoring, Yuba County WA water transfers to EWA are expected to result in a less-than-significant impact on fishery resources within the Yuba River.

9.2.5.1.4 American River Area of Analysis

EWA acquisition of Placer County WA stored reservoir water would alter American River flows downstream of French Meadows Reservoir to Folsom Reservoir from June to October. EWA acquisition of Placer County WA stored reservoir water would alter American River flows downstream of French Meadows Reservoir to Folsom Reservoir during refill of Hell Hole and French Meadows reservoirs. EWA acquisition of Placer County WA stored reservoir water would alter surface water elevations from July until refill for French Meadows and Hell Hole reservoirs. EWA acquisition of Sacramento Groundwater Authority (SGA) water via groundwater purchase would alter summer surface water elevations at Folsom Reservoir. EWA acquisition of stored groundwater from SAG members, stored reservoir water, and water *obtained through Placer County WA crop idling and retained in Folsom would alter lower American River flows, relative to the Baseline Condition.*

The analysis of potential impacts on fisheries resources in the American River Basin includes an assessment of the warmwater and coldwater fisheries of French Meadows, Hell Hole, and Folsom reservoirs, and an assessment of fisheries resources of the Middle Fork of the American River below Ralston Afterbay and the lower American River below Folsom Dam to its confluence with the Sacramento River. For lower American River fisheries resources, flow- and temperature-related impacts are discussed separately by species and lifestage. Organizationally, flow- and temperature-related impacts on fall-run Chinook salmon and steelhead are discussed together, followed by impact discussions for splittail, American shad, and striped bass.

Impacts on French Meadows and Hell Hole Reservoir Warmwater Fisheries

Based on accounts from CDFG and Tahoe National Forest representatives, it is unlikely that there is a self-sustaining warmwater fishery in French Meadows or Hell Hole reservoirs. However, analyses were completed in the event that these reservoirs do support some minor component of a warmwater fishery. Table 9-29 and Table 9-30 provide monthly median storage, elevation, and elevation changes for French Meadows and Hell Hole reservoirs, respectively. Hydrologic conditions under the Flexible Purchase Alternative would result in reductions of 2 to 8 feet msl in the median water surface elevation of French Meadows Reservoir during the April through November period, when warmwater fish juvenile rearing would be expected. At Hell Hole Reservoir, hydrologic conditions under the Flexible Purchase Alternative would result in reductions of 5 to 15 ft msl in the median water surface elevation, relative to the Baseline Condition, during the April through November period.

Table 9-29
French Meadows Reservoir Monthly Median Storage, Elevation, and Elevation Change Under Baseline and EWA Conditions*

	Storage				***Elevation***			***Elevation Change***		
Month	***Baseline (TAF)***	***EWA (TAF)***	***Diff (TAF)***	***Diff (%)***	***Baseline (ft msl)***	***EWA (ft msl)***	***Diff (ft msl)***	***Baseline (ft msl)***	***EWA (ft msl)***	***Diff (ft msl)***
Oct	67	59	-8	-12	5205	5197	-8	-14	-15	-1
Nov	59	57	-3	-5	5197	5194	-3	-8	-3	5
Dec	56	53	-3	-5	5193	5189	-3	-4	-4	0
Jan	61	58	-2	-4	5198	5196	-3	6	6	1
Feb	61	61	0	0	5199	5199	0	1	4	3
Mar	75	75	0	0	5213	5213	0	14	14	0
Apr	93	93	0	0	5229	5229	0	16	16	0
May	116	116	0	0	5246	5246	0	17	17	0
Jun	129	129	0	0	5256	5256	0	10	10	0
Jul	113	111	-3	-2	5244	5242	-2	-12	-13	-2
Aug	100	94	-5	-5	5234	5230	-4	-10	-12	-2
Sep	82	74	-8	-9	5219	5212	-7	-14	-17	-3

* Based on median monthly storage and flow over the historical record from 1974 to 2001, with a maximum 20 TAF EWA Action on French Meadows and Hell Hole Reservoirs combined.
Diff = Difference

Table 9-30
Hell Hole Reservoir Monthly Median Storage, Elevation, and Elevation Change Under Baseline and EWA Conditions*

Month	Storage				Elevation			Elevation Change		
	Baseline (TAF)	EWA (TAF)	Diff (TAF)	Diff (%)	Baseline (ft msl)	EWA (ft msl)	Diff (ft msl)	Baseline (ft msl)	EWA (ft msl)	Diff (ft msl)
Oct	120	108	-12	-10	4555	4540	-15	0	0	0
Nov	110	106	-4	-4	4542	4536	-6	-13	-4	10
Dec	104	100	-4	-4	4534	4528	-6	-8	-8	0
Jan	102	98	-4	-4	4531	4525	-5	-3	-3	1
Feb	104	104	0	0	4533	4533	0	3	8	5
Mar	110	110	0	0	4542	4542	0	9	9	0
Apr	140	140	0	0	4578	4578	0	35	35	0
May	173	173	0	0	4616	4616	0	38	38	0
Jun	191	187	-4	-2	4637	4632	-5	21	16	-5
Jul	168	160	-8	-5	4610	4601	-9	-26	-31	-4
Aug	136	124	-12	-9	4573	4559	-14	-37	-42	-5
Sep	121	109	-12	-10	4555	4540	-15	-18	-19	-1

* Based on median monthly storage and flow over the historical record from 1974 to 2001, with a maximum 20 TAF EWA Action on French Meadows and Hell Hole Reservoirs combined.
Diff = Difference

Changes in water surface elevation of French Meadows and Hell Hole reservoirs would result in corresponding changes in the availability of littoral habitat containing submerged vegetation. Such shallow, nearshore waters containing physical structure are important to producing and maintaining strong year-classes of warmwater fishes. Reductions in median end-of-month water surface elevation of French Meadows and Hell Hole reservoirs under the Flexible Purchase Alternative would not be anticipated to result in substantial reductions in the amount of habitat potentially available to warmwater fishes for spawning and/or rearing, because reductions in water surface elevation would occur outside of April and May, the primary months of the spawning and rearing period at these high elevation facilities. Further, there are no fall-spawning fish species present in French Meadows or Hell Hole reservoirs that could be affected by reductions in water surface elevation that would occur later in the year under the Flexible Purchase Alternative.

In addition, the Flexible Purchase Alternative could alter the rates by which water surface elevation in French Meadows and Hell Hole reservoirs change, relative to the Baseline Condition. Reductions in median water surface elevation between months (the magnitude of monthly reservoir drawdown) throughout the March through June period at French Meadows and Hell Hole reservoirs (Tables 9-29 and 9-30, respectively), are not expected to occur under the Flexible Purchase Alternative or the Baseline Condition. Thus, it is anticipated that reductions in water surface elevation of greater than nine feet msl per month, which could potentially result in nest dewatering events, would not occur under the Flexible Purchase Alternative or the Baseline Condition. In summary, the Flexible Purchase Alternative is not likely to result in substantial changes in the availability of littoral habitat at French Meadows and Hell Hole reservoirs, and thus, would not likely beneficially or adversely affect warmwater fish rearing. The Flexible Purchase Alternative does not alter the frequency of potential nest dewatering events in French Meadows and Hell Hole reservoirs, relative to the Baseline Condition, and thus, would not beneficially or adversely affect long-term warmwater fish nesting success. Overall, implementation of the Flexible Purchase Alternative would result in a less-than-significant impact on French Meadows and Hell Hole reservoirs warmwater fisheries, relative to the Baseline Condition.

Impacts on French Meadows and Hell Hole Reservoir Coldwater Fisheries

Hydrologic conditions under the Flexible Purchase Alternative would result in a reduction in median storage of up to 8 TAF, or 12 percent, at French Meadows Reservoir during the April through November period, relative to the Baseline Condition, as shown in Table 9-29. At Hell Hole Reservoir, hydrologic conditions under the Flexible Purchase Alternative would result in a reduction in median storage of up to 12 TAF, or 10 percent, during the April through November period, relative to the Baseline Condition. (Refer to Table 9-30.) Anticipated reductions in reservoir storage would not be expected to adversely affect the reservoir's coldwater fisheries because: 1) coldwater habitat would remain available within the reservoir during all months of all years; 2) physical habitat availability is not believed to be among the primary factors limiting coldwater fish populations; and 3) anticipated seasonal reductions in storage would not be expected to adversely affect the primary prey species utilized by coldwater fish. Therefore, changes in end-of-month storage at French Meadows and Hell Hole reservoirs under the Flexible Purchase Alternative represent a less than significant impact on coldwater fish resources, relative to the Baseline Condition.

Middle Fork American River

Table 9-31 shows that median flow in the Middle Fork of the American River under the Flexible Purchase Alternative would not differ from median flow under the Baseline Condition during October, December, and March through June. Median flows in November, January, and February under the Flexible Purchase Alternative would be decreased, relative to the Baseline Condition, by 15 to 213 cfs (up to 44 percent), while flows during June through September would increase, relative to the Baseline Condition, by 44 to 107 cfs (10 to 17 percent). The minimum instream flow requirement in the Middle Fork of the American River is 75 cfs. This minimum instream flow requirement was established to protect aquatic resources of the Middle Fork of the American River. Although substantial decreases in flow could occur in late fall and winter under the Flexible Purchase Alternative, flows would remain above minimum instream flow requirements in each of the months in which flow reductions would occur under the Flexible Purchase Alternative. In fact, flows during these months under the Flexible Purchase Alternative would remain higher than the minimum instream flow requirement by approximately 200 cfs or more.

Table 9-31
Middle Fork American River Monthly Median Flows Under Baseline and Flexible Purchase Alternative Conditions

Month	Flow Below Ralston Afterbay			
	Baseline (cfs)	Flexible Purchase Alternative (cfs)	Diff (cfs)	Diff (%)
Oct	258	258	0	0
Nov	488	275	-213	-44
Dec	265	265	0	0
Jan	281	266	-15	-5
Feb	437	325	-112	-26
Mar	615	615	0	0
Apr	554	554	0	0
May	656	656	0	0
Jun	631	698	67	11
Jul	629	736	107	17
Aug	666	773	107	16
Sep	456	500	44	10

Based on median monthly storage and flow changes in French Meadows and Hell Hole Reservoirs over the historical record from 1974 to 2001, with a maximum 20 TAF EWA Action on French Meadows and Hell Hole Reservoirs combined.
Diff = Difference

Potential flow increases under the Flexible Purchase Alternative during summer months would not be expected to result in adverse effects on Middle Fork American River aquatic resources. PG&E operations of the Middle Fork Project under the Baseline Condition currently result in highly variable flows on a daily and weekly basis. The Middle Fork Project is operated to achieve stable power production during weekdays, while weekend flows are increased substantially to provide sufficient flows for recreational activities in the river. It is assumed that releases of EWA assets under the Flexible Purchase Alternative would be managed to maximize power generation and, therefore, would be released during the week. Thus, increases in releases from Middle Fork Project facilities increase flows during the week, thereby decreasing the difference between weekday and weekend flow conditions in the Middle Fork American River below Ralston Afterbay. Such changes in the flow regime would be likely to benefit the forage base of fish species in the Middle Fork American River. Aquatic invertebrates such as stoneflies, which may contribute to the forage base for fish, are more likely to successfully colonize and reproduce in an environment with more stable flow conditions.

Changes in Middle Fork American River flows under the Flexible Purchase Alternative would not result in adverse effects on resident fish species. Overall, habitat conditions would be expected to improve during summer months due to decreased variation in weekly flows, relative to the Baseline Condition, and reductions in flows that would occur in winter months would not be of sufficient frequency or magnitude to violate instream flow requirements and adversely affect aquatic resources. Therefore, impacts on Middle Fork American River fisheries resources would be less than significant, relative to the Baseline Condition.

Impacts on Folsom Reservoir Warmwater Fisheries

Hydrologic conditions under the Flexible Purchase Alternative would result in a slight reduction in the long-term average end-of-month water surface elevation in Folsom Reservoir during the April through November period, when warmwater juvenile fish rearing may be expected to occur. (Refer to Table 9-32.) As shown in Table 9-32, long-term average end-of-month water surface elevation under the Flexible Purchase Alternative would not change during the April through June and September through November periods, and would decrease by one foot msl in July and August, relative to the Baseline Condition. Monthly mean end-of-month water surface elevation at Folsom Reservoir under the Flexible Purchase Alternative would be essentially equivalent to the Baseline Condition for 575 months of the 576 months included in the analysis. (See Appendix H pgs. 198-204.) For the entire 72-year period of record, the largest single difference in end-of-month water surface elevation under the Flexible Purchase Alternative out of 576 months simulated for the April through November period would be a two-foot decrease, relative to the Baseline Condition. (See Appendix H pgs. 198-204.)

Table 9-32
Long-term Average Folsom Reservoir End of Month Elevation Under Baseline and Flexible Purchase Alternative Conditions

	Average Elevation[1] (feet msl)		
Month	***Baseline***	***Flexible Purchase Alternative***	***Difference***
Mar	425	425	0
Apr	438	438	0
May	449	449	0
Jun	444	444	0
Jul	428	427	-1
Aug	421	420	-1
Sep	411	411	0
Oct	409	409	0
Nov	407	407	0
Dec	408	408	0

[1] Based on 72 years modeled.

Changes in water surface elevation in Folsom Reservoir during the April through November period would result in corresponding changes in the availability of reservoir littoral habitat containing submerged vegetation (willows and button brush). Such shallow, near shore waters containing physical structure are important to producing and maintaining strong year-classes of warmwater fish annually. As shown in Table 9-33, the difference in the long-term average amount of littoral habitat potentially available to warmwater fish for spawning and/or rearing in Folsom Reservoir during the April through November period under the Flexible Purchase Alternative would not differ from the long-term average amount available under the Baseline Condition. Further, the monthly mean amount of littoral habitat would not be reduced under the Flexible Purchase Alternative, relative to the Baseline Condition, in any of the 576 months simulated for the April through November period. (See Appendix H pgs. 294-300.)

Table 9-33
Long-term Average Number of Acres of Folsom Reservoir Littoral Habitat Under Baseline and Flexible Purchase Alternative Conditions

Month	Average Amount Of Littoral Habitat[1] (Acres)		Difference	
	Baseline	Flexible Purchase Alternative	(Acres)	(%)[2]
Mar	1,253	1,253	0	0.0
Apr	2,207	2,207	0	0.0
May	2,713	2,713	0	0.0
Jun	2,420	2,420	0	0.0
Jul	1,573	1,573	0	0.0
Aug	1,285	1,285	0	0.0
Sep	780	780	0	0.0
Oct	604	604	0	0.0
Nov	444	444	0	0.0
Dec	436	436	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

In addition, the Flexible Purchase Alternative could alter the extent to which water surface elevations in Folsom Reservoir change during each month of the primary warmwater fish-spawning period of March through June. As discussed in Section 9.2.1.1.1, adverse effects on spawning from nest dewatering are assumed to have the potential to occur when reservoir elevation decreases by more than nine feet within a given month. Modeling results, shown in Table 9-34, indicate that the frequency with which potential nest dewatering events could occur in Folsom Reservoir would not increase under the Flexible Purchase Alternative, compared to the Baseline Condition, during any month of the March through June spawning period.

Table 9-34
Long-term Average Surface Elevation and Number of Years with Elevation Decrease Greater than 9 feet in Folsom Reservoir Under Baseline and Flexible Purchase Alternative Conditions

Month	Average Reservoir Surface Elevation[1] (feet msl)			No. Years[1] w/Monthly Elevation Decrease During Month > 9 ft	
	Baseline	Flexible Purchase Alternative	Difference	Baseline	Flexible Purchase Alternative
Mar	425	425	0	2	2
Apr	438	438	0	1	1
May	449	449	0	2	2
Jun	444	444	0	20	20

[1] Based on 72 years modeled.

In summary, the Flexible Purchase Alternative would not result in changes in the availability of littoral habitat at Folsom Reservoir, relative to the Baseline Condition, and thus, would not beneficially or adversely affect warmwater fish rearing. Implementation of the Flexible Purchase Alternative would not alter the frequency of potential nest dewatering events in Folsom Reservoir, relative to the Baseline Condition, and thus, would not beneficially or adversely affect long-term warmwater fish nesting success. Therefore, under the Flexible Purchase Alternative, impacts on

Folsom Reservoir warmwater fisheries would be less than significant, relative to the Baseline Condition.

Impacts on Folsom Reservoir Coldwater Fisheries

Long-term average end-of-month storage in Folsom Reservoir under the Flexible Purchase Alternative would be reduced by 4 TAF or 0.6 percent in July, and 3 TAF or 0.5 percent in August, and would not change during the remaining months of the April through November period, when the reservoir thermally stratifies, relative to the Baseline Condition. (Refer to Table 9-35.) For any given month, the largest difference between long-term average end-of-month storage under the Flexible Purchase Alternative would be a 6 AF decrease, relative to the Baseline Condition, a less than one percent difference. On a monthly mean basis, Folsom Reservoir end-of-month storage under the Flexible Purchase Alternative would be essentially equivalent to the Baseline Condition for 563 of the 576 months simulated for the April through November period. (See Appendix H pgs. 115-120 and 109-110.)

Table 9-35
Long-term Average Folsom Reservoir End of Month Storage Under Baseline and Flexible Purchase Alternative Conditions

Month	Average Storage[1] (TAF)		Difference	
	Baseline	Flexible Purchase Alternative	(TAF)	(%)[2]
Apr	703	703	0	0.0
May	815	815	0	0.0
Jun	769	769	0	0.0
Jul	626	622	-4	-0.6
Aug	568	565	-3	-0.5
Sep	488	488	0	0.0
Oct	469	469	0	0.0
Nov	451	451	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

The changes in Folsom Reservoir storage that would occur under the Flexible Purchase Alternative would result from the acquisition of Placer County WA stored reservoir water from Hell Hole and French Meadows reservoirs and the purchase of SGA groundwater via groundwater purchase. Such changes in reservoir storage are unlikely to result in either potentially beneficial or adverse effects on the coldwater pool volume, relative to the Baseline Condition, due to the timing of the transfer or storage of EWA assets to or within Folsom Reservoir. In late summer, the coldwater pool volume at Folsom Reservoir is typically substantially reduced, relative to the volume of coldwater available in spring months. The transfer of EWA assets in late summer would occur when water temperatures of transferred water would be too warm to sink into the hypolimnion, and would not result in the mixing of the warm and coldwater pools. The EWA agencies could schedule release of EWA assets stored in Folsom Reservoir into the lower American River in a fish-friendly manner consistent with flow and temperature objectives and Delta export capacity. Releases could occur later in the summer when water temperatures are higher and available flows are most in need of augmentation to benefit fish, and could occur as late as December. However, these releases would not occur in a manner that would adversely affect the Folsom Reservoir coldwater pool. In addition, the anticipated storage of EWA assets via groundwater purchase in Folsom Reservoir would constitute only a fraction of storage at Folsom Reservoir (approximately 2 percent). Thus, such storage of groundwater purchase assets would not substantially alter the coldwater pool volume in Folsom Reservoir, relative to the Baseline Condition.

Overall, minor changes in storage at Folsom Reservoir would not be expected to adversely affect habitat availability or the population levels of the primary prey species utilized by coldwater fish. Therefore, changes in Folsom Reservoir end-of-month storage under the Flexible Purchase Alternative represent a less-than-significant impact on coldwater fish resources, relative to the Baseline Condition.

Temperature-related Impacts on Lake Natoma and Nimbus Fish Hatchery

CVP operations of Folsom Dam and Reservoir under the Flexible Purchase Alternative would have little effect on water temperatures below Nimbus Dam during all months of the year, relative to the Baseline Condition. Table 9-36 shows that the long-term average temperature of water released from Nimbus Dam would increase by 0.1°F to 0.2°F during March, April, May, August, and September, would decrease by 0.1°F during January, and would not change during the remaining months of the year, relative to the Baseline Condition.

Table 9-36
Long-term Average Water Temperature in the American River Below Nimbus Dam Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	56.3	56.3	0.0
Nov	56.5	56.5	0.0
Dec	51.2	51.2	0.0
Jan	47.2	47.1	-0.1
Feb	47.8	47.8	0.0
Mar	50.3	50.4	0.1
Apr	53.7	53.8	0.1
May	56.5	56.6	0.1
Jun	59.6	59.6	0.0
Jul	64.3	64.3	0.0
Aug	64.5	64.6	0.1
Sep	65.9	66.1	0.2

[1] Based on 69 years modeled.

The May through September period has been identified as the portion of the year when hatching temperatures at the fish hatchery reach annual highs. In 331 out of the 345 months simulated for the May through September period, monthly mean water temperatures below Nimbus Dam under the Flexible Purchase Alternative would be essentially equivalent to or less than those under the Baseline Condition. (See Appendix H pgs. 416-420.) Further, implementation of the Flexible Purchase Alternative would not result in measurable increases in the frequency in which index water temperatures of 60°F, 65°F, and 68°F would be exceeded, relative to the Baseline Condition. (See Appendix H pgs. 416-420.) Therefore, implementation of the Flexible Purchase Alternative would have little, if any, effect on water temperatures in Lake Natoma or hatchery operations and resultant fish production. Consequently, impacts on coldwater fisheries at Lake Natoma and hatchery operations under the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on Fall-run Chinook Salmon and Steelhead in the Lower American River

Flow-related Impacts on Adult Fall-run Chinook Salmon/Steelhead Immigration (September Through March)

Even at current minimum flow requirements (250 cfs under D-893), flow-related physical impediments to adult salmonid upstream passage are not known to occur. Therefore, flow-related impacts on adult Chinook salmon immigration primarily would be determined by flows at the mouth of the American River during the September through December period, when lower American River adult Chinook salmon immigrate through the Sacramento River and Delta in search of their natal stream to spawn. The same would be true for steelhead during the December through March period. Reduced flows at the mouth are of concern primarily because reduced flows could result in insufficient olfactory cues for immigrating adult salmonids, thereby making it more difficult for them to "home" to the lower American River. Large reductions in flow could result in higher rates of straying to other Central Valley rivers.

Table 9-37 shows that the long-term average flow at the mouth of the American River under the Flexible Purchase Alternative would increase by 0.3 percent in September and would not differ from the Baseline Condition from October through March. In all of the 504 months simulated in this period, monthly mean flows at the mouth of the American River under the Flexible Purchase Alternative would be essentially equivalent to or greater than those under the Baseline Condition. (See Appendix H pgs. 372, 361-366.)

Table 9-37
Long-term Average Flow at the Mouth of the American River Under Baseline and Flexible Purchase Alternative Conditions

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	1557	1557	0	0.0
Nov	2426	2426	0	0.0
Dec	3441	3441	0	0.0
Jan	4077	4077	0	0.0
Feb	4949	4949	0	0.0
Mar	3902	3902	0	0.0
Apr	3518	3518	0	0.0
May	3632	3632	0	0.0
Jun	3936	3936	0	0.0
Jul	3851	3958	107	2.8
Aug	2253	2299	46	2.0
Sep	2707	2716	9	0.3

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Temperature-related Impacts on Adult Fall-run Chinook Salmon/Steelhead Immigration (September Through March)

Reclamation's Lower American River Temperature Model does not account for the influence of Sacramento River water intrusion on water temperatures at the mouth. Therefore, the water temperature assessments for adult fall-run Chinook salmon and steelhead immigration are based on water temperatures modeled at the mouth of the lower American River and at Freeport in the Sacramento River. Long-term average water temperatures modeled for the Flexible Purchase Alternative would not increase or decrease by more than 0.1°F at the mouth of the American River and at Freeport in the Sacramento River, during the September through March adult immigration period, as shown in Tables 9-38 and 9-11. Monthly mean water temperatures at Freeport in the Sacramento River would be essentially equivalent to the Baseline Condition for all of the 483 months included in the analysis. (See Appendix H pgs. 492, 481-486.) At the mouth of the lower American River, monthly mean water temperatures under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition for 477 of the 483 months simulated for the September through March period.)

Table 9-38
Long-term Average Water Temperature at the Mouth of the American River Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	58.4	58.4	0.0
Nov	55.5	55.5	0.0
Dec	49.7	49.6	-0.1
Jan	46.5	46.5	0.0
Feb	48.5	48.5	0.0
Mar	51.7	51.8	0.1
Apr	55.8	55.9	0.1
May	59.7	59.8	0.1
Jun	63.2	63.3	0.1
Jul	67.2	67.2	0.0
Aug	68.1	68.1	0.0
Sep	67.3	67.3	0.0

[1] Based on 69 years modeled.

Flow-related Impacts on Adult Fall-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (October through February)

All flow-related impact assessments for adult fall-run Chinook salmon spawning and egg incubation were based on flows below Nimbus Dam and at Watt Avenue, with a greater emphasis placed on flows below Nimbus Dam. Aerial redd surveys conducted by CDFG in recent years have shown that 98 percent of all adult fall-run Chinook salmon spawning occurs upstream of Watt Avenue, with 88 percent of spawning occurring upstream of RM 17 (located just upstream of Ancil Hoffman Park). Hence, the majority of spawning occurs in the approximate 6 miles below Nimbus Dam.

Long-term average flows below Nimbus Dam and at Watt Avenue under the Flexible Purchase Alternative from October through February would be identical to those under the Baseline Condition, as shown in Tables 9-39 and 9-40. In addition, in all of the 360 months simulated for the October through February period, monthly mean flows below Nimbus Dam and at Watt Avenue under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition. (See Appendix H pgs. 313-317 and 325 -329.)

Table 9-39
Long-term Average Release From Nimbus Dam Under Baseline and Flexible Purchase Alternative Conditions

Month	***Monthly Mean Flow[1] (cfs)***		***Difference***	
	Baseline	***Flexible Purchase Alternative***	***(cfs)***	***(%)[2]***
Oct	1678	1678	0	0.0
Nov	2502	2502	0	0.0
Dec	3498	3498	0	0.0
Jan	4124	4124	0	0.0
Feb	4989	4989	0	0.0
Mar	3941	3941	0	0.0
Apr	3616	3616	0	0.0
May	3793	3793	0	0.0
Jun	4166	4166	0	0.0
Jul	4100	4208	108	2.6
Aug	2482	2528	46	1.9
Sep	2876	2885	9	0.3

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Table 9-40
Long-term Average Flow at Watt Avenue Under Baseline and Flexible Purchase Alternative Conditions

Month	***Monthly Mean Flow[1] (cfs)***		***Difference***	
	Baseline	***Flexible Purchase Alternative***	***(cfs)***	***(%)[2]***
Oct	1507	1507	0	0.0
Nov	2385	2385	0	0.0
Dec	3402	3402	0	0.0
Jan	4038	4038	0	0.0
Feb	4906	4906	0	0.0
Mar	3861	3861	0	0.0
Apr	3428	3428	0	0.0
May	3531	3531	0	0.0
Jun	3814	3814	0	0.0
Jul	3729	3838	108	2.9
Aug	2148	2199	46	2.1
Sep	2633	2642	9	0.3

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Figures 9-41 through 9-45 show exceedance curves for the American River release from Nimbus Dam for the October through February period. The basis for development of these exceedance curves was the 1922-1993 period of record. These curves demonstrate that flows under the Flexible Purchase Alternative would not differ from those under the Baseline Condition.

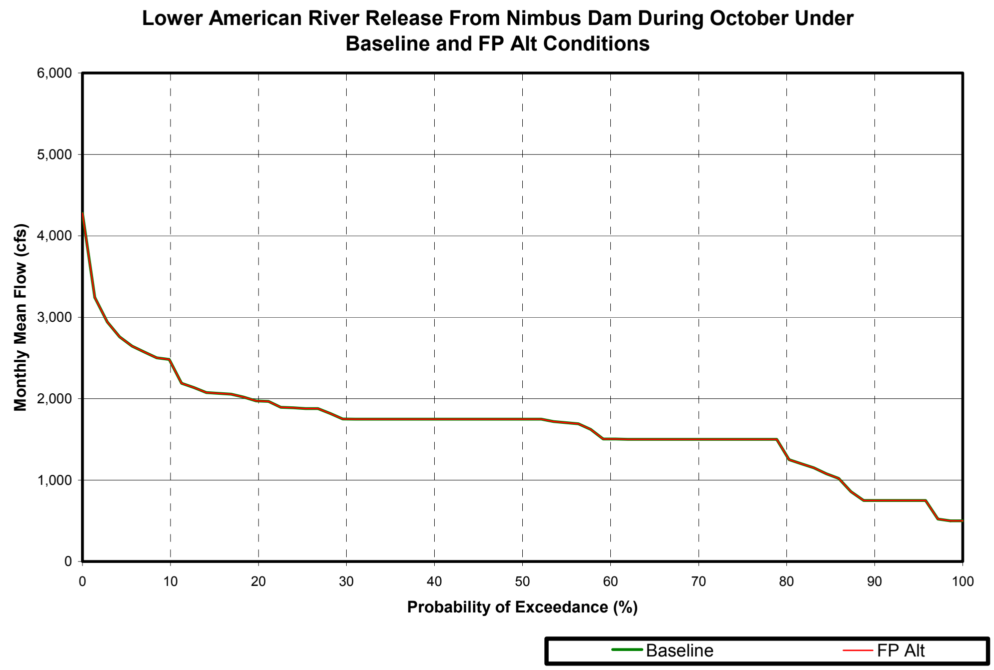

Figure 9-41
Lower American River Release From Nimbus Dam During October Under Baseline and Flexible Purchase Alternative Conditions

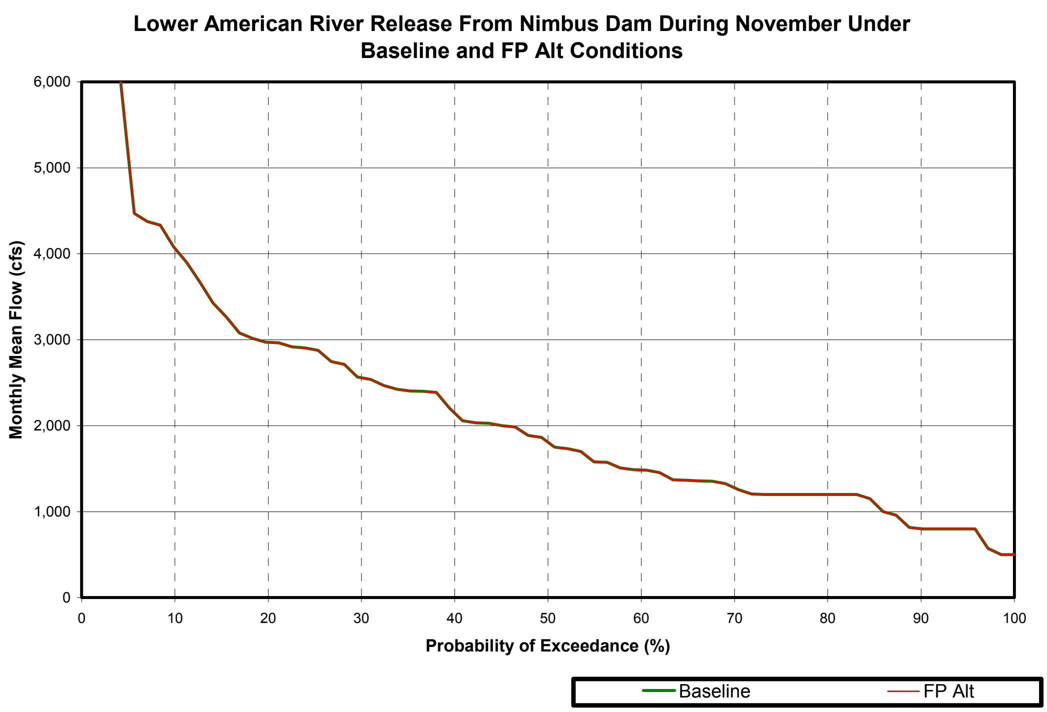

Figure 9-42
Lower American River Release From Nimbus Dam During November Under Baseline and Flexible Purchase Alternative Conditions

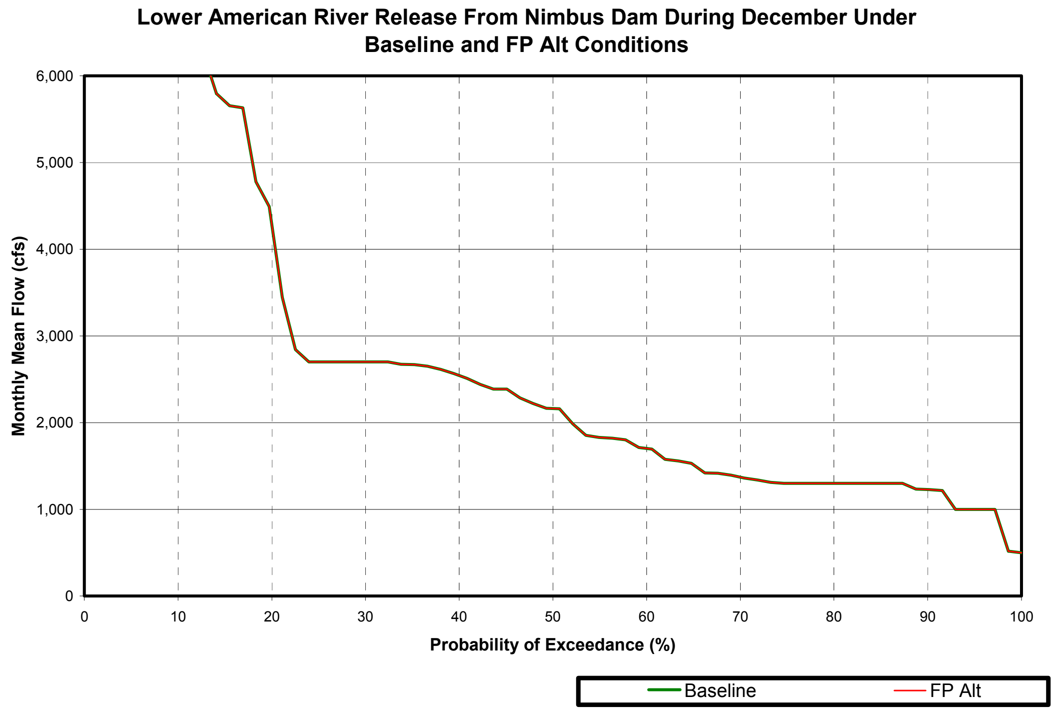

Figure 9-43
Lower American River Release From Nimbus Dam During December Under Baseline and Flexible Purchase Alternative Conditions

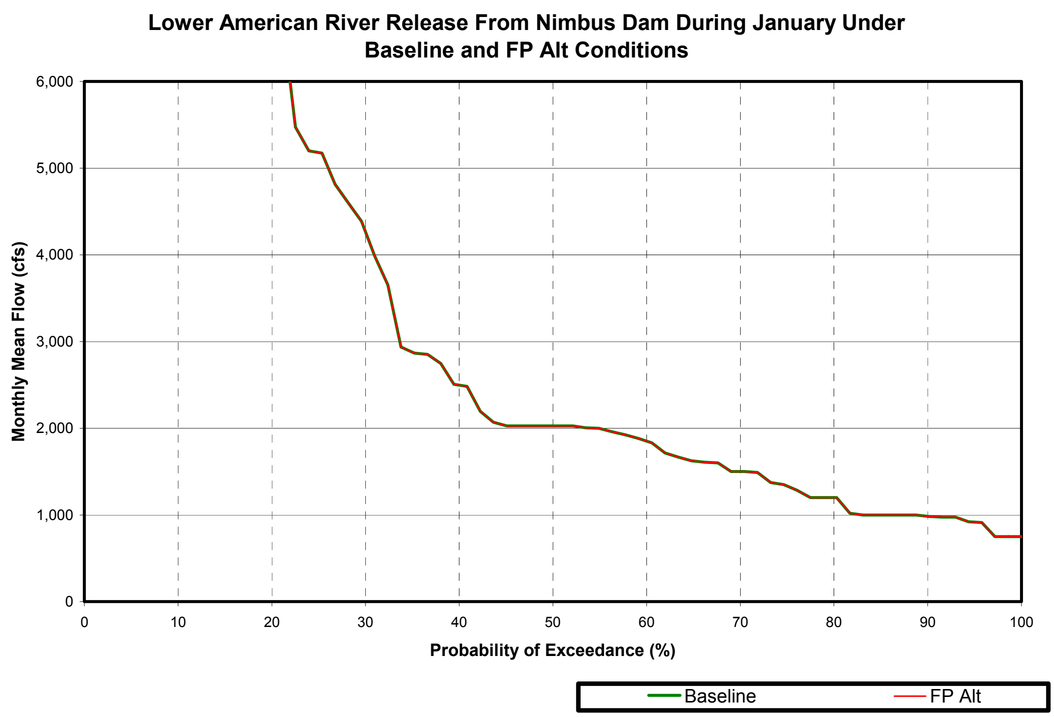

Figure 9-44
Lower American River Release From Nimbus Dam During January Under Baseline and Flexible Purchase Alternative Conditions

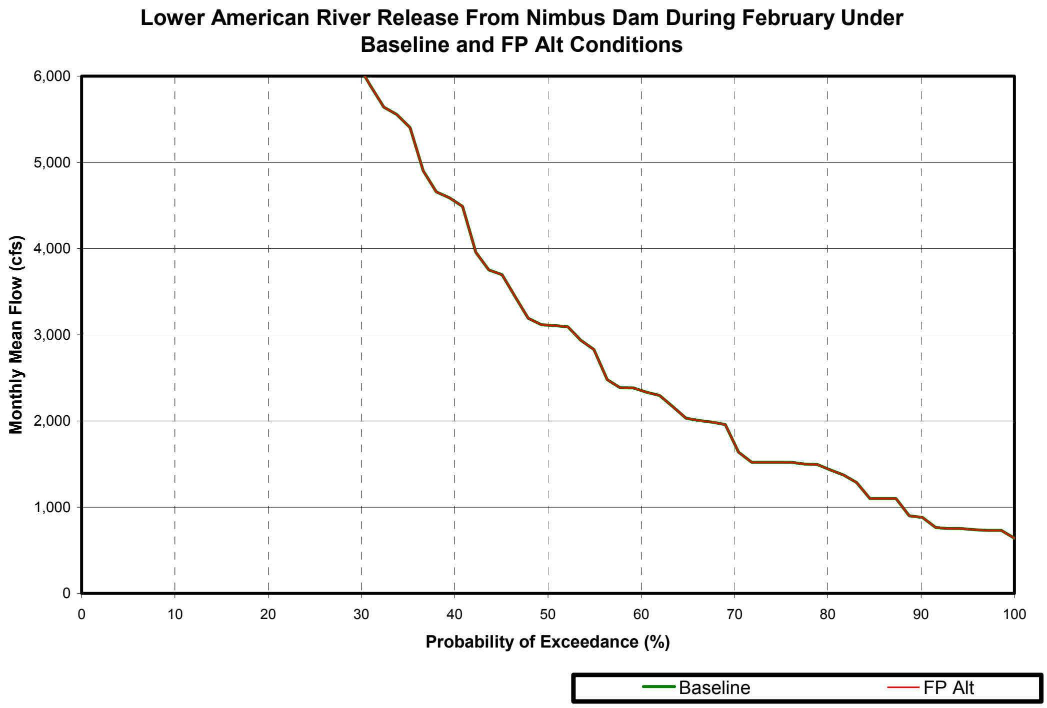

Figure 9-45
Lower American River Release From Nimbus Dam During February Under Baseline and Flexible Purchase Alternative Conditions

Reductions in flows below 2,000 cfs could reduce the amount of available Chinook salmon spawning habitat, which could result in increased redd superimposition during years when adult returns are high enough for spawning habitat to be limiting. However, these findings indicate that the Flexible Purchase Alternative would not result in flow changes when flows under the Baseline Condition would be below 2,000 cfs.

Temperature-related Impacts on Adult Fall-run Chinook Salmon Spawning, Egg Incubation, and Initial Rearing (October through February)

Under the Flexible Purchase Alternative, long-term average water temperatures below Nimbus Dam would decrease by 0.1°F in January, and would not change during October, November, December, and February, relative to the Baseline Condition, as shown in Table 9-41. In 336 out of the 345 months included in the analysis, water temperatures below Nimbus Dam under the Flexible Purchase Alternative during the October through February period would be essentially equivalent to or less than those under the Baseline Condition. (See Appendix H pgs. 409-413.) At Watt Avenue, long-term average water temperatures under the Flexible Purchase Alternative would not differ from those under the Baseline Condition during any month of the October through February period, as shown in Table 9-42. In 336 months out of the 345 months simulated for the October through February period, monthly mean water temperatures at Watt Avenue under the Flexible Purchase Alternative would be essentially equivalent to or less than those under the Baseline Condition. (See Appendix H pgs. 421-425.)

Table 9-41
Long-term Average Water Temperature in the American River below Nimbus Dam Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	56.3	56.3	0.0
Nov	56.5	56.5	0.0
Dec	51.2	51.2	0.0
Jan	47.2	47.1	-0.1
Feb	47.8	47.8	0.0
Mar	50.3	50.4	0.1
Apr	53.7	53.8	0.1
May	56.5	56.6	0.1
Jun	59.6	59.6	0.0
Jul	64.3	64.3	0.0
Aug	64.5	64.6	0.1
Sep	65.9	66.1	0.2

[1] Based on 69 years modeled.

Table 9-42
Long-term Average Water Temperature in the American River at Watt Avenue Under Baseline and Flexible Purchase Alternative Conditions

Month	Water Temperature[1] (ºF)		
	Baseline	Flexible Purchase Alternative	Difference (ºF)
Oct	57.7	57.7	0.0
Nov	55.8	55.8	0.0
Dec	50.2	50.2	0.0
Jan	46.7	46.7	0.0
Feb	48.2	48.2	0.0
Mar	51.2	51.3	0.1
Apr	55.1	55.2	0.1
May	58.7	58.7	0.0
Jun	62.0	62.0	0.0
Jul	66.2	66.2	0.0
Aug	66.9	66.9	0.0
Sep	66.8	66.8	0.0

[1] Based on 69 years modeled.

Water temperatures greater than 56°F may have the potential to adversely affect salmon spawning and egg incubation. Under the Flexible Purchase Alternative, there would be one additional occurrence in which monthly mean water temperatures would exceed 56°F below Nimbus Dam in October, relative to the Baseline Condition. (See Appendix H pgs. 409-413.) Similarly, at Watt Avenue, water temperatures under the Flexible Purchase Alternative would exceed 56°F in one additional month in October, relative to the Baseline Condition. (See Appendix H pgs. 421-425.)

The long-term average annual early lifestage survival for fall-run Chinook salmon in the American River would be 90.6 percent under the Baseline Condition and 90.5 percent under the Flexible Purchase Alternative, as shown in Table 9-43. Under the

Flexible Purchase Alternative, there would be no change in annual early lifestage survival in 20 of the 69 years simulated. In 10 of the 69 years modeled, there would be increases in annual early lifestage survival under the Flexible Purchase Alternative, and in 37 years, decreases would occur, relative to the Baseline Condition.

Table 9-43
Lower American River Salmon Survival – Fall-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	Baseline Condition Survival (%)	Flexible Purchase Alternative Survival (%)	Absolute Difference (%)	Relative Difference (%)
1922	92.5	92.2	-0.3	-0.3
1923	93.1	93.1	0.0	0.0
1924	89.7	89.7	0.0	0.0
1925	90.5	90.6	0.1	0.1
1926	90.2	90.1	-0.1	-0.1
1927	93.3	93.3	0.0	0.0
1928	92.7	92.6	-0.1	-0.1
1929	93.7	93.5	-0.2	-0.2
1930	92.9	92.8	-0.1	-0.1
1931	89.0	88.9	-0.1	-0.1
1932	83.3	83.3	0.0	0.0
1933	87.0	86.5	-0.5	-0.6
1934	86.3	86.2	-0.1	-0.1
1935	91.3	90.8	-0.5	-0.5
1936	86.0	85.8	-0.2	-0.2
1937	93.5	93.3	-0.2	-0.2
1938	91.8	91.8	0.0	0.0
1939	88.3	88.1	-0.2	-0.2
1940	86.8	86.8	0.0	0.0
1941	93.3	93.3	0.0	0.0
1942	92.9	92.9	0.0	0.0
1943	93.2	93.2	0.0	0.0
1944	93.0	92.7	-0.3	-0.3
1945	92.1	92.1	0.0	0.0
1946	93.0	93.2	0.2	0.2
1947	93.9	93.8	-0.1	-0.1
1948	93.0	93.5	0.5	0.5
1949	93.6	93.5	-0.1	-0.1
1950	88.3	88.3	0.0	0.0
1951	92.1	92.0	-0.1	-0.1
1952	92.5	92.1	-0.4	-0.4
1953	91.9	92.3	0.4	0.4
1954	93.0	93.0	0.0	0.0
1955	93.5	93.7	0.2	0.2
1956	91.9	91.5	-0.4	-0.4
1957	90.4	90.0	-0.4	-0.4
1958	82.9	82.8	-0.1	-0.1
1959	79.1	77.7	-1.4	-1.8
1960	92.3	92.0	-0.3	-0.3
1961	92.6	92.4	-0.2	-0.2
1962	90.4	90.4	0.0	0.0
1963	93.8	93.8	0.0	0.0
1964	93.6	93.5	-0.1	-0.1
1965	93.0	93.2	0.2	0.2
1966	90.2	89.6	-0.6	-0.7

Table 9-43
Lower American River Salmon Survival – Fall-run Chinook Salmon Under Baseline and Flexible Purchase Alternative Conditions

Water Year	Baseline Condition Survival (%)	Flexible Purchase Alternative Survival (%)	Absolute Difference (%)	Relative Difference (%)
1967	83.6	83.6	0.0	0.0
1968	91.7	91.3	-0.4	-0.4
1969	92.3	92.3	0.0	0.0
1970	93.2	92.8	-0.4	-0.4
1971	93.5	93.5	0.0	0.0
1972	93.0	93.0	0.0	0.0
1973	91.8	93.2	1.4	1.5
1974	92.7	92.6	-0.1	-0.1
1975	93.9	93.8	-0.1	-0.1
1976	87.7	87.5	-0.2	-0.2
1977	82.1	81.4	-0.7	-0.9
1978	89.4	89.6	0.2	0.2
1979	91.9	91.8	-0.1	-0.1
1980	92.1	92.1	0.0	0.0
1981	84.0	83.9	-0.10	-0.1
1982	93.1	93.1	0.0	0.0
1983	86.6	86.8	0.2	0.2
1984	90.1	89.4	-0.7	-0.8
1985	93.0	92.9	-0.1	-0.1
1986	90.7	90.7	0.0	0.0
1987	87.8	87.6	-0.2	-0.2
1988	85.9	86.0	0.1	0.1
1989	91.2	91.2	0.0	0.0
1990	91.2	90.7	-0.5	-0.5
Mean:	90.6	90.5	-0.1	-0.1
Median:	91.9	92.0	-0.1	-0.1
Min:	79.1	77.7	-1.4	-1.8
Max:	93.9	93.8	1.4	1.5
Year Counts				
0.0 > X >= -1.0			36	36
-1.0 > X >= -2.0			1	1
-2.0 > X >= -4.0			0	0
-4.0 > X >= -6.0			0	0
X < -6.0			0	0
0.0 < X <= 1.0			9	9
1.0 < X <= 2.0			1	1
2.0 < X <= 4.0			0	0
4.0 < X <= 6.0			0	0
X > 6.0			0	0
No Difference (X = 0.0)			20	20

Flow-related Impacts on Adult Steelhead Spawning and Egg Incubation (December through April)

Long-term average flows below Nimbus Dam and at Watt Avenue under the Flexible Purchase Alternative would be identical to flows under the Baseline Condition during December through April, as shown in Table 9-39 and Table 9-40. Monthly mean flows under the Flexible Purchase Alternative below Nimbus Dam and at Watt Avenue would be essentially equivalent to those under the Baseline Condition for all of the 360 months included in the analysis. (See Appendix H pgs. 315-319 and 327-331.)

Temperature-related Impacts on Adult Steelhead Spawning and Egg Incubation (December through April)

Long-term average water temperatures under the Flexible Purchase Alternative below Nimbus Dam would not change during December and February, would decrease by 0.1°F in January, and would increase by 0.1°F in March and April, relative to the Baseline Condition. (Refer to Table 9-41.) Monthly mean water temperatures below Nimbus Dam under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition for all of the 345 months included in the analysis [Appendix H pgs. 411-415]. Additionally, there would be no measurable increase in the frequency in which water temperatures under the Flexible Purchase Alternative at this location would exceed 56°F, relative to the Baseline Condition. (See Appendix H pgs. 411-415.)

Long term average water temperatures during the December through April period at Watt Avenue would not change from December through February, and would increase by 0.1°F during March and April, relative to the Baseline Condition, as shown in Table 9-42. Monthly mean water temperatures at Watt Avenue under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition for all of the 345 months included in the analysis. (See Appendix H pgs. 423-427.) In addition, implementation of the Flexible Purchase Alternative would not result in a measurable increase in the frequency in which monthly mean water temperatures would exceed 56°F, relative to the Baseline Condition, throughout the December through April period. (See Appendix H pgs. 423–427.)

Flow-related Impacts on Juvenile Fall-run Chinook Salmon and Steelhead Rearing and Emigration (February through June)

The majority of juvenile salmonid rearing is believed to occur upstream of Watt Avenue, and depletions (primarily diversions) generally exceed tributary accretions to the river throughout the February through June period (generally resulting in lower flows at Watt Avenue than below Nimbus Dam). Therefore, all flow-related impact assessments for juvenile fall-run Chinook salmon and steelhead rearing are based on flows at Watt Avenue. Because juvenile emigration occurs at the mouth of the American River, flow-related impacts are also assessed at this location.

Under the Flexible Purchase Alternative, long-term average flows at Watt Avenue would not differ from flows under the Baseline Condition during the February through June period. (Refer to Table 9-40.) In all of the 360 months included in the analysis, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to flows under the Baseline Condition. (Refer to Appendix H pgs. 329-333.) Flow exceedance curves for February through June at Watt Avenue are shown in Figures 9-46 through 9-50. The basis for development of these exceedance curves was the 1922-1993 period of record. These figures show that flows at Watt Avenue under the Flexible Purchase Alternative would be identical to those under the

Baseline Condition from February through June. Flows at Watt Avenue would not be expected to change under the Flexible Purchase Alternative. At the mouth of the American River, long-term average flows would not differ during the February through June period under the Flexible Purchase Alternative, relative to the Baseline Condition, as shown in Table 9-44. Under the Flexible Purchase Alternative, monthly mean flows at the mouth of the American River would be essentially equivalent to those under the Baseline Condition in all of the 360 months included in the analysis. (See Appendix H pgs. 365-369.)

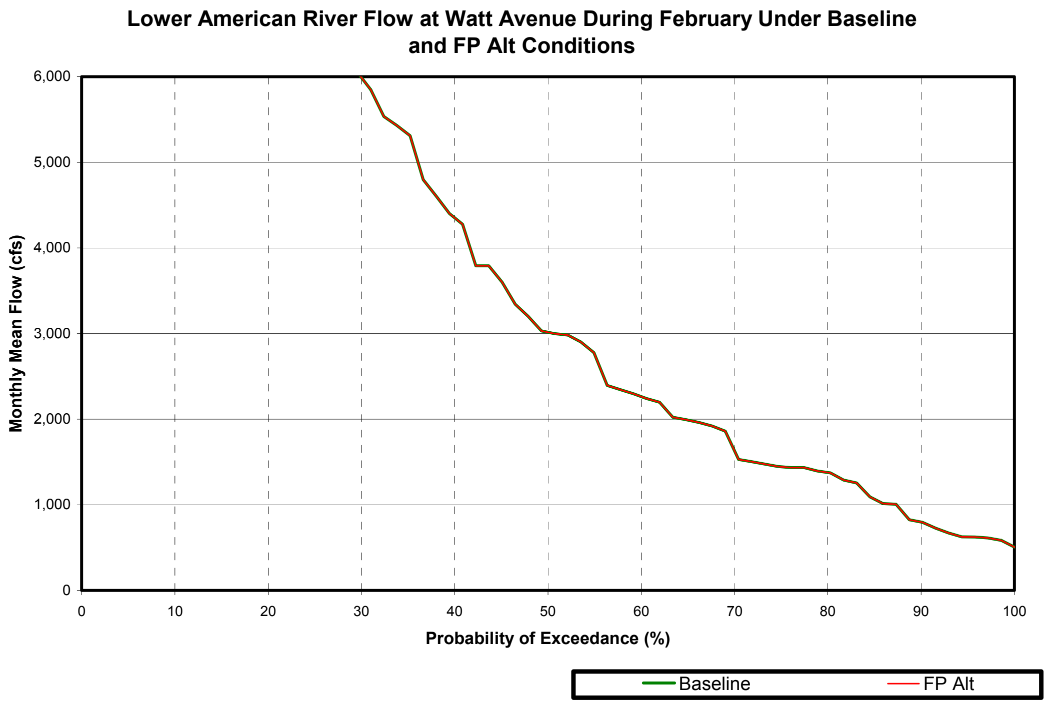

Figure 9-46
Lower American River Flow at Watt Avenue During February Under Baseline and Flexible Purchase Alternative Conditions

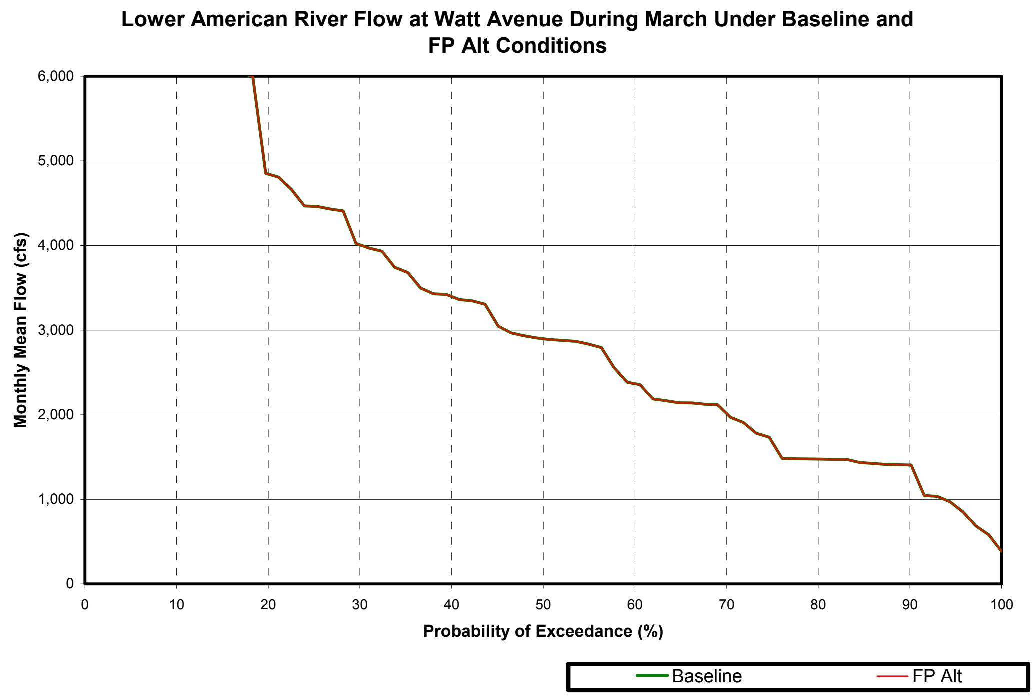

Figure 9-47
Lower American River Flow at Watt Avenue During March Under Baseline and Flexible Purchase Alternative Conditions

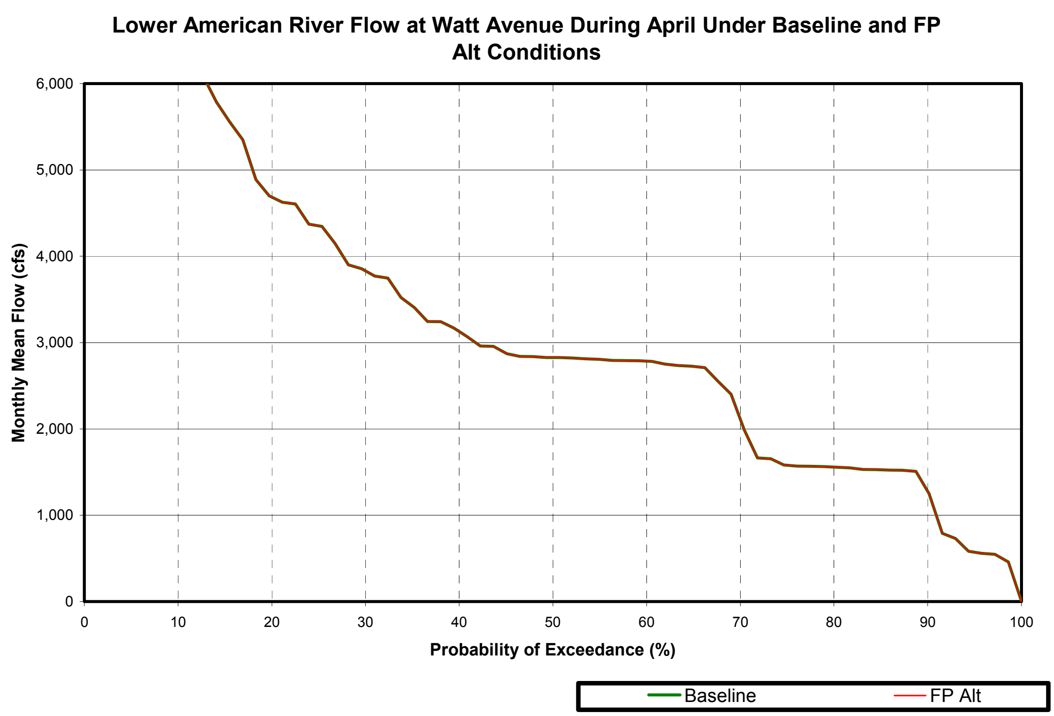

Figure 9-48
Lower American River Flow at Watt Avenue During April Under Baseline and Flexible Purchase Alternative Conditions

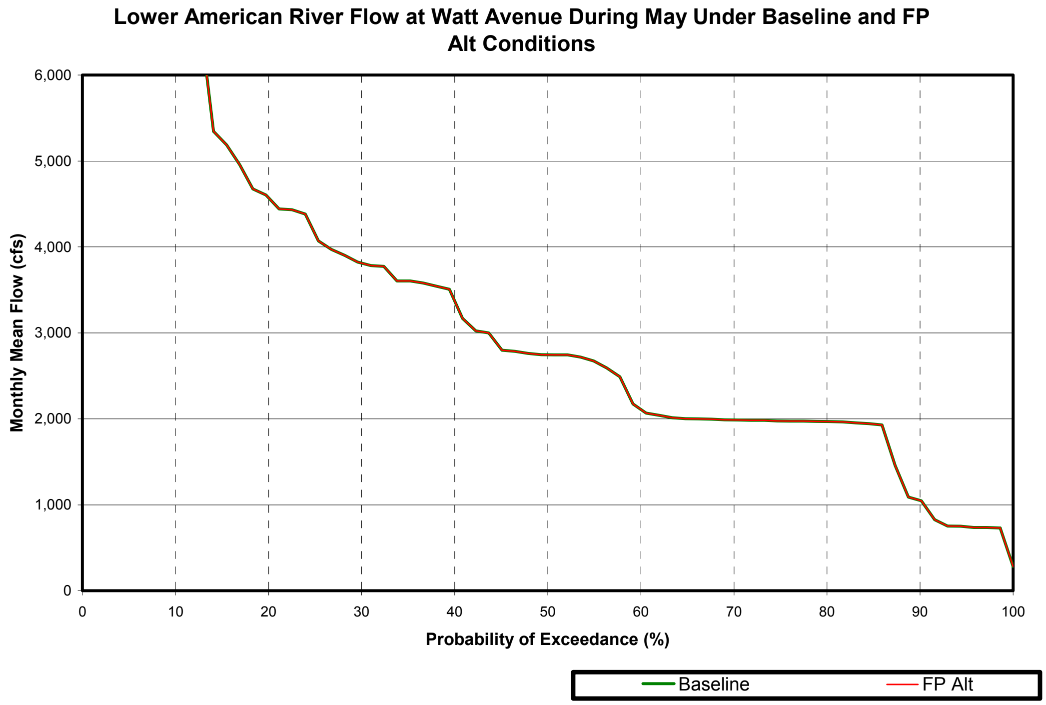

Figure 9-49
Lower American River Flow at Watt Avenue During May Under Baseline and Flexible Purchase Alternative Conditions

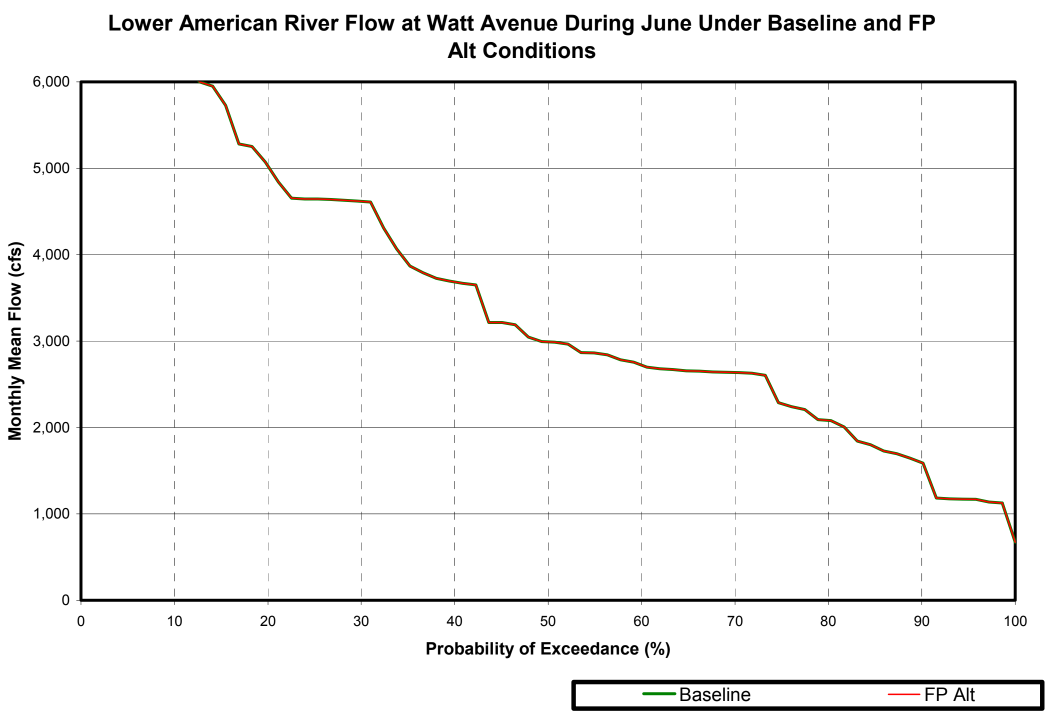

Figure 9-50
Lower American River Flow at Watt Avenue During June Under Baseline and Flexible Purchase Alternative Conditions

Table 9-44
Long-term Average Flow at the Mouth of the American River Under Baseline and Flexible Purchase Alternative Conditions

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	1557	1557	0	0.0
Nov	2426	2426	0	0.0
Dec	3441	3441	0	0.0
Jan	4077	4077	0	0.0
Feb	4949	4949	0	0.0
Mar	3902	3902	0	0.0
Apr	3518	3518	0	0.0
May	3632	3632	0	0.0
Jun	3936	3936	0	0.0
Jul	3851	3958	107	2.8
Aug	2253	2299	46	2.0
Sep	2707	2716	9	0.3

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Overall, flows in the lower American River at Watt Avenue and at the mouth would not differ substantially under the Flexible Purchase Alternative, relative to the Baseline Condition. Potential flow decreases would not be detected during the February through June period under the Flexible Purchase Alternative.

Temperature-related Impacts on Juvenile Fall-run Chinook Salmon and Steelhead Rearing and Emigration (February through June)

Water temperature modeling for juvenile fall-run Chinook salmon and steelhead rearing and emigration was simulated at four locations, in the lower American River below Nimbus Dam, at Watt Avenue, and at the mouth of the American River, as well as in the Sacramento River at Freeport. Modeling associated with the Flexible Purchase Alternative indicates that simulated long-term average water temperatures below Nimbus Dam would not change during February and June, and would increase by 0.1°F during March, April, and May, as shown in Table 9-41. Monthly mean water temperatures below Nimbus Dam under the Flexible Purchase Alternative would be essentially equivalent to or less than those under the Baseline Condition in 342 of the 345 months simulated for the February through June period. (Refer to Appendix H pgs. 473-477.) Further, there would not be any additional occurrences under the Flexible Purchase Alternative in which water temperatures would be above 65°F below Nimbus Dam, relative to the Baseline Condition. (Refer to Appendix H pgs. 473-477.)

Table 9-45
Long-term Average Water Temperature in the American River Below Nimbus Dam Under Baseline and Flexible Purchase Alternative Conditions

Month	*Water Temperature[1] (ºF)*		
	Baseline	*Flexible Purchase Alternative*	*Difference (ºF)*
Oct	56.3	56.3	0.0
Nov	56.5	56.5	0.0
Dec	51.2	51.2	0.0
Jan	47.2	47.1	-0.1
Feb	47.8	47.8	0.0
Mar	50.3	50.4	0.1
Apr	53.7	53.8	0.1
May	56.5	56.6	0.1
Jun	59.6	59.6	0.0
Jul	64.3	64.3	0.0
Aug	64.5	64.6	0.1
Sep	65.9	66.1	0.2

[1] Based on 69 years modeled.

Modeling associated with the Flexible Purchase Alternative indicates that long-term average water temperatures at Watt Avenue would not change during February, May, and June, and would increase by 0.1°F during March and April, relative to the Baseline Condition, as shown in Table 9-42. Monthly mean water temperatures at Watt Avenue under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 274 months out of the 276 months included in the analysis. (See Appendix H pgs. 426– 429.) February and March water temperatures at Watt Avenue under the Flexible Purchase Alternative would remain below 65°F for all of the 69 years modeled. During April, May, and June, there would not be a measurable increase in the frequency in which monthly mean water temperatures under the Flexible Purchase Alternative would be above 65°F, relative to the Baseline Condition.

Long-term average water temperatures at the mouth of the American River during the February through June period under the Flexible Purchase Alternative would not change during February, and would increase 0.1°F during March through June, relative to the Baseline Condition. (Refer to Table 9-38.) Monthly mean water temperatures at the mouth of the American River under the Flexible Purchase Alternative would be essentially equivalent to or less than those under the Baseline Condition in 344 of the 345 months simulated for the February through June period. (Refer to Appendix H pgs. 437-441.) Monthly mean water temperatures at the mouth of the American River would be below 65°F in all 69 years modeled for the February through April period. During May and June, implementation of the Flexible Purchase Alternative would not result in an increase in the frequency of monthly mean water temperatures above 65°F, relative to the Baseline Condition. (Refer to Appendix H pgs. 437-441.)

Long-term average water temperatures under the Flexible Purchase Alternative in the Sacramento River at Freeport would be nearly identical to those under the Baseline Condition throughout the February through June period, as shown in Table 9-11. Long-term average water temperatures under the Flexible Purchase Alternative at Freeport would not change during February and March, and would increase by 0.1°F during April, May, and June. Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 345 months simulated for the February through June period. (Refer to Appendix H pgs. 485-489.) Further, the Flexible Purchase Alternative would not result in a measurable increase in the frequency in which monthly mean water temperatures would exceed 65°F at Freeport in the Sacramento River, relative to the Baseline Condition, for all months simulated for the juvenile fall-run Chinook salmon and steelhead rearing and emigration period. (Refer to Appendix H pgs. 485-489.)

Overall, implementation of the Flexible Purchase Alternative would result in negligible changes in lower American River water temperatures below Nimbus Dam, at Watt Avenue, and at the mouth of the American River, or in the Sacramento River at Freeport, throughout the February though June juvenile fall-run Chinook salmon and steelhead rearing and emigration period.

Flow-related Impacts on Juvenile Steelhead Rearing (July through September)

The majority of juvenile salmonid rearing is believed to occur upstream of Watt Avenue, and depletions generally exceed tributary accretions to the river throughout the February through June period (generally resulting in lower flows at Watt Avenue than below Nimbus Dam); therefore, all flow-related impact assessments for juvenile steelhead rearing are based on flows at Watt Avenue.

Under the Flexible Purchase Alternative, long-term average flows at Watt Avenue in the lower American River would increase by 2.9 percent, 2.1 percent, and 0.3 percent in July, August, and September, respectively, relative to the Baseline Condition. (Refer to Table 9-40.) In all of the 216 months simulated for the July through September period, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition. (Refer to Appendix H pgs. 334-336.) Figures 9-51 through 9-53 provide flow exceedance curves for the American River at Watt Avenue during July, August and September. The basis for development of these exceedance curves was the 1922-1993 period of record. These curves demonstrate that flows would slightly increase during July and August at nearly all flow levels simulated and generally remain the same during September at all flow levels simulated. Based on these findings, flow changes under the Flexible Purchase Alternative would not be expected to reduce juvenile steelhead rearing habitat. Further, steelhead populations in the lower American River are believed to be limited by instream water temperature conditions during the July through September period (discussed below), as opposed to flow conditions.

Temperature-related Impacts on Juvenile Steelhead Rearing (July through September)

Under the Flexible Purchase Alternative, long-term average water temperatures below Nimbus Dam would not differ in July and would increase by 0.1° and 0.2°F in August and September, respectively, relative to the Baseline Condition, as shown in Table 9-41. Long-term average water temperatures in the lower American River at Watt Avenue and at the mouth would not differ during July, August and September under the Flexible Purchase Alternative compared to the Baseline Condition. (Refer to Table 9-42 and Table 9-38.)

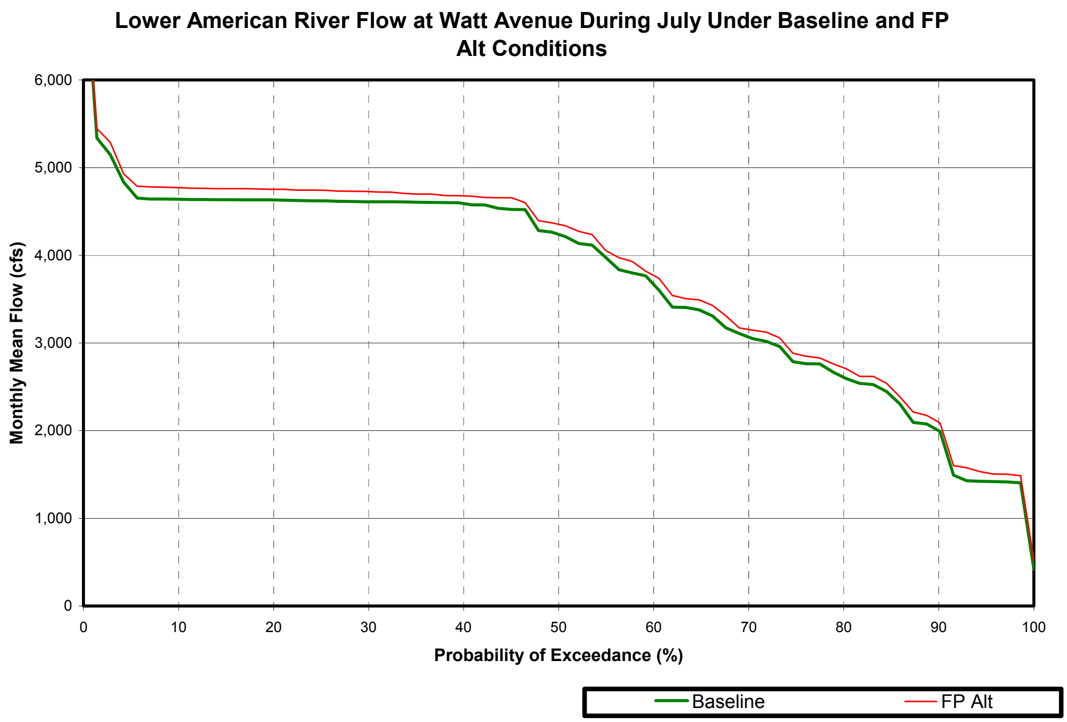

Figure 9-51
Lower American River Flow at Watt Avenue During July Under Baseline and Flexible Purchase Alternative Conditions

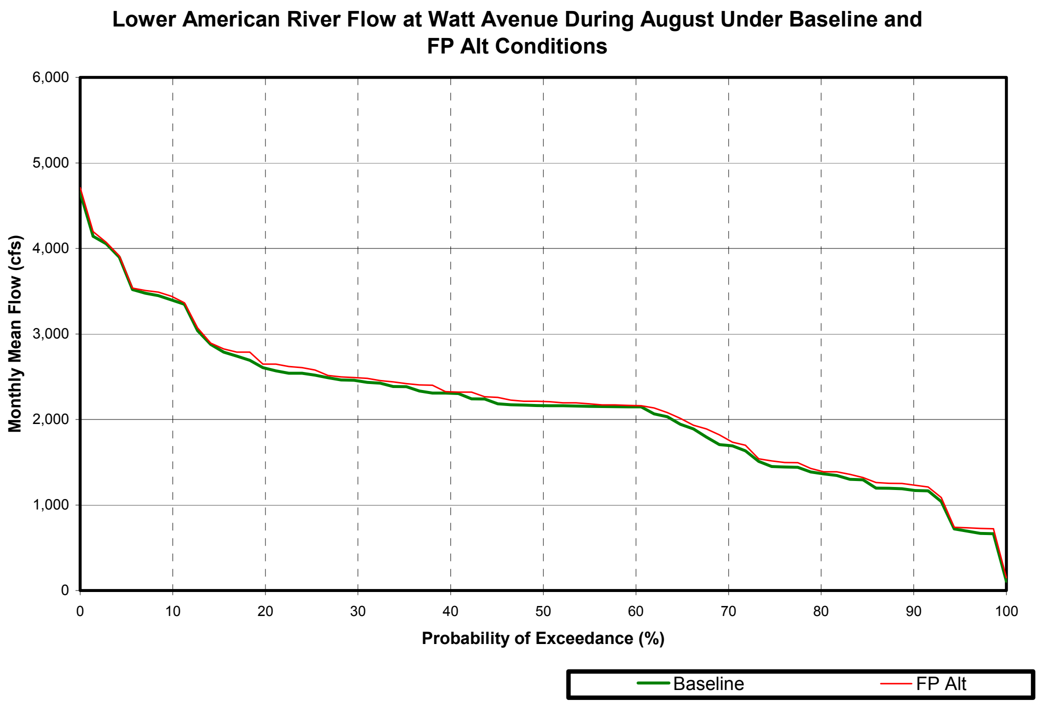

Figure 9-52
Lower American River Flow at Watt Avenue During August Under Baseline and Flexible Purchase Alternative Conditions

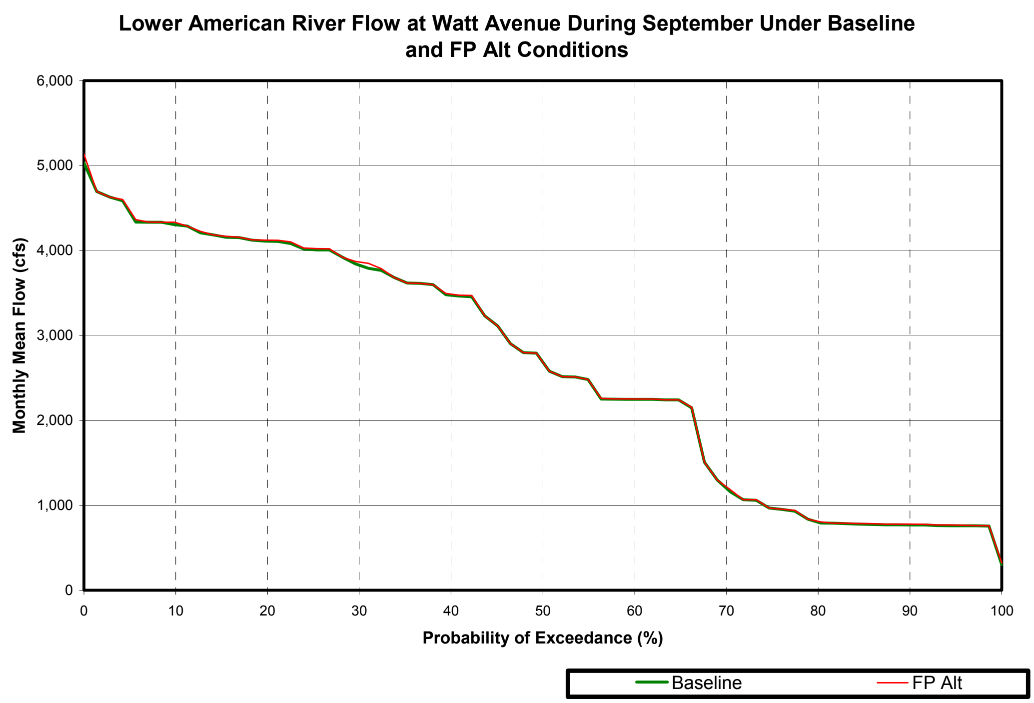

Figure 9-53
Lower American River Flow at Watt Avenue During September Under Baseline and Flexible Purchase Alternative Conditions

Monthly mean water temperatures below Nimbus Dam under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 196 out of the 207 months simulated for this three-month period. (Refer to Appendix H pgs. 418-420.) Monthly mean water temperatures at Watt Avenue under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 205 out of the 207 months simulated for this three-month period. (Refer to Appendix H pgs. 430–432.) In addition, monthly mean water temperatures at the mouth of the lower American River under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 206 out of the 207 months simulated. (Refer to Appendix H pgs. 442–444.) At each of these locations, implementation of the Flexible Purchase Alternative would not result in a measurable increase in the frequency in which July through September monthly mean water temperatures would exceed 65°F relative to the Baseline Condition. (Refer to Appendix H pgs. 418-420, 430-432, and 442-444.) In summary, there would be little difference in water temperatures between the Flexible Purchase Alternative and the Baseline Condition during the over-summer juvenile steelhead rearing months of July through September.

Flow-related Impacts on Fall/Winter Juvenile Steelhead Rearing (October through January)

The majority of juvenile salmonid rearing is believed to occur upstream of Watt Avenue, and depletions generally exceed tributary accretions to the river throughout the February through June period (generally resulting in lower flows at Watt Avenue than below Nimbus Dam); therefore, all flow-related impact assessments for juvenile steelhead rearing are based on flows at Watt Avenue.

Under the Flexible Purchase Alternative, long-term average flows at Watt Avenue in the lower American River would not change during the October through January period, relative to the Baseline Condition. (Refer to Table 9-40.) In all of the 288 months simulated for the October through January period, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition. (Refer to Appendix H pgs. 325-328.)

Temperature-related Impacts on Fall/Winter Juvenile Steelhead Rearing (October through January)

Under the Flexible Purchase Alternative, long-term average water temperatures below Nimbus Dam would not differ October through December and would decrease by 0.1°F in January, relative to the Baseline Condition, as shown in Table 9-41. Long-term average water temperature in the lower American River at Watt Avenue would not change under the Flexible Purchase Alternative, relative to the Baseline Condition. (Refer to Table 9-42.) Long-term average water temperature in the lower American River at the mouth would not change under the Flexible Purchase Alternative during October, November, or January, and would decrease by 0.1°F in December, relative to the Baseline Condition. (Refer to Table 9-38.)

Monthly mean water temperatures below Nimbus Dam under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 274 out of the 276 months simulated for the October through January period. (Refer to Appendix H pgs. 409-412.) Monthly mean water temperatures at Watt Avenue under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 267 out of the 276 months simulated for this four-month period. (Refer to Appendix H pgs. 421-424.) In addition, monthly mean water temperatures at the mouth of the American River under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 271 out of the 276 months simulated. (Refer to Appendix H pgs. 433-436.) In summary, there would be minimal differences in water temperatures between the Flexible Purchase Alternative and the Baseline Condition during the fall/winter juvenile steelhead rearing months of October through January.

Summary of Impacts on Fall-run Chinook Salmon and Steelhead in the Lower American River

In summary, potential changes in flow in the lower American River under the Flexible Purchase Alternative during the September through March period would not be of sufficient frequency or magnitude to beneficially or adversely effect adult fall-run Chinook salmon immigration or encourage straying into the lower American River. Similarly, slight fluctuations in flows under the Flexible Purchase Alternative during the October through February period would not be of sufficient frequency or magnitude to beneficially or adversely impact fall-run Chinook salmon spawning, egg incubation, and initial rearing in the lower American River. Changes in flow that would occur under the Flexible Purchase Alternative during the February through June period would not be of sufficient frequency or magnitude to beneficially or adversely effect juvenile fall-run Chinook salmon rearing and emigration.

Changes in water temperature in the lower American River under the Flexible Purchase Alternative during the September through March period would not be of sufficient frequency or magnitude to beneficially or adversely effect adult fall-run Chinook salmon immigration or encourage straying into the lower American River. Similarly, changes in water temperature under the Flexible Purchase Alternative during the October through February period would not be of sufficient frequency or magnitude to beneficially or adversely impact fall-run Chinook salmon spawning, egg incubation, and initial rearing. Although slight changes in water temperature would result in increases and decreases in annual early lifestage survival of fall-run Chinook salmon under the Flexible Purchase Alternative, these changes would not be of sufficient frequency or magnitude to beneficially or adversely impact long-term initial year class strength. Changes in water temperature that would occur under the Flexible Purchase Alternative during the February through June period would not be of sufficient frequency or magnitude to beneficially or adversely effect juvenile fall-run Chinook salmon rearing and emigration.

Potential changes in flow in the lower American River under the Flexible Purchase Alternative during the September through March period would not be of sufficient frequency or magnitude to beneficially or adversely effect adult steelhead immigration or encourage straying into the lower American River. Flow changes are not expected to occur under the Flexible Purchase Alternative during the December through April period, and thus, would not be of sufficient frequency or magnitude to beneficially or adversely impact adult steelhead spawning and egg incubation. Changes in flow that would occur in the lower American River under the Flexible Purchase Alternative during the February through June period would not be of sufficient frequency or magnitude to beneficially or adversely effect juvenile steelhead rearing and emigration. Slight changes in flow that would occur under the Flexible Purchase Alternative during the July through September and October through January periods would not be of sufficient frequency or magnitude to beneficially or adversely effect juvenile steelhead rearing.

Changes in water temperature in the lower American River under the Flexible Purchase Alternative during the September through March period would not be of sufficient frequency or magnitude to beneficially or adversely effect adult steelhead immigration or encourage straying into the lower American River. Small water temperature changes under the Flexible Purchase Alternative during the December through April period would not be of sufficient frequency or magnitude to beneficially or adversely impact adult steelhead spawning and egg incubation. Changes in water temperature that would occur in the lower American River under the Flexible Purchase Alternative during the February through June period would not be of sufficient frequency or magnitude to beneficially or adversely effect juvenile steelhead rearing and emigration. Slight changes in water temperature that would occur under the Flexible Purchase Alternative during the July through September and October through January periods would not be of sufficient frequency or magnitude to beneficially or adversely effect juvenile steelhead rearing.

Overall, the changes in flows and water temperatures in the lower American River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact fall-run Chinook salmon. Therefore, impacts on fall-run Chinook salmon in the lower American River with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, would be less than significant.

Similarly, the changes in flows and water temperatures in the lower American River under the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely impact steelhead. Therefore, impacts on steelhead in the lower American River with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, would be less than significant.

<u>Impacts on Splittail in the Lower American River</u>

Under the Flexible Purchase Alternative, long-term average flows at Watt Avenue during the February through May period would not differ from those under the

Baseline Condition, as shown in Table 9-40. In all of the 288 months simulated for this period, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition. (Refer to Appendix H pgs. 329-332.)

Long-term average usable splittail habitat at Watt Avenue would not change during any month of the February through May period under the Flexible Purchase Alternative, relative to the Baseline Condition. In fact, as shown in Table 9-46, the monthly mean quantity of submerged vegetation available under the Flexible Purchase Alternative would not change during any month simulated for the February through May period, relative to the Baseline Condition. (Refer to Appendix H pgs. 558-561.)

Table 9-46
Long-term Average Usable Splittail Habitat at Watt Avenue Under Baseline and Flexible Purchase Alternative Conditions

Month	Usable Habitat[1] (Acres)		Difference		Years Unchanged[2]		Years Increased[2]		Years Decreased[2]	
	Baseline	FP Alt	(Acres)	(%)[3]	Number	Percent	Total	From Zero	Total	To Zero
Feb	3.5	3.5	0.0	0.0	0	0%	0	0	0	0
Mar	1.7	1.7	0.0	0.0	0	0%	0	0	0	0
Apr	0.9	0.9	0.0	0.0	0	0%	0	0	0	0
May	1.2	1.2	0.0	0.0	0	0%	0	0	0	0

[1] Usable habitat is submerged vegetation over 2.4 acres.
[2] Based on 72 years modeled.
[3] Relative difference of the monthly long-term average.
FP Alt = Flexible Purchase Alternative

Long-term average water temperatures in the lower American River at Watt Avenue under the Flexible Purchase Alternative during the February through May period would not change during February and May, and would increase by 0.1°F during March and April, relative to the Baseline Condition, as shown in Table 9-42. Monthly mean water temperatures at Watt Avenue under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 274 of the 276 months simulated for the February through May period. (Refer to Appendix H pgs. 425-428.) In addition, monthly mean water temperatures would not rise above 68°F, the upper end of the reported preferred water temperature range for splittail spawning, more frequently under the Flexible Purchase Alternative than under the Baseline Condition. (Refer to Appendix H pgs. 425-428.)

At the mouth of the lower American River, long-term average water temperatures under the Flexible Purchase Alternative would not change during February, and would increase by 0.1°F during March, April, and May, relative to the Baseline Condition. (Refer to Table 9-38.) Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 275 of the 276 months included in the analysis. (Refer to Appendix H pgs. 437-440.) Further, implementation of the Flexible Purchase

Alternative would not result in an increase in the frequency in which water temperatures would exceed 68°F, relative to the Baseline Condition. (Appendix H pgs. 437-440.)

Overall, potential flow and water temperature changes during the February through May period resulting from the implementation of the Flexible Purchase Alternative would not be of sufficient frequency or magnitude to beneficially or adversely effect splittail spawning. Therefore, impacts on splittail in the lower American River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on American Shad in the Lower American River

Table 9-37 shows that long-term average flows at the mouth of the American River during May and June would not differ between the Flexible Purchase Alternative and the Baseline Condition. In addition, an analysis was performed to determine the probability that flows at the mouth of the American River during May and June under the Flexible Purchase Alternative would be above 3,000 cfs, the flow level defined by CDFG as sufficient to maintain the sport fishery for American shad. The model simulations for the Flexible Purchase Alternative indicate that there would be no difference in the frequency in which monthly mean flows at this location would be above 3,000 cfs during May and June, relative to the Baseline Condition. (See Appendix H pgs. 368 - 369.)

Further, monthly mean flows at the mouth of the American River during May and June under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 144 months included in the analysis. Therefore, potential flow-related impacts on American shad under the Flexible Purchase Alternative would be less-than-significant, relative to the Baseline Condition.

Long-term average water temperatures in the lower American River below Nimbus Dam under the Flexible Purchase Alternative would not change during May, and would increase by 0.1°F during June. (Refer to Table 9-41.) Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 135 of the 138 months simulated for the May through June period. (Refer to Appendix H pgs. 416-417.) In addition, the frequency in which monthly mean water temperatures would be within the reported preferred range for American shad spawning (60°F to 70°F) would not decrease under the Flexible Purchase Alternative, relative to the Baseline Condition.

At the mouth of the American River, long-term average water temperatures under the Flexible Purchase Alternative during May and June would increase by 0.1°F, relative to the Baseline Condition. (Refer to Table 9-38.) Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 137 of the 138 months simulated for the May through June period. (Refer to Appendix H pgs. 440-441.) Further, implementation of the Flexible Purchase Alternative would not result in a decrease in the frequency in which monthly mean water temperatures would be within the reported preferred range for American shad spawning.

Overall, negligible changes in flows and water temperatures in the lower American River under the Flexible Purchase Alternative during May and June would not be of sufficient frequency or magnitude to beneficially or adversely impact American shad attraction and spawning. Therefore, impacts on American shad in the lower American River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on Striped Bass in the Lower American River

Long-term average flows at the mouth of the American River during May and June would not differ between the Flexible Purchase Alternative and the Baseline Condition, as shown in Table 9-37. In addition, an analysis was performed to determine the probability that flows at the mouth of the American River under the Flexible Purchase Alternative during May and June would be above 1,500 cfs, the flow level defined by CDFG as sufficient to maintain the sport fishery for striped bass. The model simulations for the Flexible Purchase Alternative indicate that there would be no difference in the frequency in which monthly mean flows at the mouth of the American River would be above 1,500 cfs during May and June relative to the Baseline Condition. Furthermore, monthly mean flows during May and June under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 144 months included in the analysis. (Refer to Appendix H pgs. 368 - 369.) Therefore, potential changes in flows under the Flexible Purchase Alternative would not be of sufficient magnitude or frequency to result in significant impacts on striped bass spawning.

Long-term average water temperatures in the lower American River below Nimbus Dam under the Flexible Purchase Alternative would not change during May, and would increase by 0.1°F during June. (Refer to Table 9-41.) Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 135 of the 138 months simulated for the May through June period. (Refer to Appendix H pgs. 416-417.) In addition, the frequency in which monthly mean water temperatures would be within the reported preferred range for striped bass spawning (59°F to 68°F) would not decrease under the Flexible Purchase Alternative, relative to the Baseline Condition.

At the mouth of the American River, long-term average water temperatures under the Flexible Purchase Alternative during May and June would increase by 0.1°F, relative to the Baseline Condition. (Refer to Table 9-38.) Monthly mean water temperatures at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in 137 of the 138 months simulated for the May through June period. (Refer to Appendix H pgs. 440-441.) Further, implementation of the Flexible Purchase Alternative would not result in a decrease in the frequency in which monthly mean water temperatures would be within the reported preferred range for striped bass spawning.

Overall, changes in flows and water temperatures in the lower American River would not be of sufficient frequency or magnitude to beneficially or adversely impact striped bass spawning and initial rearing. Therefore, impacts on striped bass in the lower American River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

9.2.5.1.5 San Joaquin River Area of Analysis

The Merced River

Various EWA acquisitions could potentially affect the hydrology of the Merced River and its associated reservoirs. EWA acquisition of MID water via groundwater substitution would alter Merced River flows. EWA acquisition of MID water via groundwater substitution would alter summer surface water elevations at Lake McClure.

Potential impacts on the fisheries resources in the Merced River Basin were analyzed by evaluating reservoir conditions at Lake McClure and instream flow conditions below Crocker-Huffman Dam and at the mouth of the Merced River. Crocker-Huffman Dam is the first in a series of dams that prevents anadromous and riverine fish from accessing the upper reaches of the Merced River. There are no listed fish species present above the Crocker-Huffman Dam. Flows at the mouth of the Merced River were assessed for the frequency and magnitude of changes that could affect fall-run Chinook salmon migration or habitat availability for striped bass. Following a discussion of potential impacts on reservoir fish species of Lake McClure, flow-related impacts on riverine fish species are discussed separately by species and lifestage, including fall-run Chinook salmon and striped bass.

Impacts on Lake McClure Warmwater Fisheries

Table 9-47 provides monthly median storage, water surface elevation, and elevation changes for Lake McClure. Hydrologic conditions under the Flexible Purchase Alternative would result in increases of up to 3 feet msl in the median water surface elevation of Lake McClure during the warmwater fish spawning and initial rearing period of April through November. Changes in water surface elevation of Lake McClure would result in corresponding changes in the availability of littoral habitat containing submerged vegetation. Such shallow, nearshore waters containing physical structure are important to producing and maintaining strong year-classes of warmwater fishes.

In addition, the Flexible Purchase Alternative could alter the rates by which water surface elevation in Lake McClure would change, relative to the Baseline Condition. Reductions in median elevation between months (the magnitude of monthly drawdown) at Lake McClure are not expected to occur under the Flexible Purchase Alternative during the March through June warmwater fish spawning period. (Refer to Table 9-47.) Thus, it is not anticipated that reductions in water surface elevation of greater than 9 ft per month would occur under the Flexible Purchase Alternative.

Table 9-47
McClure Reservoir Monthly Median Storage, Elevation, and Elevation Change Under Baseline and EWA Conditions

	Storage				Elevation			Elevation Change		
Month	Baseline (TAF)	EWA (TAF)	Diff (TAF)	Diff (%)	Baseline (ft msl)	EWA (ft msl)	Diff (ft msl)	Baseline (ft msl)	EWA (ft msl)	Diff (ft msl)
Oct	598	611	13	2	778	779	2	-2	-3	-1
Nov	590	590	0	0	777	777	0	-1	-3	-2
Dec	581	581	0	0	776	776	0	-1	-1	0
Jan	584	584	0	0	776	776	0	0	0	0
Feb	627	627	0	0	781	781	0	5	5	0
Mar	656	656	0	0	784	784	0	3	3	0
Apr	683	687	3	0	787	787	0	2	3	0
May	774	781	8	1	793	794	0	6	7	0
Jun	865	877	13	1	798	799	1	5	5	0
Jul	774	792	18	2	793	794	1	-5	-4	0
Aug	682	703	22	3	787	788	2	-7	-6	1
Sep	615	640	25	4	780	783	3	-7	-6	1

Diff = Difference

In summary, the Flexible Purchase Alternative may increase the availability of littoral habitat at Lake McClure during the warmwater fish-rearing period of April through November by increasing surface elevation, and thus, may beneficially affect warmwater fish rearing. The Flexible Purchase Alternative does not alter the frequency of potential nest dewatering events in Lake McClure, and thus, would not beneficially or adversely affect long-term warmwater fish nesting success. Overall, with implementation of the Flexible Purchase Alternative, impacts on Lake McClure warmwater fisheries would be less than significant, relative to the Baseline Condition.

Impacts on Lake McClure Coldwater Fisheries

Hydrologic conditions under the Flexible Purchase Alternative would result in an increase in median storage of 3 to 25 TAF, or up to 4 percent, at Lake McClure during the April through November period, relative to the Baseline Condition, as shown in Table 9-47. Anticipated increases in reservoir storage would not be of sufficient magnitude to substantially affect the coldwater pool volume at Lake McClure, because seasonal changes in reservoir storage that would occur under the Flexible Purchase Alternative would not be large in proportion to overall storage at Lake McClure (approximately 0.3 to 2.5 percent of total volume). Therefore, increases in reservoir storage under the Flexible Purchase Alternative would not substantially alter the coldwater pool volume at Lake McClure, and thus, impacts on coldwater fisheries would be considered less than significant, relative to the Baseline Condition.

Impacts on Fall-run Chinook Salmon in the Merced River

Flow-related Impacts on Adult Fall-run Chinook Salmon Immigration (October through December)

Table 9-48 shows that long-term average flows at the mouth of the Merced River under the Flexible Purchase Alternative would increase by 23.2 percent during October, 73.3 percent during November and would not change during December, relative to the Baseline Condition. In all of the 216 months included in the analysis, monthly mean flows at the mouth of the Merced River would be essentially equivalent to or greater than those under the Baseline Condition. (Refer to Appendix H pgs. 976-978.)

Table 9-48
Long-term Average Flow at the Mouth of the Merced River Under Baseline and Flexible Purchase Alternative Conditions

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	881	1085	204	23.2
Nov	288	499	211	73.3
Dec	438	438	0	0.0
Jan	596	596	0	0.0
Feb	936	936	0	0.0
Mar	654	654	0	0.0
Apr	517	517	0	0.0
May	865	865	0	0.0
Jun	827	827	0	0.0
Jul	333	333	0	0.0
Aug	189	189	0	0.0
Sep	193	193	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Table 9-49 shows that long-term average flows below Crocker-Huffman Dam under the Flexible Purchase Alternative would increase by 25.0 percent during October, 90.9 percent during November and would not change during December, relative to the Baseline Condition. Further, in all of the 216 months simulated for the October through December period, monthly mean flows below Crocker-Huffman Dam under the Flexible Purchase Alternative would be essentially equivalent to or greater than those under the Baseline Condition. (Refer to Appendix H pgs. 964-967.) Thus, decreases in monthly mean flows at both locations would not be expected to occur during any month of the October through December period under the Flexible Purchase Alternative.

Table 9-49
Long-term Average Flow in the Merced River Below Crocker-Huffman Dam Under Baseline and Flexible Purchase Alternative Conditions

Month	Monthly Mean Flow[1] (cfs)		Difference	
	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	812	1015	203	25.0
Nov	231	441	210	90.9
Dec	353	353	0	0.0
Jan	493	493	0	0.0
Feb	784	784	0	0.0
Mar	500	500	0	0.0
Apr	501	501	0	0.0
May	894	894	0	0.0
Jun	881	881	0	0.0
Jul	329	329	0	0.0
Aug	159	159	0	0.0
Sep	178	178	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Flow-related Impacts on Adult Fall-run Chinook Salmon Spawning, and Egg Incubation, and Initial Rearing (October through December)

Table 9-49 shows that long-term average flows under the Flexible Purchase Alternative below Crocker-Huffman Dam would increase by 25 percent during October and by approximately 91 percent during November, and would not change during December, relative to the Baseline Condition. In all of the 216 months simulated for the October through December period, monthly mean flows under the Flexible Purchase Alternative below Crocker-Huffman Dam would be essentially equivalent to or greater than those under the Baseline Condition. (Refer to Appendix H pgs. 964-966.)

Increases in flows and presumed increases in spawning habitat would occur under the Flexible Purchase Alternative during October and November, relative to the Baseline Condition. Under the Baseline Condition, long-term average flows would increase from November to December, whereas under the Flexible Purchase Alternative, long-term average flows would decrease from November to December, as shown in Tables 9-48 and 9-49.

Flow-related Impacts on Juvenile Fall-run Chinook Salmon Rearing and Emigration (January through June)

Under the Flexible Purchase Alternative, long-term average flows below Crocker-Huffman Dam would not change, relative to the Baseline Condition, during the January through June period, as shown in Table 9-49. Monthly mean flows at this location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition in all of the 432 months simulated for the January through June period. (Refer to Appendix H pgs. 967-972.) At the mouth of the Merced River, long-term average flows under the Flexible Purchase Alternative would not differ from flows under the Baseline Condition during the January through June period. (Refer to Table 9-48.) In all of the 432 months simulated, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition. (Refer to Appendix H pgs. 979-984.)

Summary of Impacts on Fall-run Chinook Salmon in the Merced River

The increases in flows simulated under the Flexible Purchase Alternative during the fall-run Chinook salmon immigration period of October through December would generally be considered beneficial, yet with increases of such magnitude (73.3 percent and 90.0 percent), additional discussion is warranted. Increases in flows at the mouth of the Merced River and below Crocker-Huffman Dam would occur only during October and November. Under the Baseline Condition, monthly mean flows below Crocker Huffman Dam would be reduced by about 72 percent from October to November, when adults would have been attracted to the spawning grounds, and spawning would have generally already commenced. (Refer to Table 9-49.) The significant increases in flows with implementation of the Flexible Purchase Alternative would provide greater balance during the fall spawning period, providing higher, more stable flows. Therefore, relative to the Baseline Condition, the Flexible Purchase Alternative would be expected to result in a more beneficial flow regime for adult fall-run Chinook salmon immigration by decreasing the extent of the average monthly flow reduction that occurs between October and November. Moreover, higher flows in the fall stimulate upstream migration of fall-run Chinook salmon and conversely, low flows may inhibit or delay migration to spawning areas (USBR 2000). Additionally, fall flows provide access to the spawning gravels and may be important in attracting returning spawners to the San Joaquin River system. Causes of decline for Chinook salmon have been attributed to isolation from historical spawning areas, loss of habitat, and impaired conditions for smolt emigration, including decreasing flows and increasing water temperatures (Reclamation and SJRGA 1999). Higher flows during the fall would potentially alleviate some of these concerns. It has been stated that increases of flows greater than 10 percent would be considered beneficial (Reclamation and SJRGA 1999). Although increased flows and increased spawning habitat would be available during November under the Flexible Purchase Alternative, relative to the Baseline Condition, it should be pointed out that flows increase from November to December under the Baseline Condition and decrease from November to December under the Flexible Purchase Alternative. This change in flow pattern may raise the potential for redd dewatering. However, the more beneficial flow regime resulting in higher and more stable flows, increased spawning habitat, facilitation of upstream migration, and other beneficial effects associated with higher overall flows under the Flexible Purchase Alternative, would make the potential for redd dewatering comparatively minor. Therefore, potential flow-related impacts on adult fall-run Chinook salmon immigration with implementation of the Flexible Purchase Alternative are considered potentially beneficial.

The decrease in flows from November to December during the fall-run Chinook salmon spawning and egg incubation period under the Flexible Purchase Alternative could result in an increased likelihood of potential redd dewatering events. However, implementation of the Flexible Purchase Alternative would result in a more beneficial flow regime, relative to the Baseline Condition, including higher, more stable flows, increased availability of spawning habitat, the potential facilitation of upstream migration, and other potential beneficial effects associated with higher overall flows. Thus, flow changes that would occur with implementation of the Flexible Purchase Alternative may affect, but are unlikely to adversely affect, adult fall-run Chinook salmon spawning, egg incubation, and initial rearing.

Flows during the rearing and emigration period of January through June are not expected to change, and thus, would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile Chinook salmon.

Overall, the changes in flows in the Merced River under the Flexible Purchase Alternative, relative to the Baseline Condition, may be of sufficient frequency and magnitude to beneficially impact fall-run Chinook salmon. However, the overall beneficial impact cannot be quantified at this time. Impacts on Merced River fall-run

Chinook salmon with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, are anticipated to be less than significant.

<u>Impacts on Striped Bass in the Merced River</u>

Under the Flexible Purchase Alternative, long-term average flows below Crocker-Huffman Dam during the May through June striped bass spawning and initial rearing period would not change, relative to the Baseline Condition, as shown in Table 9-49. In all of the 144 months simulated for this period, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition. (See Appendix H pgs. 971-972.) At the mouth of the Merced River, long-term average flows under the Flexible Purchase Alternative during the May through June spawning and initial rearing period would not differ, relative to flows under the Baseline Condition, as shown in Table 9-48. In all of the 144 months included in the analysis, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to flows under the Baseline Condition. (See Appendix H pgs. 983-984.) Overall, changes in flows Merced River would not be of sufficient frequency or magnitude to beneficially or adversely impact striped bass spawning and initial rearing. Therefore, impacts on striped bass in the Merced River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

The San Joaquin River

EWA acquisition of MID water via groundwater substitution would alter San Joaquin River flows.

Potential impacts on the fisheries resources in the San Joaquin River were analyzed by evaluating instream flow conditions at Vernalis and at the confluence with the Merced River. Flow-related impacts are discussed separately by species and lifestage. Organizationally, potential flow-related impacts for most life stages of fall-run Chinook salmon and steelhead are discussed together. When combined, the time periods specified take into account the entire life stage of both fall-run Chinook salmon and steelhead. Therefore, some periods may be extended over those detailed in the methodology section. Potential flow related impacts are discussed individually for splittail, delta smelt, American shad, and striped bass.

<u>Impacts on Fall-run Chinook Salmon and Steelhead in the San Joaquin River</u>

Flow-related Impacts on Fall-run Chinook Salmon and Steelhead Adult Immigration (October through January)

The methodology states that adult fall-run Chinook salmon immigration occurs during October through December and adult steelhead immigration occurs from December through February. However, the analysis below considers the entire immigration period for both species. Long-term average flows in the San Joaquin

River below the confluence of the Merced River under the Flexible Purchase Alternative would increase by 14.6 percent and 28.8 percent in October and November, respectively, and would not change from December through January, as shown in Table 9-50. Throughout the October through January period, monthly mean flows under the Flexible Purchase Alternative in the San Joaquin River below the confluence of the Merced River would be essentially equivalent to those under the Baseline Condition in all of the 288 months included in the analysis, monthly mean flows at this location would be essentially equivalent to those under the Baseline Condition. (See Appendix H pgs. 988-991.)

Table 9-50
Long-term Average Flow in the San Joaquin River Below the Merced River Confluence Under Baseline and Flexible Purchase Alternative Conditions

	Monthly Mean Flow[1] (cfs)		Difference	
Month	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	1391	1594	203	14.6
Nov	729	939	210	28.8
Dec	1138	1138	0	0.0
Jan	1648	1648	0	0.0
Feb	2381	2381	0	0.0
Mar	2066	2066	0	0.0
Apr	1739	1739	0	0.0
May	2236	2236	0	0.0
Jun	1997	1997	0	0.0
Jul	830	830	0	0.0
Aug	575	575	0	0.0
Sep	774	774	0	0.0

[1] Based on 72 years modeled.
Relative difference of the monthly long-term average.

Table 9-51 shows that long-term average flows under the Flexible Purchase Alternative in the San Joaquin River at Vernalis would increase by 6.7 percent and 10.6 percent in October and November, respectively, and would not change from December through January, relative to the Baseline Condition. Further, in all of the 288 months simulated for the October through January period, monthly mean flows at his location under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition. (See Appendix H pgs. 73-76.)

Table 9-51
Long-term Average Delta Inflow from the San Joaquin River at Vernalis Under Baseline and Flexible Purchase Alternative Conditions

	Monthly Mean Flow[1] (cfs)		Difference	
Month	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]
Oct	3,016	3,219	203	6.7
Nov	1,980	2,190	210	10.6
Dec	3,038	3,038	0	0.0
Jan	4,505	4,505	0	0.0
Feb	6,392	6,392	0	0.0
Mar	6,361	6,361	0	0.0
Apr	6,127	6,127	0	0.0
May	5,482	5,482	0	0.0
Jun	4,219	4,219	0	0.0

Table 9-51
Long-term Average Delta Inflow from the San Joaquin River at Vernalis Under Baseline and Flexible Purchase Alternative Conditions

	Monthly Mean Flow[1] (cfs)		Difference	
Month	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]
Jul	2,314	2,314	0	0.0
Aug	1,696	1,696	0	0.0
Sep	1,909	1,909	0	0.0

[1] Based on 72 years modeled.
[2] Relative difference of the monthly long-term average.

Flow-related Impacts on Adult Fall-run Chinook Salmon and Steelhead Spawning and Egg Incubation (October through January)

As described in the above discussion of adult fall-run Chinook salmon and steelhead immigration, flows under the Flexible Purchase Alternative in the San Joaquin River below the confluence of the Merced River and at Vernalis would increase during October and November, and would not change from December through January, relative to the Baseline Condition.

Flow-related Impacts on Juvenile Fall-run Chinook Salmon Rearing and Emigration (January through June)

Under the Flexible Purchase Alternative, long-term average flows in the San Joaquin River below the confluence of the Merced River would not differ from those under the Baseline Condition during the January through June period. (See Table 9-50.) In all of the 432 months simulated for the January through June period, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition. (Refer to Appendix H pgs. 991-996.) Flow exceedance curves for the January through June period are shown in Figures 9-54 through 9-56. The basis for development of these exceedance curves was the 1922-1993 period of record. The figures demonstrate that flows under the Flexible Purchase Alternative would be identical to those under the Baseline Condition in each month of the January through June period.

Long-term average flows in the San Joaquin River at Vernalis under the Flexible Purchase Alternative would be identical to those under the Baseline Condition for each month of the January through June period, as shown in Table 9-51. Monthly mean flows at Vernalis under the Flexible Purchase Alternative would be essentially equivalent to those under the Baseline Condition for all of the 432 months included in the analysis. (Refer to Appendix H pgs. 76-81.) Thus, implementation of the Flexible Purchase Alternative would not be expected to change flows, relative to the Baseline Condition, during any month of the January through June period.

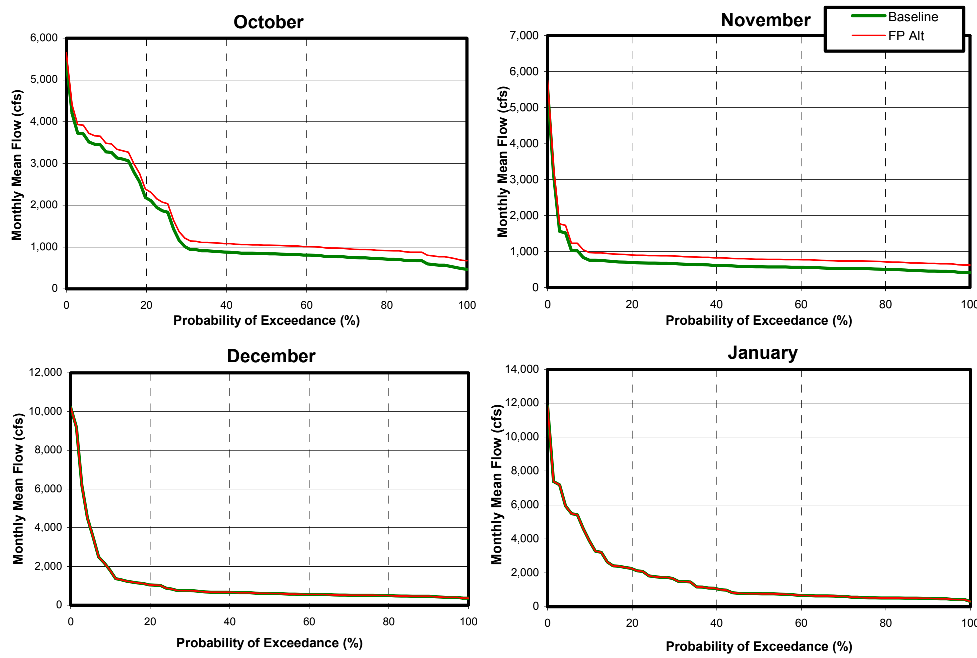

Figure 9-54
San Joaquin Flow Below Merced River
Under Baseline and Flexible Purchase Alternative Conditions

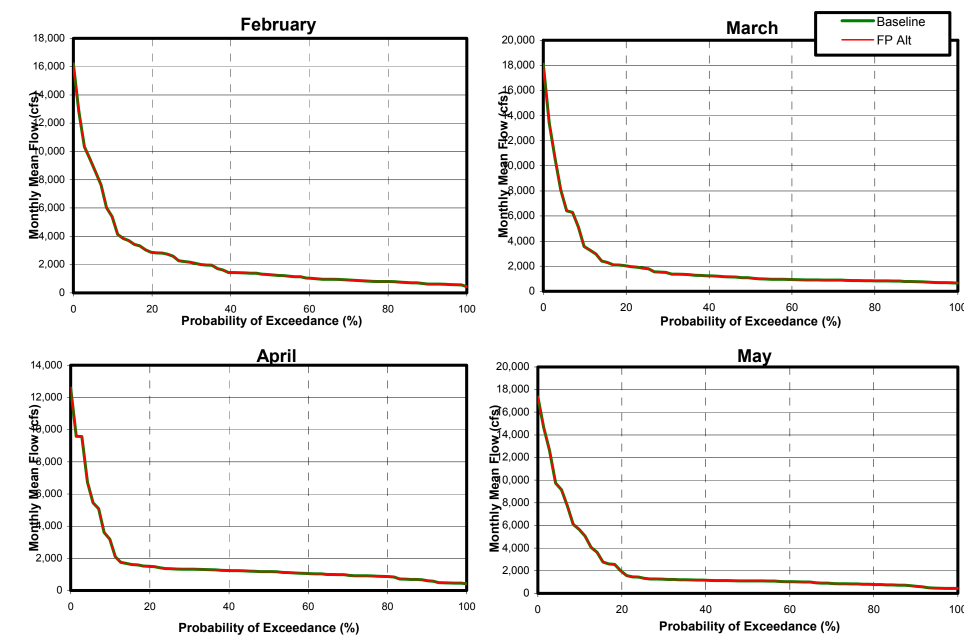

Figure 9-55
San Joaquin Flow Below Merced River
Under Baseline and Flexible Purchase Alternative Conditions

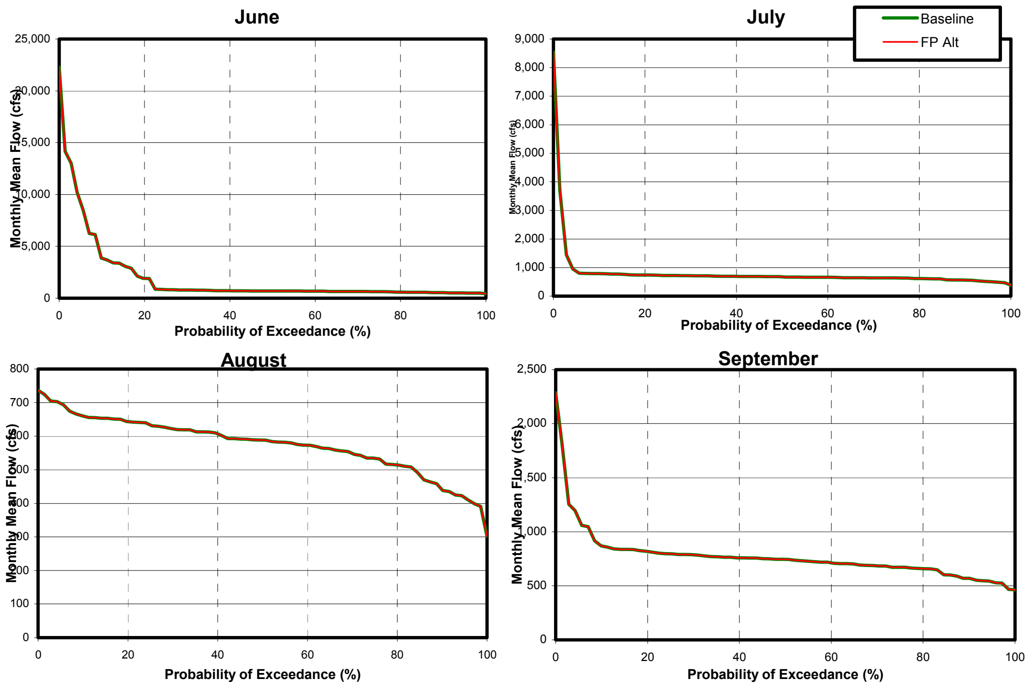

Figure 9-56
San Joaquin Flow Below Merced River
Under Baseline and Flexible Purchase Alternative Conditions

Flow-Related Impacts on Over-summer Juvenile Steelhead Rearing (July through September)

Under the Flexible Purchase Alternative, long-term average flows in the San Joaquin River below the confluence of the Merced River and at Vernalis would not decrease for a given month of the July through September period, relative to the Baseline Condition. (Refer to Table 9-50 and Table 9-51.) Further, in all of the 216 months simulated for the juvenile steelhead over-summer rearing period, monthly mean flows under the Flexible Purchase Alternative at both locations would be essentially equivalent to flows under the Baseline Condition. (Refer to Appendix H pgs. 997-999 and 82-84.) Overall, flows under the Flexible Purchase Alternative during the July through September period would not be expected to change, relative to the Baseline Condition.

Flow-related Impacts on Juvenile Steelhead Rearing (October Through December)

Under the Flexible Purchase Alternative, long-term average flows in the San Joaquin River below the confluence of the Merced River would increase by 14.6 percent in October, 28.8 percent in November, and not change in December, relative to the Baseline Condition. (Refer to Table 9-50.) Under the Flexible Purchase Alternative, long-term average flows in the San Joaquin River at Vernalis would increase 6.7 percent in October, 10.6 percent in November, and not change in December, relative to the Baseline Condition. (Refer to Table 9-51.) Further, in all of the 216 months simulated for the October through December juvenile steelhead rearing period, monthly mean flows under the Flexible Purchase Alternative at both locations would be essentially equivalent to or greater than flows under the Baseline Condition. (Refer to Appendix H pgs. 988-990 and 73-75.)

Flow-related Impacts on Juvenile Steelhead Emigration (November through May)

Juvenile steelhead emigration occurs from November through May (SJRGA 1999). As can be concluded from the discussion of potential flow-related impacts on adult fall-run Chinook salmon and steelhead immigration and juvenile fall-run Chinook salmon rearing and emigration, potential changes in flows at the confluence of the Merced River and at Vernalis under the Flexible Purchase Alternative during November through June would not be expected to adversely affect adult immigration or juvenile fall-run Chinook salmon rearing. As shown in Tables 9-50 and 9-51, there would be a 28.8 percent increase in flows in the San Joaquin River below the Merced River confluence, and a 10.6 percent increase of flows at Vernalis during November. Flows would not change at either location from December through May.

Summary of Impacts on Fall-run Chinook Salmon and Steelhead in the San Joaquin River

Under the Baseline Condition, mean monthly flows at the confluence of the Merced River would decrease by about 48 percent from October to November, when adult Chinook salmon would have been attracted to spawning grounds, and spawning would have generally already commenced. (Refer to Table 9-50.) The significant increases in flows under the Flexible Purchase Alternative would provide greater balance during the fall spawning period, providing higher, more stable flows. Therefore, relative to the Baseline Condition, the Flexible Purchase Alternative would be expected to result in a more beneficial flow regime for adult fall-run Chinook salmon immigration by decreasing the extent of the average monthly flow reduction between October and November. Moreover, higher flows in the fall stimulate upstream migration of fall-run Chinook salmon and conversely, low flows may inhibit or delay migration to spawning areas (USBR 2000). Additionally, fall flows provide access to the spawning gravels and may be important in attracting returning spawners to the San Joaquin River system. Causes of decline for Chinook salmon have been attributed to isolation from historical spawning areas, loss of habitat, and impaired conditions for smolt emigration, including decreasing flows and increasing water temperatures (Reclamation and SJRGA 1999). Higher flows during the fall would potentially alleviate some of these concerns and flow increases greater than 10 percent are considered beneficial (Reclamation and SJRGA 1999). Therefore, potential flow-related impacts on adult fall-run Chinook salmon immigration in the San Joaquin River under the Flexible Purchase Alternative are considered potentially beneficial.

As described above in the analysis of potential flow-related impacts on adult fall-run Chinook salmon and steelhead immigration, increases in flows and presumed increases in spawning habitat would occur under the Flexible Purchase Alternative during October and November, although the decrease in flows from November to December could result in an increased likelihood of potential redd dewatering events, because potentially more fish would have spawned. However, implementation of the

Flexible Purchase Alternative would result in a more beneficial flow regime, relative to the Baseline Condition, providing higher, more stable flows, increased availability of spawning habitat, the potential facilitation of upstream migration, and other potential beneficial effects associated with higher overall flows. Thus, flow changes that would occur under the Flexible Purchase Alternative may affect, but are unlikely to adversely affect, adult fall-run Chinook salmon and steelhead spawning and egg incubation.

Flows during the rearing and emigration period of January through June are not expected to change, and thus, would not be of sufficient frequency or magnitude to beneficially or adversely affect juvenile Chinook salmon or steelhead.

Flows are not expected to change during the juvenile steelhead over-summer-rearing period of July through September or during the juvenile steelhead emigration period of November through May, and thus, would not beneficially or adversely impact juvenile steelhead over-summer rearing or emigration.

The substantial increase in flow under the Flexible Purchase Alternative during the October through December juvenile steelhead rearing period could potentially benefit juvenile steelhead by increasing the amount of rearing habitat. An increase in flow would likely be beneficial only if rearing habitat during this time period were limiting in some manner. However, since data is not available supporting this clause, it is concluded that the increase in flows during the October through December juvenile steelhead rearing period would not beneficially or adversely affect juvenile rearing.

Overall, the changes in flows in the San Joaquin River under the Flexible Purchase Alternative, relative to the baseline, may be of sufficient frequency and magnitude to beneficially impact fall-run Chinook salmon and steelhead. However, the overall beneficial impact cannot be quantified at this time. Thus, impacts on San Joaquin River fall-run Chinook salmon and steelhead with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, would be less than significant.

<u>Impacts on Splittail in the San Joaquin River</u>

Under the Flexible Purchase Alternative, long-term average flows in the San Joaquin River below the confluence of the Merced River during the February through May spawning period would not differ from flows under the Baseline Condition, as shown in Table 9-50. In all of the 360 months simulated for this period, monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to flows under the Baseline Condition. (See Appendix H pgs. 992-995.) Similarly, at Vernalis, long-term average flows under the Flexible Purchase Alternative during the February through May spawning period would be identical to flows under the Baseline Condition, as shown in Table 9-58. Monthly mean flows under the Flexible Purchase Alternative at Vernalis would be essentially equivalent to those under the Baseline

Condition in all of the 360 months simulated for the February through May period. (See Appendix H pgs. 77-80.)

Overall, changes in flows in the San Joaquin River are not expected during the February through May spawning period, and thus, would not be of sufficient frequency or magnitude to beneficially or adversely impact splittail spawning. Therefore, impacts on splittail in the San Joaquin River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on American Shad in the San Joaquin River

Under the Flexible Purchase Alternative, long-term average flows in the San Joaquin River below the confluence of the Merced River during the May through June spawning period would be identical to flows under the Baseline Condition. (Refer to Table 9-50.) In fact, in all of the 144 months included in the analysis, monthly mean flows would be essentially equivalent to those under the Baseline Condition. (Refer to Appendix H pgs. 995-996.) Under the Flexible Purchase Alternative, the long-term average flow at Vernalis during the May through June spawning period would not differ compared to flows under the Baseline Condition, as shown in Table 9-51. In all 144 months simulated for this period, flows would be essentially equivalent to flows under the Baseline Condition. (Refer to Appendix H pgs. 80-81.)

Overall, changes in flows in the San Joaquin River are not expected during the May and June spawning period, and thus, would not be of sufficient frequency or magnitude to beneficially or adversely impact American shad spawning. Therefore, impacts on American shad in the San Joaquin River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on Striped Bass in the San Joaquin River

Under the Flexible Purchase Alternative, the long-term average flow at the confluence of the Merced River during the May through June rearing period would not differ compared to flows under the Baseline Condition, as shown in Table 9-50. In all 144 months simulated for this two-month period, flows would be essentially equivalent to flows under the Baseline Condition. (Refer to Appendix H pgs. 995-996.) Under the Flexible Purchase Alternative, the long-term average flow at Vernalis during the May through June period would not differ compared to flows under the Baseline Condition, as shown in Table 9-51. In all 144 months simulated for this period, flows would be essentially equivalent to flows under the Baseline Condition. (Refer to Appendix H pgs. 80-81.)

Overall, changes in flows in the San Joaquin River are not expected during the May and June spawning and initial rearing period, and thus, would not be of sufficient frequency or magnitude to beneficially or adversely impact striped bass spawning and initial rearing. Therefore, impacts on striped bass in the San Joaquin River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

Impacts on Delta Smelt in the San Joaquin River

Delta smelt are found in the San Joaquin River downstream of Vernalis. Long-term average flows at Vernalis would not differ during the January through June spawning period under the Flexible Purchase Alternative compared to the Baseline Condition, as shown in Table 9-50. Monthly mean flows at Vernalis during January through June under the Flexible Purchase Alternative would be essentially equivalent to the Baseline Condition for all 432 months included in the analysis. (Refer to Appendix H pgs. 76-81.)

Overall, changes in flows in the San Joaquin River are not expected during the January through June spawning period, and thus, would not be of sufficient frequency or magnitude to beneficially or adversely impact delta smelt spawning and initial rearing. Therefore, impacts on delta smelt in the San Joaquin River with implementation of the Flexible Purchase Alternative would be less than significant, relative to the Baseline Condition.

9.2.5.2 Sacramento-San Joaquin Delta Region

Delta outflow, X_2 location, E/I ratio, and frequency and magnitude of reverse flows (QWEST) have been identified as indicators of fishery habitat quality and availability within the Delta. Results of hydrologic modeling over a 15-year period of record were used to assess the potential effects of EWA operations on habitat conditions within the Delta supporting fish and macroinvertebrates. Comparative analyses of monthly hydrologic modeling results between the Baseline Condition and EWA operations were used to assess changes in potential habitat conditions based on: 1) Delta outflow; 2) X_2 location; 3) E/I ratio; and 4) the frequency and magnitude of reverse flow (QWEST).

Although habitat conditions within the Delta are important to fish and macroinvertebrates year-round, many of the species spawn and utilize the estuary as larval and juvenile rearing habitat and/or as a migratory corridor during the late winter and early spring. As a result, analysis of hydrologic modeling results as indicators of habitat conditions focused primarily on the seasonal period from February through June based on the life-cycle of many of the species inhabiting the system. Analyses also were conducted to identify and evaluate potential impacts on habitat conditions during all months.

In addition to the analysis of habitat conditions, results of hydrologic modeling were used to compare salvage at the SWP and CVP facilities for Chinook salmon, steelhead, striped bass, splittail, and delta smelt under the Baseline Condition and with EWA operation. Salvage estimates for delta smelt, Chinook salmon, steelhead, splittail, and striped bass were developed based upon historical salvage records, which exhibit variation due to interannual variability in the abundance and distribution of each species. Salvage modeling, described in Section 9.2.1.3, Estuarine Fish Species in the Delta, provides an indication of the relative effect of CVP and SWP pumping operations under the Flexible Purchase Alternative and Baseline Condition.

As part of the EWA Program described in Chapter 2, export pumping would be curtailed in July if the density data shows that fish species of concern are present at the SWP and CVP pumping facilities. The occurrence and density of fish species of concern would be determined from routine salvage monitoring. This practice would be effective in preventing potential salvage-related adverse effects at the CVP and SWP pumping facilities resulting from implementation of the Flexible Purchase Alternative. (Refer to Attachment 1, Modeling Description for additional discussion.)

An analysis of potential impacts related to implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario is presented first (Section 9.2.5.2.1), followed by an analysis of potential impacts related to implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario (Section 9.2.5.2.2).

9.2.5.2.1. Maximum Water Purchase Scenario

Delta Outflow

Delta outflow provides an indicator of freshwater flow passing through the Delta and habitat conditions further downstream within San Pablo Bay and Central San Francisco Bay. Delta outflow affects salinity gradients within these downstream bays and the geographic distribution and abundance of various fish and macroinvertebrates (Baxter et al. 1999).

Reductions in long-term average Delta outflow under the Maximum Water Purchase Scenario would not occur with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, as shown in Table 9-52. Delta outflow during the period of February through June is believed to be of greatest concern for potential effects on spawning and rearing habitat and downstream transport flows for delta smelt, splittail, salmonids, striped bass, and other aquatic species in the Delta. Long-term average Delta outflow would increase by approximately 1.6 to 7.7 percent (ranging from 53.5 to 97.3 TAF per month) during the February through June period. Monthly mean flows under the Flexible Purchase Alternative would be essentially equivalent to or greater than flows under the Baseline Condition in all months included in the simulation. (Refer to Appendix H pgs. A1-A12.) Detectable decreases in Delta outflow would not occur with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, relative to the Baseline Condition, in any of the 75 months simulated for the February through June period. Therefore, the changes in Delta outflow resulting from implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would result in beneficial impacts on fisheries resources in the Delta.

Table 9-52 Long-term Average Delta Outflow Under Baseline Condition and Flexible Purchase Alternative (Maximum Water Purchase Scenario) Conditions					
	Monthly Mean Flow[1] (cfs)		**Difference**		
Month	**Baseline**	**Flexible Purchase Alternative**	**(cfs)**	**(%)[2]**	**TAF[2]**
Oct	7,494	7,494	0	0	0
Nov	14,729	14,729	0	0	0
Dec	29,135	29,762	627	2.2	37.3
Jan	35,403	36,000	597	1.7	35.5
Feb	57,924	58,824	900	1.6	53.5
Mar	53,136	54,665	1,529	2.9	90.9
Apr	29,039	30,674	1,635	5.6	97.3
May	17,995	19,372	1,377	7.7	81.9
Jun	13,767	14,792	1,025	7.4	60.9
Jul	7,915	8,354	439	5.6	26.1
Aug	4,192	4,492	300	7.2	17.9
Sep	5,574	5,884	310	5.6	18.5

[1] Based on 1979-1993 period of record.
[2] Relative difference of the monthly long-term average.

X_2 Location

The location of the 2 ppt salinity near-bottom isohaline (X_2 location) has been identified as an indicator of estuarine habitat conditions within the Bay-Delta system. The location of X_2 within Suisun Bay during the February through June period is thought to be directly and/or indirectly related to the reproductive success and survival of the early lifestages for a number of estuarine species. Results of statistical regression analyses suggest that abundance of several estuarine species is greater during the spring when the X_2 location is within the western portion of Suisun Bay, with lower abundance correlated with those years when the X_2 location is farther to the east near the confluence between the Sacramento and San Joaquin rivers.

Under implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, the long-term average position of X_2 would not shift upstream during any month, as shown in Table 9-53. In addition, the monthly mean position of X_2 would move downstream or would not shift, relative to the Baseline Condition, in all of the 75 months simulated with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario for this period. (Refer to Appendix H pgs. A13-A24.) Therefore, changes in the location of X_2 resulting from implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would result in beneficial impacts on fisheries resources in the Delta.

Table 9-53 Long-term Average Delta X_2 Position Under Baseline and Flexible Purchase Alternative (Maximum Water Purchase Scenario) Conditions			
Month	**Monthly Mean Position[1] (km)**		
	Baseline	**Flexible Purchase Alternative**	**Difference**
Oct	85.3	84.5	-0.8
Nov	83.6	83.4	-0.2
Dec	80.3	80.2	-0.1
Jan	76.9	76.6	-0.3

Table 9-53
Long-term Average Delta X_2 Position Under Baseline and Flexible Purchase Alternative (Maximum Water Purchase Scenario) Conditions

Month	Monthly Mean Position[1] (km)		
	Baseline	**Flexible Purchase Alternative**	**Difference**
Feb	71.7	71.3	-0.4
Mar	66.4	66.0	-0.4
Apr	64.5	63.8	-0.7
May	67.8	67.0	-0.8
Jun	72.0	70.9	-1.1
Jul	75.9	74.7	-1.2
Aug	79.5	78.6	-0.9
Sep	84.5	83.6	-0.9

[1] Kilometers from the Golden Gate Bridge.

Export/Inflow Ratio

Exports from the SWP and CVP result in direct effects, including salvage and entrainment losses, for many fish and macroinvertebrates. Export operations also are thought to indirectly affect survival; however, indirect effects have been difficult to quantify. The ratio between exports and Delta inflow (E/I ratio) has been identified as an indicator of the vulnerability of fish and macroinvertebrates to direct and indirect effects resulting from SWP and CVP operations. The E/I ratio limits are identified in the 1995 Water Quality Control Plan, with the greatest reductions in exports relative to inflows occurring during the biologically sensitive February through June period.

The long-term average E/I ratio with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would decrease during all months of the February through June period, relative to the Baseline Condition, as shown in Table 9-54. The long-term average E/I ratio would increase during July, August, and September with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario. This increase would occur outside of the biologically sensitive February through June period. The monthly mean E/I ratio with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would be identical to or less than (a reduced proportion of exports, relative to inflow) the E/I ratio under the Baseline Condition in all of the 75 months simulated for the February through June period. (Refer to Appendix H pgs. A49-A60.) Such changes are not likely to adversely affect covered Delta fish species.

The model simulations conducted for the Flexible Purchase Alternative included conformance with export requirements set forth in the SWRCB Interim Water Quality Control Plan. Thus, the Delta E/I ratios under the Flexible Purchase Alternative and Baseline Condition would not exceed the maximum export ratio as set by the SWRCB Interim Water Quality Control Plan. (Refer to Appendix H pgs. A49-A60.) However, relaxation of the E/I ratio is considered an EWA asset. If the Management Agencies determine that the risk to fish is relatively low, then pumping above the applicable limit may be undertaken, with the additional water credited to the EWA. Such actions will not be taken if there is the potential to affect State or Federally protected species, and will only be taken under the unanimous direction of the Management Agencies. Therefore, the E/I ratios resulting from implementation of the Flexible Purchase

Alternative under the Maximum Water Purchase Scenario are not likely to adversely affect delta smelt, splittail, steelhead, fall-, late-fall-, winter-, or spring-run Chinook salmon in the Delta.

Table 9-54
Long-term Average Delta E/I Ratio Under Baseline and Flexible Purchase Alternative (Maximum Water Purchase Scenario) Conditions

Month	Monthly Mean Ratio[1] (%)		Difference	
	Baseline	Flexible Purchase Alternative	(%)	(%)[2]
Oct	49	49	0	0
Nov	39	39	0	0
Dec	37	34	-3	-8.1
Jan	36	34	-2	-5.6
Feb	23	20	-3	-13.0
Mar	21	17	-4	-19.0
Apr	18	12	-6	-33.3
May	20	13	-7	-35.0
Jun	27	22	-5	-18.5
Jul	32	36	+4	+12.5
Aug	51	55	+4	+7.8
Sep	57	60	+3	+5.3

[1] Based on 1979-1993 period of record.
[2] Relative difference of the monthly long-term average.

Reverse Flows (QWEST)

Reverse flows (also referred to as QWEST) have been identified as an indicator of the potential risk of adverse effects on planktonic fish eggs and larvae and the survival of downstream migrating juvenile Chinook salmon smolts. The potential for adverse effects associated with reverse flow is greatest during the late winter-spring period (February through June). Reverse flows occur primarily when freshwater inflow is low and export pumping is high, causing the lower San Joaquin River to change direction and flow upstream. Reversed flows are evaluated based on model simulations of the direction and magnitude of flows in the lower San Joaquin River in the vicinity of Jersey Point.

Under the Baseline Condition, reverse flows would occur in 25 months out of the 75 months simulated for the February through June period (33.3 percent of the time). Reverse flows would occur less frequently with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, in 13 of the 75 months simulated, or 17.3 percent of the time. (Refer to Appendix H pgs. A41-A45.) Table 9-55 illustrates that the frequency of reverse flows under the Flexible Purchase Alternative would be substantially reduced across all flow ranges during February through June, relative to the Baseline Condition. In most months in which reverse flows would occur under the Baseline Condition, flows would be positive or the magnitude of reverse flow substantially reduced under the Maximum Water Purchase Scenario. (Refer to Appendix H pgs. A41-A45.)

Table 9-55
Frequency[1] of Reverse Flows (QWEST) Over Varying Flow Ranges

Reverse Flow Range (cfs)	*Baseline Condition*	*Flexible Purchase Alternative (Maximum Water Purchase Scenario)*
February		
<0	6	5
<-100	4	3
<-250	0	0
<-500	0	0
<-1000	0	0
<-2000	0	0
March		
<0	6	1
<-100	3	0
<-250	0	0
<-500	0	0
<-1000	0	0
<-2000	0	0
April		
<0	2	1
<-100	0	0
<-250	0	0
<-500	0	0
<-1000	0	0
<-2000	0	0
May		
<0	5	2
<-100	0	0
<-250	0	0
<-500	0	0
<-1000	0	0
<-2000	0	0
June		
<0	6	4
<-100	3	1
<-250	1	1
<-500	0	0
<-1000	0	0
<-2000	0	0

[1] Based on the 1979-1993 period of record for each month.

Overall, implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would provide a benefit to reverse flows, relative to the Baseline Condition, by decreasing the frequency of reverse flows and reducing the magnitude when reverse flows would still occur. Overall, such changes would be considered a benefit to juvenile salmonid emigration and the transport of planktonic eggs and larvae. Therefore, implementation of the Flexible Purchase Alternative may beneficially affect the survival of planktonic fish eggs and larvae and downstream migrating juvenile Chinook salmon smolts.

Salvage at the SWP and CVP Export Facilities

Salvage estimates for delta smelt, Chinook salmon, steelhead, and splittail, were developed based upon historical salvage records, which exhibit variation due to interannual variability in the abundance and distribution of each species. Salvage modeling, described in Section 9.2.1.3, Estuarine Fish Species in the Delta, provides an indication of the relative effect of CVP and SWP pumping operations with implementation of the Flexible Purchase Alternative and under the Baseline Condition. This section provides an analysis of potential salvage-related effects with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario on delta smelt, Chinook salmon, steelhead, splittail, and striped bass.

Delta Smelt

Under the Flexible Purchase Alternative (Maximum Water Purchase Scenario), a net reduction in delta smelt salvage would occur over the 15-year period of record included in the analysis, relative to the Baseline Condition. Average annual salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario decrease by 135,887 delta smelt relative to the Baseline Condition. (Refer to Table 9-56.)

Annual and monthly changes in delta smelt salvage estimates with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, over the 15-year period of record included in the analysis under the Maximum Water Purchase scenario are provided in Table 9-56. Annual salvage estimates decrease in every year by 293 to 66,002 delta smelt, relative to the Baseline Condition, except for one year (in 1991 there is an estimated increase of 398 delta smelt), as shown in Table 9-56. Monthly mean delta smelt salvage estimates under the Flexible Purchase Alternative would not change during October and November, relative to the Baseline Condition. From December through July, implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would result in monthly mean reductions in salvage ranging from 2,358 to 61,929 delta smelt, relative to the Baseline Condition. During August and September, monthly mean salvage with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would increase by 4,763 and 1,117 delta smelt, respectively, relative to the Baseline Condition.

While annual salvage estimates exhibit a decrease in 14 of the 15 years simulated with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, there would be isolated occurrences of increases in delta smelt salvage in 34 of the 150 months simulated for the December through September period. However, such changes would not be of sufficient magnitude to result in increases in annual delta smelt salvage in 14 of the 15 years simulated.

As discussed in Chapter 2 and in Section 9.2.3, ASIP Conservation Measures, real-time operations would be implemented as needed to avoid pumping operations that would result in increased delta smelt salvage. Based on modeling output and the efficiency of real-time adjustment of operations (real-time implementation of the environmental measures outlined in Section 9.2.3, ASIP Conservation Measures) in response to abundance and distribution monitoring, implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would result in overall beneficial impacts on delta smelt salvage, relative to the Baseline Condition.

Table 9-56
Change in Delta Smelt Salvage at the SWP and CVP Pumps Under the Maximum Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979				-125	-188	-337	-1,350	-3,121	-2,440	2,463	181	15	-4,902
1980	0	0	0	-188	-348	-408	-816	-238	-9,006	915	3,314	105	-6,668
1981	0	0	-416	0	-1,128	-6,552	-1,522	-37,501	-3,836	-15,305	235	24	-66,002
1982	0	0	-63	-781	-1,257	-634	-73	-218	-36	712	414	39	-1,897
1983	0	0	-161	-862	-254	-61	-10	-8	-2,932	852	0	245	-3,191
1984	0	0	0	0	-2	-186	-50	-5,046	-1,553	761	3	9	-6,065
1985	0	0	-340	0	-30	-57	-282	-456	-7,955	63	34	50	-8,973
1986	0	0	-20	-71	-356	-241	-128	-26	-39	112	166	0	-603
1987	0	0	-22	-5	-53	-357	-3,402	-3,886	-5,925	-892	75	150	-14,319
1988	0	0	-1,337	-862	-100	0	0	-4,816	0	418	0	0	-6,697
1989	0	0	0	-44	-6	-32	-40	-366	-581	-1,884	74	31	-2,848
1990	0	0	0	-27	-80	-56	0	0	-7,656	960	2	0	-6,857
1991	0	0	0	0	0	-213	-121	-857	0	880	261	448	398
1992	0	0	0	-10	-102	-164	-20	0	0	3	0	0	-293
1993	0	0	0	-89	-59	-49	0	-5,389	-1,681	293	5	0	-6,970
Total	0	0	-2,358	-3,063	-3,964	-9,347	-7,814	-61,929	-43,642	-9,651	4,763	1,117	-135,887

Chinook Salmon
With implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, a net reduction in Chinook salmon salvage would occur over the 15-year period of record, relative to the Baseline Condition. Average annual salvage estimates under the Maximum Water Purchase Scenario would decrease by 1,123,826 Chinook salmon, relative to the Baseline Condition. (Refer to Table 9-57.)

Annual and monthly changes in Chinook salmon salvage estimates at the CVP and SWP pumps with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, relative to the Baseline Condition, are provided in Table 9-57. Annual salvage estimates decrease in every year by 2,529 to 320,526 Chinook salmon, relative to the Baseline Condition, as shown in Table 9-57. Monthly mean Chinook salmon salvage estimates under the Flexible Purchase Alternative would not change in October and November, relative to the Baseline Condition. From December through June, implementation of the Flexible Purchase Alternative would result in monthly mean decreases in salvage ranging from 7,383 to 444,219 Chinook salmon, relative to the Baseline Condition. During July, August, and September, monthly mean salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would increase by 2,742, 286, and 555 Chinook salmon, respectively, relative to the Baseline Condition.

Table 9-57
Change in Chinook Salmon Salvage at the SWP and CVP Pumps Under the Maximum Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979				-586	-197	-700	-55,499	-55,646	-1,570	1,450	75	28	-112,645
1980	0	0	-466	-238	-27	-20	-86,314	-54,922	-16,405	-567	10	519	-158,431
1981	0	0	-102	0	-156	-5,630	-24,295	-15,608	-64	0	14	0	-45,839
1982	0	0	-2,161	-1,300	-3,084	-3,354	-6,557	-71,783	-15,742	32	4	0	-103,945
1983	0	0	-15,916	-3,451	-3,350	-1,593	-6,707	-19,821	-37,634	284	0	0	-88,189
1984	0	0	0	0	-6	-1,290	-45,834	-46,789	-16,714	4	133	0	-110,496
1985	0	0	-1,625	0	-362	-829	-16,828	-48,989	-10,555	29	0	2	-79,156
1986	0	0	-399	-190	-93,319	-25,239	-57,136	-86,099	-59,386	1,244	0	0	-320,526
1987	0	0	-94	-27	-78	-4,394	-16,697	-11,139	-4,062	15	2	3	-36,471
1988	0	0	-4,804	-1,015	-913	0	-1,902	-14,700	0	248	21	2	-23,062
1989	0	0	0	-118	-9	-2,071	-770	-6,591	-148	0	6	0	-9,701
1990	0	0	-51	-298	-164	-744	0	0	-1,273	1	0	0	-2,529
1991	0	0	0	0	0	-1,355	-3,919	-7,895	0	0	0	0	-13,169
1992	0	0	0	-108	-1,814	-5,750	-2,877	0	0	0	0	0	-10,547
1993	0	0	0	-51	-67	-122	-4,429	-4,236	-238	2	21	0	-9,120
Total	0	0	-25,617	-7,383	-103,545	-53,091	-329,762	-444,219	-163,792	2,742	286	555	-1,123,826

While annual salvage estimates exhibit a decrease with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, there would be isolated occurrences of increases in SWP Chinook salmon salvage in 24 of the 150 months simulated for the December through September period. However, such changes would not be of sufficient magnitude to result in increases in annual salvage in any year simulated over the 15-year period of record included in the analysis. Thus, while there would be increases in Chinook salmon salvage with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario in individual months of the simulation, annual salvage estimates for Chinook salmon would decrease, relative to the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would result in overall beneficial impacts on Chinook salmon salvage, relative to the Baseline Condition.

Steelhead

A net reduction in steelhead salvage would occur with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, relative to the Baseline Condition, over the 15-year period of record included in the analysis. Average annual salvage estimates under the Maximum Water Purchase Scenario would be reduced by 28,928 steelhead, relative to the Baseline Condition. (Refer to Table 9-58.)

Annual and monthly changes in salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, relative to the Baseline Condition, are shown in Table 9-58. Annual salvage would decrease in every year by 293 to 4,085 steelhead, relative to the Baseline Condition, as shown in Table 9-58. Monthly mean steelhead salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would not change from August through November, relative to the Baseline Condition. From December through June, implementation of the Flexible Purchase Alternative would result in monthly mean reductions in salvage ranging from 428 to 12,182 steelhead, relative to the Baseline Condition. During July, monthly mean salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would increase by five steelhead, relative to the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would result in overall beneficial impacts on steelhead salvage, relative to the Baseline Condition.

Table 9-58
Change in Steelhead Salvage at the SWP and CVP Pumps Under the Maximum Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979				-34	-93	-260	-1,425	-775	0	0	0	0	-2,588
1980	0	0	-2	-15	-48	-7	-738	-671	-55	0	0	0	-1,536
1981	0	0	-12	0	-132	-2,397	-1,452	-92	0	0	0	0	-4,085
1982	0	0	-32	-65	-130	-90	-1,790	-1,526	-373	0	0	0	-4,005
1983	0	0	-755	-40	-16	0	0	-75	0	0	0	0	-887
1984	0	0	0	0	0	-24	-261	-8	0	0	0	0	-293
1985	0	0	-2	0	-18	-145	-353	-163	0	0	0	0	-682
1986	0	0	0	-2	-144	-71	-423	-182	0	5	0	0	-815
1987	0	0	-138	-9	-12	-2,715	-546	-81	0	0	0	0	-3,500
1988	0	0	-83	-55	-189	0	-164	-170	0	0	0	0	-661
1989	0	0	0	-2	-42	-1,464	-34	-26	0	0	0	0	-1,568
1990	0	0	0	0	-383	-846	0	0	0	0	0	0	-1,230
1991	0	0	0	0	0	-1,988	-206	-31	0	0	0	0	-2,225
1992	0	0	0	-289	-1,016	-1,247	-39	0	0	0	0	0	-2,590
1993	0	0	0	-39	-588	-928	-395	-314	0	0	0	0	-2,264
Total	0	0	-1,024	-550	-2,810	-12,182	-7,826	-4,114	-428	5	0	0	-28,928

Splittail

With implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, there would be a net reduction in splittail salvage, relative to the Baseline Condition, over the 15-year period of record included in the analysis. Average annual salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would decrease by 1,014,290 splittail, relative to the Baseline Condition. (Refer to Table 9-59.)

Annual and monthly change in splittail salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, relative to the Baseline Condition, over the 15-year period of record included in the analysis are provided in Table 9-59. Annual salvage estimates decrease in every year by 628 to 699,086 splittail, relative to the Baseline Condition, except for one year (in 1984 there is an estimated increase of 603 splittail), as shown in Table 9-59. Monthly mean splittail salvage estimates under the Flexible Purchase Alternative would not change in October and November, relative to the Baseline Condition. From December through June, implementation of the Flexible Purchase Alternative would result in monthly mean reductions in salvage ranging from 1,673 to 575,902 splittail, relative to the Baseline Condition. During July, August, and September, monthly mean salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would increase by 60,415, 34,596, and 2,996 splittail, respectively, relative to the Baseline Condition.

While annual salvage estimates exhibit a decrease in 14 of the 15 years simulated with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, there would be isolated occurrences of increases in splittail salvage in 35 of the 150 months simulated for the December through September period. However, such changes would not be of sufficient magnitude to result in increases in annual splittail salvage in 14 of the 15 years simulated.

Table 9-59
Change in Splittail Salvage at the SWP and CVP Pumps Under the Maximum Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979				-1	-38	-398	-1,479	-9,931	-10,819	2,979	778	71	-18,838
1980	0	0	-91	-1,613	-3,254	-69	-4,310	-23,974	-66,341	46	2,198	341	-97,068
1981	0	0	-20	0	-299	-1,819	-2,823	-29,018	0	0	16	0	-33,963
1982	0	0	-73	-1,241	-3,442	-1,371	-1,274	-9,822	-23,597	13,903	20,387	166	-6,365
1983	0	0	-737	-497	-3,791	-1,437	-515	-8,712	-59,762	9,261	4,804	194	-61,192
1984	0	0	0	0	-218	-1,114	-2,807	-2,315	-3,868	8,776	1,941	208	603
1985	0	0	-138	0	-371	-677	-1,662	-700	-14,563	383	78	20	-17,630
1986	0	0	0	-10	-356	-2,094	-16,567	-368,329	-339,879	22,726	3,675	1,748	-699,086
1987	0	0	-89	-74	-268	-2,357	-642	-373	-54,289	-436	96	106	-58,326
1988	0	0	-518	-2,602	-1,315	0	-259	-1,378	0	1,178	24	47	-4,824
1989	0	0	0	-32	-83	-1,351	-104	-2,308	-670	-994	455	79	-5,008
1990	0	0	-6	-132	-757	-1,192	0	0	0	1,459	0	0	-628
1991	0	0	0	0	0	-1,337	-648	-1,329	0	459	0	0	-2,855
1992	0	0	0	-35	-642	-839	-22	0	0	0	55	0	-1,482
1993	0	0	0	-1,439	-457	-448	-1,459	-2,489	-2,114	675	89	16	-7,627
Total	0	0	-1,673	-7,675	-15,292	-16,502	-34,572	-460,681	-575,902	60,415	34,596	2,996	-1,014,290

Although there would be increases in splittail salvage with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario in one year and in individual months of the simulation, annual splittail salvage estimates would decrease in 14 of the 15 years simulated, relative to the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would result in overall beneficial impacts on splittail salvage, relative to the Baseline Condition.

Striped Bass

With implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, there would be a net reduction in striped bass salvage, relative to the Baseline Condition, over the 15-year period of record included in the analysis. Average annual salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would decrease by 8,935,211 striped bass, relative to the Baseline Condition. (Refer to Table 9-60.)

Table 9-60
Change in Striped Bass Salvage at the SWP and CVP Pumps Under the Maximum Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979				-8,826	-4,485	-4,242	-17,619	-22,746	-306,443	303,742	69,339	2,757	11,477
1980	0	0	-13,204	-1,264	-1,435	-201	-4,872	-391	-340,030	-377,333	217,262	40,460	-481,008
1981	0	0	-9,691	0	-2,538	-11,056	-5,455	-573,284	-398,328	-690,377	31,842	1,834	-1,657,052
1982	0	0	-8,090	-15,566	-12,801	-3,561	-8,536	-2,940	-26,663	230,894	139,488	18,278	310,503
1983	0	0	-51,197	-9,417	-7,039	-983	-749	-2,671	-13,244	10,617	15,353	2,781	-56,549
1984	0	0	0	0	-273	-321	-3,775	-9,699	-474,933	974,583	28,344	8,591	522,516
1985	0	0	-24,799	0	-1,420	-1,473	-1,692	-11,193	-2,069,967	72,709	8,370	1,442	-2,028,023
1986	0	0	-6,065	-4,968	-37,481	-5,607	-853	-23,360	-5,474,745	2,979,732	174,696	52,965	-2,345,686
1987	0	0	-6,524	-3,749	-3,043	-6,896	-2,338	-74,155	-2,352,908	-412,880	9,673	8,122	-2,844,697
1988	0	0	-39,350	-7,649	-14,796	0	-332	-223,777	0	588,763	52,364	8,873	364,096
1989	0	0	0	-2,615	-2,983	-3,636	-84	-334,230	-1,165,724	-671,695	12,286	2,032	-2,166,650
1990	0	0	-714	-7,899	-7,600	-7,801	0	0	-341,601	228,030	54,293	14,987	-68,306
1991	0	0	0	0	0	-8,009	-1,531	-40,828	0	948,362	80,261	15,094	993,350
1992	0	0	0	-2,969	-40,625	-17,025	-183	0	0	127,063	11,835	7,915	86,011
1993	0	0	0	-18,400	-6,587	-6,747	-577	-96	-994,599	1,351,688	93,979	6,148	424,808
Total	0	0	-159,633	-83,323	-143,105	-77,559	-48,595	-1,319,370	-13,959,185	5,663,898	999,384	192,277	-8,935,211

Annual and monthly change in striped bass salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, relative to the Baseline Condition, over the 15-year period of record included in the analysis are provided in Table 9-60. Annual salvage estimates decrease in 8 of the 15 years simulated by 56,594 to 2,844,697 striped bass, relative to the Baseline Condition, and increase by 11,477 to 993, 350 striped bass in 7 of the 15 years simulated, as shown in Table 9-60. Monthly mean striped bass salvage estimates under the Flexible Purchase Alternative would not change in October and November, relative to the Baseline Condition. From December through June, implementation of the Flexible Purchase Alternative would result in monthly mean reductions in salvage ranging from 48,595 to 13,959,185 striped bass, relative to the Baseline Condition. During July, August, and September, monthly mean salvage estimates with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would increase by 5,663,898, 999,384, and 192,277 striped bass, respectively, relative to the Baseline Condition.

Salvage losses of striped bass during the spring months are primarily small juvenile fish (young-of-the-year), while salvage of striped bass during the fall is primarily comprised of larger juveniles that have survived and grown throughout the summer and fall months. As a result of natural mortality, smaller juvenile striped bass salvage during the spring would have a lower probability (on an individual basis) of surviving to become reproductive adults compared to the expected survival rate of larger juveniles salvaged during the fall. The potential for adverse effects of salvage losses on the overall striped bass population are, therefore, a combination of both the number of fish salvaged and their probability of survival to become reproductive adults.

There would be frequent occurrences of measurable increases in striped bass salvage in 41 of the 150 months simulated during December through September, resulting in increases in long-term average annual salvage in 7 of the 15 years simulated. However, with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario, there would be a net reduction in salvage of 8,935,211 striped bass, relative to the Baseline Condition. Therefore, potential salvage-related impacts on striped bass with implementation of the Flexible Purchase Alternative under the Maximum Water Purchase Scenario would be less than significant, relative to the Baseline Condition.

9.2.5.2.2 *Typical Water Purchase Scenario*

Delta Outflow

Reductions in long-term average Delta outflow under the Typical Water Purchase Scenario would not occur with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, as shown in Table 9-61. Delta outflow during the period of February through June is believed to be of greatest concern for potential effects on spawning and rearing habitat and downstream transport flows for delta smelt, splittail, salmonids, and other aquatic species in the Delta. Long-term average Delta outflow would increase by approximately 1.3 to 6.9 percent (ranging from 43.5 to 64.7 TAF per month) during the February through June period. Monthly mean flows with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would be essentially equivalent to or greater than flows under the Baseline Condition in all months included in the simulation. (Refer to Appendix H pgs. B1-B12.) Detectable decreases in Delta outflow would not occur with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, relative to the Baseline Condition, in any of the 75 months simulated for the February through June period. Therefore, changes in Delta outflow resulting from implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would result in beneficial impacts on fisheries resources in the Delta.

Table 9-61
Long-term Average Delta Outflow Under Baseline and Flexible Purchase Alternative (Typical Water Purchase Scenario) Conditions

Month	Monthly Mean Flow[1] (cfs)		Difference		
	Baseline	Flexible Purchase Alternative	(cfs)	(%)[2]	TAF[2]
Oct	7,494	7,494	0	0	0
Nov	14,729	14,729	0	0	0
Dec	29,135	29,669	534	1.8	31.8
Jan	35,403	35,805	401	1.1	23.9
Feb	57,924	58,656	732	1.3	43.5
Mar	53,136	54,123	987	1.9	58.7
Apr	29,039	30,111	1072	3.7	63.8
May	17,995	19,082	1087	6.0	64.7
Jun	13,767	14,718	950	6.9	56.5
Jul	7,915	8,280	365	4.6	21.7
Aug	4,192	4,476	284	6.8	16.9
Sep	5,574	5,867	293	5.3	17.4

[1] Based on the 1979-1993 period of record.
[2] Relative difference of the monthly long-term average.

X_2 Location

With implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, the long-term average position of X_2 would not shift upstream during any month of the February through June period, as shown in Table 9-62. In addition, the monthly mean position of X_2 would move downstream or would not shift, relative to the Baseline Condition, in all of the 75 months simulated with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario. (Refer to Appendix H pgs. B13-B24.) Therefore, changes in the location of X_2 resulting from implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would result in beneficial impacts on fisheries resources in the Delta.

Table 9-62
Long-term Average Delta X_2 Position Under Baseline and Flexible Purchase Alternative (Typical Water Purchase Scenario) Conditions

Month	Monthly Mean Position[1] (km)		
	Baseline	Flexible Purchase Alternative	Difference
Oct	85.3	84.5	-0.8
Nov	83.6	83.4	-0.2
Dec	80.3	80.3	0
Jan	76.9	76.6	-0.3
Feb	71.7	71.5	-0.2
Mar	66.4	66.1	-0.3
Apr	64.5	64.1	-0.4
May	67.8	67.3	-0.5
Jun	72.0	71.2	-0.8
Jul	75.9	74.8	-1.1
Aug	79.5	78.7	-0.8
Sep	84.5	83.7	-0.8

[1] Kilometers from the Golden Gate Bridge.

Export/Inflow Ratio

The long-term average E/I ratio with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would decrease during all months of the February through June period, relative to the Baseline Condition, as shown in Table 9-63. The long-term average E/I ratio would increase during July, August, and September with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario. This increase would occur outside of the biologically sensitive February through June period. The monthly mean E/I ratio with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would be identical to or less than (a reduced proportion of exports, relative to inflow) the E/I ratio under the Baseline Condition in all of the 75 months simulated for the February through June period. (Refer to Appendix H pgs. B49-B60.) Such changes are not likely to adversely affect covered Delta fish species.

Table 9-63
Long-term Average Delta E/I Ratio Under Baseline and Flexible Purchase Alternative (Typical Water Purchase Scenario) Conditions

Month	Monthly Mean Ratio[1] (%)		Difference	
	Baseline	Flexible Purchase Alternative	(%)	(%)[2]
Oct	49	49	0	0
Nov	39	39	0	0
Dec	37	35	-2	-5.4
Jan	36	35	-1	-2.8
Feb	23	21	-2	-8.7
Mar	21	19	-2	-9.5
Apr	18	14	-4	-22.2
May	20	14	-6	-30.0
Jun	27	22	-5	-18.5
Jul	32	36	+4	+12.5
Aug	51	55	+4	+7.8
Sep	57	60	+3	+5.3

[1] Based on the 1979-1993 period of record.
[2] Relative difference of the monthly long-term average.

The model simulations conducted for the Flexible Purchase Alternative included conformance with export requirements set forth in the SWRCB Interim Water Quality Control Plan. Thus, the Delta E/I ratios under the Flexible Purchase Alternative and Baseline Condition would not exceed the maximum export ratio as set by the SWRCB Interim Water Quality Control Plan. (Refer to Appendix H pgs. B49-B60.) However, relaxation of the E/I ratio is an EWA asset. If the Management Agencies determine that the risk to fish is relatively low, then pumping above the applicable limit may be undertaken, with the additional water credited to the EWA. Such actions will not be taken if there is the potential to affect State or Federally protected species, and will only be taken under the unanimous direction of the Management Agencies. Therefore, the E/I ratios resulting from implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario are not likely to adversely affect delta smelt, splittail, striped bass, steelhead, fall-, late-fall-, winter-, or spring-run Chinook salmon in the Delta.

Reverse Flows (QWEST)

Under the Baseline Condition, reverse flows would occur in 25 months out of the 75 months simulated for the February through June period (33.3 percent of the time). Reverse flows would occur less frequently with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, in 16 of the 75 months simulated, or 21.3 percent of the time. (Refer to Appendix H pgs. B41-B45.) Table 9-64 illustrates that the frequency of reverse flows from February through June under the Flexible Purchase Alternative would be unchanged or substantially reduced across all flow ranges, relative to the Baseline Condition. In most months in which reverse flows would occur under the Baseline Condition, flows would be positive or the magnitude of reverse flow substantially reduced under the Typical Water Purchase Scenario. (Refer to Appendix H pgs. B41-B45.)

Table 9-64
Frequency[1] of Reverse Flows (QWEST) Over Varying Flow Ranges

Reverse Flow Range (cfs)	*Baseline Condition*	*Flexible Purchase Alternative (Typical Water Purchase Scenario)*
February		
<0	6	6
<-100	4	3
<-250	0	0
<-500	0	0
<-1000	0	0
<-2000	0	0
March		
<0	6	3
<-100	3	1
<-250	0	0
<-500	0	0
<-1000	0	0
<-2000	0	0
April		
<0	2	1
<-100	0	0
<-250	0	0
<-500	0	0
<-1000	0	0
<-2000	0	0
May		
<0	5	2
<-100	0	0
<-250	0	0
<-500	0	0
<-1000	0	0
<-2000	0	0
June		
<0	6	4
<-100	3	1
<-250	1	1
<-500	0	0
<-1000	0	0
<-2000	0	0

[1] Based on the 1979-1993 period of record for each month.

Overall, implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would provide a benefit to reverse flows, relative to the Baseline Condition, by decreasing the frequency of reverse flows and reducing the magnitude when reverse flows would still occur. Overall, such changes would be considered a benefit to juvenile salmonid emigration and the transport of planktonic eggs and larvae. Therefore, implementation of the Flexible Purchase Alternative would beneficially affect the survival of planktonic fish eggs and larvae and downstream migrating juvenile Chinook salmon smolts.

Salvage at the SWP and CVP Export Facilities

Salvage estimates for delta smelt, Chinook salmon, steelhead, and splittail, were developed based upon historical salvage records, which exhibit variation due to interannual variability in the abundance and distribution of each species. Salvage modeling, described in Section 9.2.1.3, Estuarine Fish Species in the Delta, provides an indication of the relative effect of CVP and SWP pumping operations with implementation of the Flexible Purchase Alternative and under the Baseline Condition. This section provides an analysis of potential salvage-related effects with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario on delta smelt, Chinook salmon, steelhead, splittail, and striped bass.

Delta Smelt

Under the Flexible Purchase Alternative (Typical Water Purchase Scenario), a net reduction in delta smelt salvage would occur over the 15-year period of record included in the analysis, relative to the Baseline Condition. Average annual salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario decrease by 93,690 delta smelt relative to the Baseline Condition. (Refer to Table 9-65.)

Annual and monthly changes in delta smelt salvage estimates at the CVP and SWP pumps with implementation of the Flexible Purchase Alternative, relative to the Baseline Condition, over the 15-year period of record included in the analysis under the Typical Water Purchase scenario are provided in Table 9-65. Annual salvage estimates decrease in every year by 293 to 26,355 delta smelt, relative to the Baseline Condition, as shown in Table 9-65. Monthly mean delta smelt salvage estimates under the Flexible Purchase Alternative would not change during October and November, relative to the Baseline Condition. From December through July, implementation of the Flexible Purchase Alternative would result in monthly mean reductions in salvage ranging from 1,533 to 41,354 delta smelt, relative to the Baseline Condition. During August and September, monthly mean salvage under the Flexible Purchase Alternative would increase by 4,711 and 928 delta smelt, respectively, relative to the Baseline Condition.

While annual salvage estimates exhibit a decrease with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, there would be isolated occurrences of increases in delta smelt salvage in 31 of the 150 months simulated for the December through September period. However, such changes would not be of sufficient magnitude to result in increases in annual delta smelt salvage for any of the 15 years simulated. In fact, annual delta smelt salvage would decrease, relative to the Baseline Condition in all 15 years simulated for the analysis.

As discussed in Chapter 2, Alternatives, Including the Proposed Action/Proposed Project, real-time operations would be implemented as needed to avoid pumping operations that would result in increased delta smelt salvage. Based on modeling output and the efficiency of real-time adjustment of operations (real-time implementation of environmental measures outlined in Section 9.2.3, ASIP Conservation Measures) in response to abundance and distribution monitoring, implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would result in overall beneficial impacts on delta smelt salvage, relative to the Baseline Condition.

Table 9-65
Change in Delta Smelt Salvage at the SWP and CVP Pumps Under the Typical Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979				-42	-125	-225	-442	-1,874	-2,440	2,463	181	15	-2,489
1980	0	0	0	-188	-348	-408	-498	-127	-6,754	-8,217	3,314	105	-13,121
1981	0	0	-416	0	-1,128	-1,966	-1,036	-13,130	-3,836	-5,102	235	24	-26,355
1982	0	0	-63	-781	-1,257	-634	-73	-218	-36	712	414	39	-1,897
1983	0	0	-161	-862	-254	-61	-10	-8	-2,199	852	0	245	-2,458
1984	0	0	0	0	-2	-186	-21	-2,895	-1,165	761	3	9	-3,496
1985	0	0	-170	0	-30	-29	-255	-906	-6,524	63	34	50	-7,765
1986	0	0	-20	-71	-356	-145	-128	-18	-19	91	104	0	-561
1987	0	0	-15	0	-35	-208	-1,301	-3,886	-5,925	-19	-21	132	-11,279
1988	0	0	-668	-287	-35	0	0	-4,816	-487	290	0	0	-6,004
1989	0	0	-21	-44	-6	-32	-40	-366	-581	441	74	31	-543
1990	0	0	0	-9	-27	-28	0	-28	-7,656	136	0	0	-7,612
1991	0	0	0	0	0	-106	-121	-531	-2,708	1,240	368	277	-1,582
1992	0	0	0	-10	-102	-164	-20	0	0	3	0	0	-293
1993	0	0	0	-60	-59	-33	0	-7,318	-1,022	250	5	0	-8,237
Total	0	0	-1,533	-2,352	-3,765	-4,223	-3,945	-36,121	-41,354	-6,036	4,711	928	-93,690

Chinook Salmon

With implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, a net reduction in Chinook salmon salvage would occur over the 15-year period of record, relative to the Baseline Condition. Average annual salvage estimates under the Typical Water Purchase Scenario would decrease by 895,433 Chinook salmon, relative to the Baseline Condition. (Refer to Table 9-66.)

Annual and monthly changes in Chinook salmon salvage estimates at the CVP and SWP pumps with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, relative to the Baseline Condition, are provided in Table 9-66. Annual salvage would decrease in every year by 2,117 to 252,497 Chinook salmon, relative to the Baseline Condition, as shown in Table 9-66. Monthly mean Chinook salmon salvage estimates under the Flexible Purchase Alternative would not change in October and November, relative to the Baseline Condition. From December through June, implementation of the Flexible Purchase Alternative would result in monthly mean decreases in salvage ranging from 6,073 to 356,022 Chinook salmon, relative to the Baseline Condition. During July, August, and September, monthly mean salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would increase by 2,181, 274, and 551 Chinook salmon, respectively, relative to the Baseline Condition.

While annual salvage estimates exhibit a decrease with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, there would be isolated occurrences of increases in SWP Chinook salmon salvage in 20 of the 150 months simulated for the December through September period. However, such changes would not be of sufficient magnitude to result in increases in annual salvage in any year simulated over the 15-year period of record included in the analysis. Thus, while there would be increases in Chinook salmon salvage with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario in individual months of the simulation, annual salvage estimates for Chinook salmon would decrease, relative to the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would result in overall beneficial impacts on Chinook salmon salvage, relative to the Baseline Condition.

Table 9-66
Change in Chinook Salmon Salvage at the SWP and CVP Pumps Under the Typical Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979				-195	-131	-467	-31,668	-32,892	-1,570	1,450	75	28	-65,370
1980	0	0	-466	-238	-27	-20	-60,802	-35,637	-12,304	-567	10	519	-109,532
1981	0	0	-102	0	-156	-1,689	-21,608	-12,312	-64	0	14	0	-35,916
1982	0	0	-2,161	-1,300	-3,084	-3,354	-6,557	-71,783	-15,742	32	4	0	-103,945
1983	0	0	-15,916	-3,451	-3,350	-1,593	-6,707	-19,821	-28,226	284	0	0	-78,780
1984	0	0	0	0	-6	-1,290	-24,188	-29,496	-25,410	4	133	0	-80,252
1985	0	0	-812	0	-362	-415	-13,751	-56,365	-9,911	29	0	2	-81,584
1986	0	0	-399	-190	-93,319	-15,144	-57,136	-57,399	-29,693	784	0	0	-252,497
1987	0	0	-63	0	-52	-2,167	-13,631	-11,139	-4,062	-4	-1	-1	-31,120
1988	0	0	-2,402	-338	-320	0	-1,348	-14,700	-53	168	15	2	-18,978
1989	0	0	-52	-118	-9	-2,071	-770	-6,591	-148	0	6	0	-9,753
1990	0	0	-51	-99	-55	-372	0	-266	-1,273	0	0	0	-2,117
1991	0	0	0	0	0	-678	-3,919	-5,484	-500	0	0	0	-10,581
1992	0	0	0	-108	-1,814	-5,750	-2,877	0	0	0	0	0	-10,547
1993	0	0	0	-34	-67	-81	-1,957	-2,136	-205	2	18	0	-4,461
Total	0	0	-22,424	-6,073	-102,751	-35,090	-246,917	-356,022	-129,162	2,181	274	551	-895,433

Steelhead

A net reduction in steelhead salvage would occur with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, relative to the Baseline Condition, over the 15-year period of record included in the analysis. Average annual salvage estimates under the Typical Water Purchase Scenario would be reduced by 20,386 steelhead, relative to the Baseline Condition. (Refer to Table 9-67.)

Annual and monthly changes in steelhead salvage estimates at the CVP and SWP pumps with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, relative to the Baseline Condition, are shown in Table 9-67. Annual salvage would decrease in ever year by 180 to 4,005 steelhead, relative to the Baseline Condition, as shown in Table 9-67. Monthly mean steelhead salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would not change from August through November, relative to the Baseline Condition. From December through June, implementation of the Flexible Purchase Alternative would result in monthly mean reductions in salvage ranging from 414 to 7,088 steelhead, relative to the Baseline Condition. During July, monthly mean salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would increase by three steelhead, relative to the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would result in overall beneficial impacts on steelhead salvage, relative to the Baseline Condition.

Table 9-67
Change in Steelhead Salvage at the SWP and CVP Pumps Under the Typical Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979				-11	-62	-173	-707	-473	0	0	0	0	-1,428
1980	0	0	-2	-15	-48	-7	-507	-458	-41	0	0	0	-1,078
1981	0	0	-12	0	-132	-719	-1,016	-24	0	0	0	0	-1,903
1982	0	0	-32	-65	-130	-90	-1,790	-1,526	-373	0	0	0	-4,005
1983	0	0	-755	-40	-16	0	0	-75	0	0	0	0	-887
1984	0	0	0	0	0	-24	-151	-5	0	0	0	0	-180
1985	0	0	-1	0	-18	-73	-220	-221	0	0	0	0	-532
1986	0	0	0	-2	-144	-43	-423	-121	0	3	0	0	-728
1987	0	0	-92	0	-8	-1,213	-302	-81	0	0	0	0	-1,695
1988	0	0	-42	-18	-103	0	-78	-170	0	0	0	0	-411
1989	0	0	-5	-2	-42	-1,464	-34	-26	0	0	0	0	-1,573
1990	0	0	0	0	-128	-423	0	-3	0	0	0	0	-554
1991	0	0	0	0	0	-994	-206	-24	0	0	0	0	-1,224
1992	0	0	0	-289	-1,016	-1,247	-39	0	0	0	0	0	-2,590
1993	0	0	0	-26	-588	-618	-165	-200	0	0	0	0	-1,597
Total	0	0	-941	-468	-2,434	-7,088	-5,636	-3,407	-414	3	0	0	-20,386

Splittail

With implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, there would be a net reduction in splittail salvage, relative to the Baseline Condition, over the 15-year period of record included in the analysis. Average annual salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would decrease by 656,597 splittail, relative to the Baseline Condition. (Refer to Table 9-68.)

Annual and monthly change in splittail salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, relative to the Baseline Condition, over the 15-year period of record included in the analysis are provided in Table 9-68. Annual salvage would decrease in every year by 75 to 409,257 splittail, relative to the Baseline Condition, as shown in Table 9-68. Monthly mean splittail salvage estimates under the Flexible Purchase Alternative would not change in October and November, relative to the Baseline Condition. From December through June, implementation of the Flexible Purchase Alternative would result in monthly mean reductions in salvage ranging from 1,322 to 375,810 splittail, relative to the Baseline Condition. During July, August, and September, monthly mean salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would increase by 47,272, 34,061, and 2,687 splittail, respectively, relative to the Baseline Condition.

While annual salvage estimates exhibit a decrease with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario for each year simulated over the 15-year period of record, there would be isolated occurrences of increases in splittail salvage in 36 of the 150 months simulated for the December through September period. However, such changes would not be of sufficient magnitude to result in increases in annual salvage in any year simulated under the Flexible Purchase Alternative. Thus, although there would be increases in splittail salvage with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario in individual months of the simulation, annual splittail salvage estimates would decrease, relative to the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would result in overall beneficial impacts on splittail salvage, relative to the Baseline Condition.

Table 9-68
Change in Splittail Salvage at the SWP and CVP Pumps Under the Typical Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
1979				0	-26	-266	-474	-4,595	-10,819	2,979	778	71	-12,351
1980	0	0	-91	-1,613	-3,254	-69	-2,861	-12,446	-49,756	-10,584	2,198	341	-78,134
1981	0	0	-20	0	-299	-546	-2,541	-8,210	0	0	16	0	-11,600
1982	0	0	-73	-1,241	-3,442	-1,371	-1,274	-9,822	-23,597	13,903	20,387	166	-6,365
1983	0	0	-737	-497	-3,791	-1,437	-515	-8,712	-44,822	9,261	4,804	194	-46,251
1984	0	0	0	0	-218	-1,114	-1,615	-1,609	-6,445	8,776	1,941	208	-75
1985	0	0	-69	0	-371	-339	-963	-1,602	-7,063	383	78	20	-9,925
1986	0	0	0	-10	-356	-1,256	-16,567	-245,553	-169,939	19,755	3,198	1,472	-409,257
1987	0	0	-60	0	-178	-1,208	-389	-373	-54,289	13	63	89	-56,332
1988	0	0	-259	-867	-666	0	-136	-1,378	-614	724	16	32	-3,147
1989	0	0	-7	-32	-83	-1,351	-104	-2,308	-670	205	455	79	-3,815
1990	0	0	-6	-44	-252	-596	0	-111	0	780	0	0	-230
1991	0	0	0	0	0	-668	-648	-825	-5,886	490	0	0	-7,539
1992	0	0	0	-35	-642	-839	-22	0	0	0	50	0	-1,487
1993	0	0	0	-959	-457	-298	-648	-6,489	-1,910	585	76	14	-10,088
Total	0	0	-1,322	-5,298	-14,036	-11,357	-28,759	-304,034	-375,810	47,272	34,061	2,687	-656,597

Striped Bass

With implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, there would be a net reduction in striped bass salvage, relative to the Baseline Condition, over the 15-year period of record included in the analysis. Average annual salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would decrease by 7,087,274 striped bass, relative to the Baseline Condition. (Refer to Table 9-69.)

Annual and monthly change in striped bass salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, relative to the Baseline Condition, over the 15-year period of record included in the analysis are provided in Table 9-69. Annual salvage estimates decrease in 9 of the 15 years simulated by 53,238 to 2,409,375 striped bass, relative to the Baseline Condition, and increase by 6,616 to 310,503 striped bass in 6 of the 15 years simulated, as shown in

Table 9-69. Monthly mean striped bass salvage estimates under the Flexible Purchase Alternative would not change in October and November, relative to the Baseline Condition. From December through June, implementation of the Flexible Purchase Alternative would result in monthly mean reductions in salvage ranging from 35,821 to 12,289,541 striped bass, relative to the Baseline Condition. During July, August, and September, monthly mean salvage estimates with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would increase by 5,682,524, 891,257, and 164,809 striped bass, respectively, relative to the Baseline Condition.

Table 9-69
Change in Striped Bass Salvage at the SWP and CVP Pumps Under the Typical Water Purchase Scenario – Flexible Purchase Alternative vs. Baseline Condition

Year	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Total*
1979				-2,942	-2,990	-2,828	-11,156	-13,337	-306,443	303,742	69,339	2,757	36,142
1980	0	0	-13,204	-1,264	-1,435	-201	-3,373	-152	-255,023	-798,525	217,262	40,460	-815,454
1981	0	0	-9,691	0	-2,538	-3,317	-4,312	-160,382	-398,328	-230,126	31,842	1,834	-775,017
1982	0	0	-8,090	-15,566	-12,801	-3,561	-8,536	-2,940	-26,663	230,894	139,488	18,278	310,503
1983	0	0	-51,197	-9,417	-7,039	-983	-749	-2,671	-9,933	10,617	15,353	2,781	-53,238
1984	0	0	0	0	-273	-321	-2,066	-7,543	-1,316,151	974,583	28,344	8,591	-314,837
1985	0	0	-12,399	0	-1,420	-737	-1,587	-93,218	-1,626,016	72,709	8,370	1,442	-1,652,857
1986	0	0	-6,065	-4,968	-37,481	-3,364	-853	-15,573	-2,737,372	2,620,207	148,024	44,061	6,616
1987	0	0	-4,349	0	-2,029	-4,167	-1,004	-74,155	-2,352,908	14,787	7,776	6,673	-2,409,375
1988	0	0	-19,675	-2,550	-4,727	0	-132	-223,777	-59,966	393,993	32,509	4,691	120,366
1989	0	0	-10,633	-2,615	-2,983	-3,636	-84	-334,230	-1,165,724	155,133	12,286	2,032	-1,350,455
1990	0	0	-714	-2,633	-2,533	-3,900	0	-16,422	-341,601	31,373	29,352	8,519	-298,560
1991	0	0	0	0	0	-4,004	-1,531	-24,981	-946,451	630,339	60,011	10,185	-276,432
1992	0	0	0	-2,969	-40,625	-17,025	-183	0	0	117,752	11,032	7,213	75,195
1993	0	0	0	-12,267	-6,587	-4,498	-254	-159,908	-746,963	1,155,044	80,270	5,294	310,131
Total	0	0	-136,017	-57,191	-125,460	-52,543	-35,821	-1,129,290	-12,289,541	5,682,524	891,257	164,809	-7,087,274

Salvage losses of striped bass during the spring months are primarily small juvenile fish (young-of-the-year), while salvage of striped bass during the fall is primarily comprised of larger juveniles that have survived and grown throughout the summer and fall months. As a result of natural mortality, smaller juvenile striped bass salvage during the spring would have a lower probability (on an individual basis) of surviving to become reproductive adults compared to the expected survival rate of larger juveniles salvaged during the fall. The potential for adverse effects of salvage losses on the overall striped bass population are, therefore, a combination of both the number of fish salvaged and their probability of survival to become reproductive adults.

There would be frequent occurrences of measurable increases in striped bass salvage in 43 of the 150 months simulated during December through September, resulting in increases in long-term average annual salvage in 6 of the 15 years simulated. However, with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario, there would be a net reduction in salvage of 7,087,274 striped bass, relative to the Baseline Condition. Therefore, potential salvage-related impacts on striped bass with implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would be less than significant, relative to the Baseline Condition.

As discussed in Chapter 2 and in Section 9.2.3, ASIP Conservation Measures, opportunities exist for reducing and/or avoiding adverse effects of salvage loss identified through these analyses. Results of real-time biological monitoring information (e.g., results of daily salvage, results of fishery monitoring performed elsewhere within the Delta, etc.) can be used, in combination with an adaptive management process, for allocating available EWA resources to reduce or avoid adverse impacts on Delta species. Modification of operations based on real-time biological data could result in impacts on water supply operations, unless mitigated through storage and/or other operational strategies.

9.2.5.3 Export Service Area

Within the Export Service Area, there are no Federally or State listed anadromous, estuarine, or riverine special-status species. The main channelized waterway in this area is the California Aqueduct, an artificial canal that is not managed for fishery resources. However, there are several non-project reservoirs within the Export Service Area that may be affected by EWA actions. This section provides an analysis of potential impacts on fisheries resources under the Flexible Purchase Alternative at San Luis Reservoir, Anderson Reservoir, Lake Perris, Castaic Lake, and Diamond Valley Lake.

9.2.5.3.1 Export Service Area Reservoirs

Borrowing EWA assets from San Luis Reservoir, Anderson Reservoir, Diamond Valley Lake, Castaic Lake, Lake Perris, and Lake Mathews via source shifting would not change the normal operating parameters of these reservoirs.

Generally, under the Flexible Purchase Alternative, if source shifting were implemented in surface water storage facilities, the participating reservoir levels would decrease prior to time under the Baseline Condition, and return to levels under the Baseline Condition later in the year, after EWA has paid water back to the Projects. The purpose of implementing source shifting is to protect the San Luis Reservoir from reaching its low-point earlier with EWA than it would have without the EWA Program. Under the Baseline Condition, water surface elevations in San Luis Reservoir would begin to decrease in mid-April and would continue to decrease until reservoir storage reached approximately 300 TAF, the level where water quality begins to create problems for contractors. Under the Flexible Purchase Alternative, EWA acquisitions would not reduce San Luis Reservoir levels below 300 TAF.

If projections show San Luis Reservoir storage levels would decrease to 300 TAF earlier in the year than normal, then the EWA agencies would implement source shifting agreements. Source shifting would decrease the water surface level, and therefore, decrease the amount of available spawning and rearing habitat for warm water fish and the amount of habitat available to coldwater fish. In some years, San Luis Reservoir storage would fall below 300 TAF without the EWA. In this situation, the EWA agencies would not be responsible for source shifting to return storage level to 300 TAF, but would only need to shift sources to bring the storage back up to the without-EWA levels. Therefore, implementation of the Flexible Purchase Alternative would not adversely affect the normal operating procedures of San Luis Reservoir. Consequently, impacts on warmwater and coldwater fisheries would be considered less than significant.

Santa Clara Valley Water District is considering two actions involving the EWA Program. The first action would be pre-delivery of project water using the District's Anderson Reservoir. Pre-delivery actions would occur in the fall when EWA assets would be in risk of spill from San Luis Reservoir. EWA water assets would be transferred to Anderson Reservoir using the Cross Valley Pipeline only if Anderson Reservoir had available capacity under Anderson Reservoir's flood control operation rules (Anderson Reservoir needs to maintain flood control runoff capacity December through March of each year). The Santa Clara Valley Water District may also use the EWA Program's ability to source shift assets based on conditions of San Luis Reservoir. If San Luis Reservoir were in risk of reaching low-point earlier than without EWA, the District would delay delivery of its project water supply later into the year to protect water quality of San Luis Reservoir. The District would only engage in source shifting if it could maintain its 20,000 acre-feet minimum storage amount and address in-stream flow requirements for Coyote Creek.

Metropolitan WD has access to water stored in Diamond Valley Lake, Castaic Lake, Lake Perris, and Lake Mathews, and may draw these reservoir levels down in the process of obtaining their entitlement water. However, before Metropolitan WD shifts operations, both the water supply and water quality of the potential source would be evaluated. If a particular reservoir would be altered beyond the confines of normal operating ranges as a result of withdrawing entitlement water, Metropolitan WD would choose another option for obtaining water. Overall, reductions that may take place within the terminal reservoirs, Castaic Lake, Lake Perris, Diamond Valley Lake, or Lake Mathews, would not likely be beyond normal operational parameters. Therefore, storage levels under the Flexible Purchase Alternative would not differ from the Baseline Condition. Consequently, inundated riparian habitat for warmwater fish species and available habitat for coldwater fish species would not be adversely affected.

When source shifting begins under the Flexible Purchase Alternative, water surface elevations in the reservoirs would decrease, as compared to the Baseline Condition. As the water is paid back, water levels would return to water surface elevations similar to those under the Baseline Condition. Source shifting does lower water levels temporarily, but only within existing operational parameters. The reservoirs in the Export Service Area would not be operated outside of their standard operational ranges. Implementation of the EWA program would not result in any potential impacts on littoral habitat or spawning grounds within these reservoirs that would be beyond the range of fluctuations that occur under the Baseline Condition. Therefore, EWA acquisition of borrowed assets from San Luis Reservoir, Anderson Reservoir, and Diamond Valley Lake, Castaic Lake, Lake Mathews, and Lake Perris within the Export Service Area would have a less than significant impact on warm water and coldwater fish species.

9.2.6 Environmental Consequences/Environmental Impacts of the Fixed Purchase Alternative

Extensive hydrologic modeling was performed for the Flexible Purchase Alternative to provide a quantitative basis from which to assess potential impacts of the Flexible Purchase Alternative on the fisheries and aquatic habitats within the EWA Area of analysis. As discussed in Section 3.3, Framework for Environmental Consequences/ Environmental Impact Analysis, the effects analysis for fisheries resources does not depend on the location of a particular seller, but on the total amount of EWA water to be transferred via a particular tributary and receiving water body. Therefore, fisheries effects were evaluated based on the largest amount of water that EWA agencies could manage for Delta fish actions (approximately 600 TAF), regardless of whether the specific water sellers could be identified at this time. The effects analysis with implementation of the Flexible Purchase Alternative represents a "worst case scenario" based on the maximum amount of water purchased by the EWA agencies. The impacts described in Section 9.2.5, Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative, represent the effects on fisheries and aquatic ecosystems for this maximum transfer amount. The analysis of the Fixed Purchase Alternative incorporates implementation of the variable operational assets described in Attachment 1, Modeling Description.

The Fixed Purchase Alternative would involve the same actions as the Flexible Purchase Alternative, but to a lesser degree. The Fixed Purchase Alternative specifies purchases of 35 TAF from the Upstream from the Delta Region, and 150 TAF from the Export Service Area, for a total purchase of 185 TAF. While the amounts in each region are fixed, the acquisition types and sources could vary. The EWA agencies would most likely seek stored reservoir water for the entire purchase, however the EWA agencies may also rotate acquisitions among diverse sources. The Fixed Purchase Alternative assumes that the EWA agencies would acquire 35 TAF from any mix of upstream from the Delta sources. However, the total acquisition amount allowed under the Fixed Purchase Alternative from the Upstream from the Delta Region (35 TAF) could also be purchased from a single source (Oroville-Wyandotte ID or Yuba County WA), potentially resulting in the same impacts as those associated with the Flexible Purchase Alternative.

Potential impacts associated with implementation of the Fixed Purchase Alternative were analyzed on a qualitative basis, in relation to the hydrologic modeling results for the maximum amount of water that could be purchased under the Flexible Purchase Alternative. Data generated as part of the Flexible Purchase Alternative analysis is also used to approximate the in-Delta fishery impacts that could occur under the Flexible Purchase Alternative.

9.2.6.1 Upstream from the Delta Region

9.2.6.1.1 Sacramento River Area of Analysis

EWA acquisition of Sacramento River contractor water via groundwater substitution and crop idling would alter Sacramento River flows downstream from Lake Shasta during June. EWA acquisition of Sacramento River contractor water via groundwater substitution and crop idling would alter surface water elevations at Lake Shasta from June through September.

Under the Flexible Purchase Alternative, changes in Shasta Reservoir storage and water surface elevations are not anticipated to reduce the availability of littoral habitat for warmwater fish, increase the potential for nest dewatering events for warmwater fish, reduce the volume of the coldwater pool, or affect the primary prey species of coldwater fish. No significant impacts on reservoir fish species under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on warmwater and coldwater fish species within Shasta Reservoir with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

Under the Flexible Purchase Alternative, changes in Sacramento River flows and water temperatures would not be of sufficient frequency or magnitude to beneficially or adversely affect attraction or adult immigration of anadromous species, spawning habitat availability, egg incubation, initial rearing success, long-term initial year-class strength, or juvenile rearing and emigration of Chinook salmon, Central Valley steelhead, Sacramento splittail, striped bass, or American shad, as applicable. In addition, under the Flexible Purchase Alternative, there would be no additional occurrences, relative to the Baseline Condition, in which Sacramento River water temperatures would exceed the NOAA Fisheries Winter-run Chinook salmon BO temperature criterion.

No significant impacts on the fish species of primary management concern under the Flexible Purchase Alternative were identified within the Sacramento River. Impacts considered less than significant under the Flexible Purchase Alternative would also be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on fish species of primary management concern within the Sacramento River with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

Implementation of the Flexible Purchase Alternative has the potential to reduce agricultural return flows in Butte Creek, downstream of the Western Canal Siphon (Butte Creek Siphon), primarily from July through September.

Under the Flexible Purchase Alternative, potentially reduced agricultural return flows downstream of the Western Canal Siphon would not occur during the appropriate time period to beneficially or adversely affect anadromous salmonid adult immigration and juvenile emigration, and splittail spawning.

No significant impacts on the fish species of primary management concern under the Flexible Purchase Alternative were identified within Butte Creek. Impacts considered less than significant under the Flexible Purchase Alternative would also be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on fish species of primary management concern within Butte Creek with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

9.2.6.1.2 Feather River Area of Analysis

EWA acquisition of Oroville-Wyandotte ID stored reservoir water would alter surface water elevations in Sly Creek and Little Grass Valley reservoirs from November until refill. EWA acquisition of Oroville-Wyandotte ID stored reservoir water would alter surface water elevations in Lake Oroville from the November prior to the transfer until the following September. EWA acquisition of Feather River contractor water via groundwater substitution and crop idling would alter summer surface water elevations in Lake Oroville. EWA acquisition of Feather River contractor water via groundwater substitution and crop idling would alter Feather River flows below Lake Oroville, relative to the Baseline Condition.

Under the Flexible Purchase Alternative, changes in Project and non-Project reservoir storage and water surface elevations are not anticipated to reduce the availability of littoral habitat for warmwater fish, increase the potential for nest dewatering events for warmwater fish, reduce the volume of the coldwater pool, or affect the primary prey species of coldwater fish. No significant impacts on reservoir fish species under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on warmwater and coldwater fish species within Sly Creek and Little Grass Valley reservoirs and Lake Oroville with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

Under the Flexible Purchase Alternative, changes in Feather River flows and water temperatures would not be of sufficient frequency or magnitude to beneficially or adversely affect attraction or adult immigration of anadromous species, spawning habitat availability, egg incubation, initial rearing success, or juvenile rearing and emigration of Chinook salmon, Central Valley steelhead, Sacramento splittail, striped bass, or American shad, as applicable. In addition, under the Flexible Purchase Alternative, there would be no additional occurrences, relative to the Baseline Condition, in which Feather River water temperatures would exceed the NOAA Fisheries temperature criteria for spring-run Chinook salmon and steelhead.

No significant impacts on the fish species of primary management concern under the Flexible Purchase Alternative were identified with the Feather River Area of analysis. Impacts considered less than significant under the Flexible Purchase Alternative would also be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on fish species of primary management concern within the Feather River Area of analysis with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

9.2.6.1.3 Yuba River Area of Analysis

EWA acquisition of Yuba County WA water via groundwater substitution would alter Yuba River flows during April through June. EWA acquisition of Yuba County WA water via groundwater substitution and crop idling would alter water surface elevations in New Bullards Bar Reservoir during April through June, relative to the Baseline Condition. EWA acquisition of Yuba County WA stored reservoir water would alter surface water elevations from July until refill at New Bullards Bar Reservoir.

Under the Flexible Purchase Alternative, changes in New Bullards Bar Reservoir storage and water surface elevations are not anticipated to reduce the availability of littoral habitat for warmwater fish, increase the potential for nest dewatering events for warmwater fish, reduce the volume of the coldwater pool, or affect the primary prey species of coldwater fish. No significant impacts on reservoir fish species under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on warmwater and coldwater fish species in New Bullards Bar Reservoir with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

Changes in Yuba River water temperature and flows are expected under the Flexible Purchase Alternative, relative to the Baseline Condition. The potential for these changes to beneficially or adversely impact anadromous salmonid adult immigration and juvenile emigration is still in question. It is expected that the changes in water temperature and flow within the Yuba River with implementation of the Flexible Purchase Alternative would be less than significant. The Yuba County WA and management agencies responsible for managing the Yuba River Basin are continuing to work towards understanding the processes that could affect fish resources within the Yuba River. As part of these ongoing efforts, water transfer strategies have been carefully designed, implemented, and monitored to avoid adverse impacts on juvenile and adult anadromous salmonids.

No significant impacts on the fish species of primary management concern under the Flexible Purchase Alternative were identified within the Yuba River Area of analysis. Impacts considered less than significant under the Flexible Purchase Alternative would also be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on fish species of primary management concern within the Yuba River Area of analysis with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

9.2.6.1.4 American River Area of Analysis

EWA acquisition of Placer County WA stored reservoir water would alter American River flows downstream of French Meadows Reservoir to Folsom Reservoir from June to October. EWA acquisition of Placer County WA stored reservoir water would alter American River *flows downstream of French Meadows and Hell Hole reservoirs to Folsom Reservoir during refill of Hell Hole and French Meadows reservoirs. EWA acquisition of Placer County WA stored reservoir water would alter surface water elevations from July until refill for French Meadows and Hell Hole reservoirs. EWA acquisition of Sacramento Groundwater Authority (SGA) water via groundwater purchase would alter summer surface water elevations at Folsom Reservoir. EWA acquisition of stored groundwater from SGA members, stored reservoir water, and water obtained through Placer County WA crop idling and retained in Folsom would alter lower American River flows, relative to the Baseline Condition*.

Under the Flexible Purchase Alternative, changes in Project and non-Project reservoir storage and water surface elevations are not anticipated to reduce the availability of littoral habitat for warmwater fish, increase the potential for nest dewatering events for warmwater fish, reduce the volume of the coldwater pool, or affect the primary prey species of coldwater fish. No significant impacts on reservoir fish species under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on warmwater and coldwater fish species within French Meadows, Hell Hole, and Folsom reservoirs with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

Under the Flexible Purchase Alternative, changes in lower American River flows and water temperatures would not be of sufficient frequency or magnitude to beneficially or adversely affect attraction or adult immigration of anadromous species, spawning habitat availability, egg incubation, initial rearing success, long-term initial year-class strength, or juvenile rearing and emigration of Chinook salmon, Central Valley steelhead, Sacramento splittail, striped bass, or American shad, as applicable. In addition, implementation of the Flexible Purchase Alternative would not result in a measurable increase in the frequency in which monthly mean water temperatures would exceed 65°F during the anadromous salmonid rearing period. Further, under the Flexible Purchase Alternative, there would be one additional occurrence below Nimbus Dam and one additional occurrence at Watt Avenue in which monthly mean water temperatures would exceed 56°F in October, relative to the Baseline Condition, during the anadromous salmonid spawning and egg incubation period.

Changes in Middle Fork American River flows under the Flexible Purchase Alternative would not result in adverse effects on resident fish species. Overall, habitat conditions would be expected to improve during summer months due to decreased variation in weekly flows, relative to the Baseline Condition, and reductions in flows that would occur in winter months would not be of sufficient frequency or magnitude to violate instream flow requirements and adversely affect aquatic resources. Therefore, impacts on Middle Fork American River fisheries resources would be less than significant, relative to the Baseline Condition.

No significant impacts on the fish species of primary management concern under the Flexible Purchase Alternative were identified within the American River Area of analysis. Impacts considered less than significant under the Flexible Purchase Alternative would also be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on fish species of primary management concern within the American River Area of analysis with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

9.2.6.1.5 San Joaquin River Area of Analysis

Various EWA acquisitions could potentially affect the hydrology of the Merced River and its associated reservoirs. EWA acquisition of MID water via groundwater substitution would alter Merced River flows. EWA acquisition of MID water via groundwater substitution would alter summer surface water elevations at Lake McClure.

Under the Flexible Purchase Alternative, changes in Lake McClure storage and water surface elevations are not anticipated to reduce the availability of littoral habitat for warmwater fish, increase the potential for nest dewatering events for warmwater fish, reduce the volume of the coldwater pool, or affect the primary prey species of coldwater fish. No significant impacts on reservoir fish species under the Flexible Purchase Alternative were identified. Impacts considered less than significant under the Flexible Purchase Alternative also would be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on warmwater and coldwater fish species in Lake McClure with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

Under the Flexible Purchase Alternative, changes in Merced River flows and would not be of sufficient frequency or magnitude to beneficially or adversely affect attraction or adult immigration of anadromous species, spawning habitat availability, egg incubation, initial rearing success, or juvenile rearing and emigration of Chinook salmon and striped bass, as applicable. No significant impacts on the fish species of primary management concern under the Flexible Purchase Alternative were identified within the Merced River. Impacts considered less than significant under the Flexible Purchase Alternative would also be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on fish species of primary management concern within the Merced River with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

EWA acquisition of MID water via groundwater substitution would alter San Joaquin River flows.

Under the Flexible Purchase Alternative, changes in San Joaquin River flows would not be of sufficient frequency or magnitude to beneficially or adversely affect attraction or adult immigration of anadromous species, spawning habitat availability, egg incubation, initial rearing success, or juvenile rearing and emigration of Chinook salmon, Central Valley steelhead, Sacramento splittail, striped bass, American shad, or delta smelt, as applicable.

No significant impacts on the fish species of primary management concern under the Flexible Purchase Alternative were identified within the San Joaquin River. Impacts considered less than significant under the Flexible Purchase Alternative would also be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on fish species of primary management concern within the San Joaquin River with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

9.2.6.2 Sacramento-San Joaquin Delta Region

Various EWA Actions could potentially affect habitat conditions (Delta outflow, the position of X_2, the export/inflow ratio, and the frequency and magnitude of reverse flows) within the Delta during the December through June period, as well as fish salvage at the CVP and SWP pumping plants.

Under the Flexible Purchase Alternative, the evaluation of potential impacts on Delta fisheries involves two study scenarios, including: 1) the Maximum Water Purchase Scenario; and 2) the Typical Water Purchase Scenario. Although the Maximum Water Purchase Scenario represents potential worst-case effects on fish resources upstream from the Delta, the Typical Water Purchase Scenario was developed to analyze a more likely representation of potential worst-case effects within the Delta. Attachment 1, Modeling Description, provides a more detailed discussion of the two scenarios, the modeling process, and in-Delta fishery benefits provided by the EWA Program.

With implementation of the Flexible Purchase Alternative under both the Maximum and Typical Water Purchase Scenarios, long-term average Delta outflow would increase, relative to the Baseline Condition, and monthly mean flows would be essentially equivalent to or greater than flows under the Baseline Condition. The monthly mean position of X_2 would move downstream or would not shift, relative to the Baseline Condition, under both the Maximum Water Purchase and Typical Water Purchase Scenarios. The monthly mean E/I ratio would be identical to or less than (a reduced proportion of exports, relative to inflow) the E/I ratio under the Baseline Condition in all of the months simulated for the February through June period, under both the Maximum Water Purchase and Typical Water Purchase Scenarios. Implementation of the Flexible Purchase Alternative under both the Maximum Water Purchase Scenario and Typical Water Purchase Scenario would provide a benefit to reverse flows, relative to the Baseline Condition, by decreasing the frequency of reverse flows and reducing the magnitude when reverse flows would still occur. Overall, such changes would be considered a benefit to juvenile salmonid emigration and the transport of planktonic eggs and larvae. Therefore, the habitat conditions resulting from implementation of the Flexible Purchase Alternative under both the

Maximum Water Purchase Scenario and Typical Water Purchase Scenario would result in beneficial impacts on fisheries resources in the Delta.

Annual salvage estimates for delta smelt, Chinook salmon, steelhead, and splittail exhibit a decrease in all 15 years simulated under the Typical Water Purchase Scenario, relative to the Baseline Condition. Under the Maximum Water Purchase Scenario, average annual Chinook salmon and steelhead salvage estimates would decrease in all 15 years simulated, and delta smelt and splittail salvage estimates would decrease in 14 out of the 15 years simulated. Striped bass salvage estimates would decrease in 8 of the 15 years simulated under the Maximum Water Purchase Scenario, and would decrease in 9 of the 15 years simulated under the Typical Water Purchase Scenario. Although there would be increases in salvage with implementation of the Flexible Purchase Alternative under both the Maximum Water Purchase and Typical Water Purchase Scenarios in individual months and in some years, annual salvage estimates for delta smelt, Chinook salmon, steelhead, splittail, and striped bass would decrease, relative to the Baseline Condition. Therefore, implementation of the Flexible Purchase Alternative under the Typical Water Purchase Scenario would result in overall beneficial impacts on Delta fisheries related to salvage at the SWP/CVP export facilities, relative to the Baseline Condition.

Total fish actions under the Fixed Purchase Alternative would be less than under the Flexible Purchase Alternative (for both the Maximum Water Purchase and Typical Water Purchase Scenarios), therefore benefits to fish from December through June would be less under the Fixed Purchase Alternative than the Flexible Purchase Alternative. Because the Fixed Purchase Alternative limits upstream from the Delta transfers to 35 TAF, export of this relatively small volume of water would likely result in fewer adverse impacts from water transfers during July through September than those occurring with implementation of the Flexible Purchase Alternative. Therefore, the qualitative conclusion is that the Fixed Purchase Alternative would provide fewer environmental benefits than the benefits resulting from implementation of the Flexible Purchase Alternative.

However, given that the majority of benefits provided by the EWA Program occur within the Delta due to export reductions to benefit fish, the process described below was used in an effort to reasonably approximate salvage-related impacts within the Delta with implementation of the Fixed Purchase Alternative.

It was estimated in the CALFED ROD that the average annual variable operational asset would be 70 TAF. (See CALFED Bay-Delta Program Record of Decision page 58.) For this analysis it is assumed that the available Fixed Purchase Alternative annual assets will total 255 TAF (185 + 70 = 255 TAF). Using the results from the Typical Water Purchase Scenario, the EWA benefits, measured in reduced fish salvaged at the CVP and SWP pumping plants during the December through June period, for the Fixed Water Purchase Alternative were calculated by multiplying the annual benefits during the December through June period under the Typical Water Purchase Scenario by 255 TAF and dividing it by the assets available or used in that year under the Typical Water Purchase Scenario. (See second column in Tables 9-70 through 9-74 below.) This calculation does not allow the ratio to exceed 1.0. The increase in fish salvage due to increased export of EWA water purchased from the Upstream from the Delta Region during the July through September period for the Fixed Water Purchase Alternative was calculated in a similar manner, using a ratio of 35 TAF divided by the amount of water exported under the Typical Water Purchase Scenario during that period. (See third column in Tables 9-70 through 9-74 below.) The results of the analysis using the above process to calculate the overall, net changes in fish salvage under the Fixed Water Purchase Alternative are shown in Tables 9-70 through 9-74.

The second column of Tables 9-70 through 9-74 shows the decrease in the number of fish salvaged under the Typical Water Purchase Scenario during December though June due to the reduction of available assets with implementation of the Fixed Purchase Alternative. The third column shows the decrease in the number of fish salvaged under the Typical Water Purchase Scenario during the July through the September period. The fourth column is the total of the first two columns. The fifth column is the total reduction in salvage calculated for the Typical Water Purchase Scenario. (See Section 9.2.4.2.2, Typical Water Purchase Scenario.) The sixth column is the reduction in fish salvage for the Fixed Water Purchase Alternative calculated by subtracting column four from column five.

Table 9-70
Chinook Salmon Salvage – Fixed Purchase Alternative

Year	*Dec-Jun*	*Jul-Sep*	*Net Change*	*Typical Water Purchase Scenario Annual Total*	*Fixed Purchase Alternative Annual Total*
1979	10,040	-1,305	8,735	-65,370	-56,635
1980	39,620	-445	39,175	-109,532	-70,357
1981	5,390	-10	5,380	-35,916	-30,536
1982	0	0	0	-103,945	-103,945
1983	0	0	0	-78,780	-78,780
1984	28,940	-115	28,825	-80,252	-51,427
1985	12,240	-15	12,225	-81,584	-69,359
1986	91,180	-715	90,465	-252,497	-162,032
1987	4,665	0	4,665	-31,120	-26,455
1988	0	-160	-160	-18,978	-19,138
1989	0	-5	-5	-9,753	-9,758
1990	0	0	0	-2,117	-2,117
1991	0	0	0	-10,581	-10,581
1992	0	0	0	-10,547	-10,547
1993	1,615	-15	1,600	-4,461	-2,861
Total	193,690	-2,785	190,905	-895,433	-704,528

Table 9-71
Splittail Salvage – Fixed Purchase Alternative

Year	Dec-Jun	Jul-Sep	Net Change	Typical Water Purchase Scenario Annual Total	Fixed Purchase Alternative Annual Total
1979	2,425	-3,215	-790	-12,351	-13,141
1980	29,040	-2,185	26,855	-78,134	-51,279
1981	1,740	-10	1,730	-11,600	-9,870
1982	0	0	0	-6,365	-6,365
1983	0	0	0	-46,251	-46,251
1984	3,960	-9,285	-5,325	-75	-5,400
1985	1,560	-255	1,305	-9,925	-8,620
1986	156,125	-22,225	133,900	-409,257	-275,357
1987	8,475	-145	8,330	-56,332	-48,002
1988	0	-665	-665	-3,147	-3,812
1989	0	-525	-525	-3,815	-4,340
1990	0	-645	-645	-230	-875
1991	0	-470	-470	-7,539	-8,009
1992	0	-45	-45	-1,487	-1,532
1993	3,840	-580	3,260	-10,088	-6,828
Total	207,165	-40,250	166,915	-656,596	-489,681

Table 9-72
Delta Smelt Salvage – Fixed Purchase Alternative

Year	Dec-Jun	Jul-Sep	Net Change	Typical Water Purchase Scenario Annual Total	Fixed Purchase Alternative Annual Total
1979	770	-2,235	-1,465	-2,489	-3,954
1980	5,995	-2,940	3,055	-13,121	-10,066
1981	3,990	-180	3,810	-26,355	-22,545
1982	0	0	0	-1,897	-1,897
1983	0	0	0	-2,458	-2,458
1984	1,535	-910	625	-3,496	-2,871
1985	1,185	-80	1,105	-7,765	-6,660
1986	270	-180	90	-561	-471
1987	1,705	-80	1,625	-11,279	-9,654
1988	0	-250	-250	-6,004	-6,254
1989	0	-390	-390	-543	-933
1990	0	-115	-115	-7,612	-7,727
1991	0	-1,810	-1,810	-1,582	-3,392
1992	0	0	0	-293	-293
1993	3,055	-220	2,835	-8,237	-5,402
Total	18,505	-9,390	9,115	-93,692	-84,577

Table 9-73 Steelhead Salvage – Fixed Purchase Alternative					
Year	**Dec-Jun**	**Jul-Sep**	**Net Change**	**Typical Water Purchase Scenario Annual Total**	**Fixed Purchase Alternative Annual Total**
1979	215	0	215	-1,428	-1,213
1980	390	0	390	-1,078	-688
1981	285	0	285	-1,903	-1,618
1982	0	0	0	-4,005	-4,005
1983	0	0	0	-887	-887
1984	65	0	65	-180	-115
1985	80	0	80	-532	-452
1986	265	0	265	-728	-463
1987	255	0	255	-1,695	-1,440
1988	0	0	0	-411	-411
1989	0	0	0	-1,573	-1,573
1990	0	0	0	-554	-554
1991	0	0	0	-1,224	-1,224
1992	0	0	0	-2,590	-2,590
1993	575	0	575	-1,597	-1,022
Total	2,130	0	2,130	-20,386	-18,255

Table 9-74 Striped Bass Salvage – Fixed Purchase Alternative					
Year	**Dec-Jun**	**Jul-Sep**	**Net Change**	**Typical Water Purchase Scenario Annual Total**	**Fixed Purchase Alternative Annual Total**
1979	50,955	-323,220	-272,265	36,142	-236,123
1980	386,345	-221,640	164,705	-815,454	-650,749
1981	121,305	-23,575	97,730	-775,017	-677,287
1982	0	0	0	-310,503	-310,503
1983	0	0	0	-53,238	-53,238
1984	477,485	-859,790	-382,305	-314,837	-697,142
1985	260,305	-43,735	216,570	-1,652,857	-1,436,287
1986	1,010,045	-255,920	754,125	6,616	760,741
1987	365,790	-25,725	340,065	-2,409,375	-2,069,310
1988	0	-370,825	-370,825	120,366	-250,459
1989	0	-120,310	-120,310	-1,350,455	-1,470,765
1990	0	-57,470	-57,470	-298,560	-356,030
1991	0	-67,250	-67,250	-276,432	-343,682
1992	0	-116,955	-116,955	75,195	-41,760
1993	334,970	-1,066,920	-731,950	310,131	-421,819
Total	3,007,200	-3,553,335	-546,135	-7,087,274	-7,633,409

The results of this analysis verify the above-stated qualitative conclusion, which indicates that the beneficial impacts resulting from implementation of the Fixed Purchase Alternative would be less than the benefits provided under the Typical Water Purchase Scenario. For each fish species analyzed, implementation of the Fixed Purchase Alternative would result in net salvage-related benefits in every year of the study period. For striped bass, these are some years when implementation of the

Fixed Purchase Alternative would not result in beneficial effects, however, the overall net reduction in fish salvage for the entire study period would be 7,633,409 striped bass. Therefore, implementation of the Fixed Purchase Alternative would result in less-than-significant impacts on fisheries and aquatic resources within the Sacramento-San Joaquin Delta Region.

9.2.6.3 Export Service Area

Borrowing EWA assets from San Luis Reservoir, Anderson Reservoir, Diamond Valley Lake, Castaic Lake, Lake Mathews, and Lake Perris via source shifting would not change the normal operating parameters of these reservoirs.

Under the Flexible Purchase Alternative, EWA acquisition of borrowed assets from San Luis Reservoir, Anderson Reservoir, and Diamond Valley Lake, Castaic Lake, Lake Mathews, and Lake Perris within the Export Service Area would have a less than significant impact on warmwater and coldwater fish species. (Refer to Section 9.2.5.3.1, Export Service Area Reservoirs.) Impacts considered less than significant under the Flexible Purchase Alternative would also be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative). Therefore impacts on warmwater and coldwater fish species within the Export Service Area with implementation of the Fixed Purchase Alternative are anticipated to be less than significant.

9.2.7 Comparative Analysis of Alternatives

The Fixed Purchase Alternative would be limited to a maximum upstream from the Delta acquisition of 35 TAF, compared to the maximum 600 TAF of water that could be purchased under the Flexible Purchase Alternative. In addition, the Fixed Purchase Alternative limits export service area transfers to 150 TAF, whereas the Flexible Purchase Alternative does not specify transfer limits from the Upstream from the Delta Region or the Export Service Area. As discussed in Section 9.2.6, the impacts described in Section 9.2.5, Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative, represent the effects on fisheries and aquatic ecosystems for a maximum transfer amount (Maximum Water Purchase Scenario) within the Upstream from the Delta Region and Export Service Area, and for both the Maximum Water Purchase Scenario and Typical Water Purchase Scenario within the Delta Region. Impacts considered less than significant under the Flexible Purchase Alternative also would be considered less than significant for a lesser or identical transfer amount (the Fixed Purchase Alternative).

EWA agencies would prefer to purchase water from upstream sources because the water is generally less expensive. The amount that could be purchased would be limited by the excess capacity of the Delta export pumps to move the water to export areas south of the Delta. During wet years, excess pump capacity may be limited to as little as 50 to 60 TAF of EWA asset water because the pumps primarily would be used to export State and Federal Project water to Export Service Area users. During dry years, when there would be less Project water available for pumping (and therefore the pumps would have greater available capacity), the EWA Project Agencies could acquire up to 600 TAF of water from sources upstream from the Delta. Potential impacts on the Delta with the Flexible Purchase Alternative would vary depending on the water-year type, with more potential impacts occurring during wet years when more water is moved through the Delta.

EWA asset acquisition in the Export Service Area under the Flexible Purchase Alternative would be dependent on the water year type north of the Delta. Export pump capacity during wet years would limit the ability of the EWA Project Agencies to move assets through the Delta, requiring reliance on greater purchase amounts from Export Service Area sources. During wet years, acquisitions within the Export Service Area could involve up to 600 TAF of assets. The EWA agencies would acquire assets from stored groundwater and idled cropland sources. The EWA agencies would acquire less water from the Export Service Area during dry years, when most of the assets needed could be moved through the Delta. Moving stored groundwater into the California Aqueduct, therefore, would be less of a concern during dry years.

Table 9-75 summarizes and compares the potential impacts and level of significance relative to fisheries and aquatic ecosystems with implementation of the EWA program under both the Flexible Purchase Alternative and Fixed Purchase Alternative.

9.2.8 Mitigation Measures

The ASIP conservation measures presented in Section 9.2.3 have been developed to reduce effects on fisheries and aquatic resources to less than significant levels. No adverse effects on fisheries and aquatic resources are anticipated with implementation of the Flexible Purchase Alternative or Fixed Purchase Alternative for any of the acquisition types associated with the EWA Program. Consequently, no mitigation measures are proposed for fisheries and aquatic resources.

9.2.9 Potentially Significant Unavoidable Impacts

Within the EWA Action Area, no potentially significant impacts on fisheries and aquatic resources with implementation of the Flexible Purchase Alternative or Fixed Purchase Alternative were identified. Therefore, there are no potentially significant unavoidable impacts on fisheries and aquatic resources associated with implementation of the EWA Program.

9.2.10 Cumulative Effects

The analysis of potential cumulative impacts on fisheries and aquatic resources within the EWA Area of analysis is based on a discussion of potential impacts resulting from the comparative analysis of the Flexible Purchase Alternative and the cumulative condition. CALSIM II hydrologic modeling output (see Attachment 1, Modeling Description) for reservoir storage volumes, water surface elevations, and river flows were used as a baseline for the comparative analysis, which is discussed in detail in Section 9.2.5, Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative. The analysis includes an assessment of potential impacts on reservoir, riverine, and Delta fish species using the relative change in flows, reservoir

Table 9-75 Fisheries and Aquatic Ecosystems Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts									
Region	***Area of Analysis***	***Asset Acquisition Type***	***Result***	***Potentially Affected Resource***	***Potential Effects***	***Flexible Alternative Change from Baseline***	***Fixed Alternative Change from Baseline***	***Significance of Flexible Purchase Alternative***	***Significance of Fixed Purchase Alternative***
Upstream from the Delta Region	Sacramento River	Groundwater Substitution and Crop Idling	Seasonal changes in the timing of releases from Lake Shasta.	Shasta Reservoir warmwater fisheries	Reduction in the acreage of littoral habitat available for spawning and rearing; increase in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Less-than-significant impact	Less-than-significant impact
				Shasta Reservoir coldwater fisheries	Reduction in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Less-than-significant impact	Less-than-significant impact
			Altered flows in the Sacramento River.	Sacramento River winter-run, spring-run, fall-run, and late fall-run Chinook salmon and steelhead	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for adult immigration, spawning, egg incubation, initial rearing, juvenile rearing, and juvenile emigration.	Changes in flows and water temperatures would not be of sufficient frequency or magnitude to adversely or beneficially affect winter-run, spring-run, fall-run, or late-fall-run Chinook salmon or steelhead adult immigration, spawning, egg incubation, and initial rearing, or juvenile rearing and emigration.	Changes in flows and water temperatures would not be of sufficient frequency or magnitude to adversely or beneficially affect winter-run, spring-run, fall-run, or late-fall-run Chinook salmon or steelhead adult immigration, spawning, egg incubation, and initial rearing, or juvenile rearing and emigration.	Less-than-significant impact	Less-than-significant impact

Table 9-75
Fisheries and Aquatic Ecosystems
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region (cont)	Sacramento River (cont)	Groundwater Substitution and Crop Idling (cont)	Altered flows in the Sacramento River (cont)	Sacramento River splittail	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for spawning.	Decreases in flows would not occur during the splittail spawning period, and increases in flows would not be of sufficient frequency or magnitude to beneficially or adversely affect the availability of splittail spawning habitat. There would be no substantial change in the frequency in which water temperatures would be within the reported preferred range for splittail spawning.	Decreases in flows would not occur during the splittail spawning period, and increases in flows would not be of sufficient frequency or magnitude to beneficially or adversely affect the availability of splittail spawning habitat. There would be no substantial change in the frequency in which water temperatures would be within the reported preferred range for splittail spawning.	Less-than-significant impact	Less-than-significant impact
				Sacramento River American shad	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for spawning.	Decreases in flows would not occur during the American shad spawning period of May through June; there would be no substantial change in the frequency in which Sacramento River water temperatures would be within the reported preferred range for American shad spawning.	Decreases in flows would not occur during the American shad spawning period of May through June; there would be no substantial change in the frequency in which Sacramento River water temperatures would be within the reported preferred range for American shad spawning.	Less-than-significant impact	Less-than-significant impact
				Sacramento River striped bass	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for spawning.	Decreases in flows would not occur during the striped bass spawning period of May through June; there would be no substantial change in the frequency in which Sacramento River water temperatures would be within the reported preferred range for striped bass spawning.	Decreases in flows would not occur during the striped bass spawning period of May through June; there would be no substantial change in the frequency in which Sacramento River water temperatures would be within the reported preferred range for striped bass spawning.	Less-than-significant impact	Less-than-significant impact

Table 9-75
Fisheries and Aquatic Ecosystems
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region (cont)	Sacramento River (cont)	Groundwater Substitution and Crop Idling (cont)	Decreased agricultural return flows in Butte Creek from July through September.	Butte Creek spring-run, fall-run, and late-fall-run Chinook salmon and steelhead	Reduction in adult holding and spawning or juvenile rearing habitat; decreases in flows during adult immigration or juvenile emigration for spring-run, fall-run, or late-fall-run Chinook salmon or steelhead.	Decreases in agricultural return flows to Butte Creek would occur downstream of holding, spawning, and rearing habitat for spring-run, fall-run, or late-fall-run Chinook salmon and steelhead (below the Western Canal Siphon); decreases in agricultural return flows would occur outside of the migration periods when adult or juvenile spring-run, fall-run, or late-fall-run Chinook salmon and steelhead would be present.	Decreases in agricultural return flows to Butte Creek would occur downstream of holding, spawning, and rearing habitat for spring-run, fall-run, or late-fall-run Chinook salmon and steelhead (below the Western Canal Siphon); decreases in agricultural return flows would occur outside of the migration periods when adult or juvenile spring-run, fall-run, or late-fall-run Chinook salmon and steelhead would be present.	Less-than-significant impact	Less-than-significant impact
				Butte Creek Sacramento splittail	Reduction in spawning habitat in the Sutter Bypass conveyance canals, if present.	Reductions in agricultural return flows would be expected to occur after the cessation of splittail spawning.	Reductions in agricultural return flows would be expected to occur after the cessation of splittail spawning.	Less-than-significant impact	Less-than-significant impact
	Feather River	Stored Reservoir Water Purchase	Additional water releases from Little Grass Valley and Sly Creek reservoirs.	Little Grass Valley and Sly Creek reservoirs warmwater fisheries	Reduction in the acreage of littoral habitat available for spawning and rearing; increase in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Less-than-significant impact	Less-than-significant impact
				Little Grass Valley and Sly Creek reservoirs coldwater fisheries	Reduction in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Less-than-significant impact	Less-than-significant impact

Table 9-75
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Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region (cont)	Feather River (cont)	Groundwater Substitution, Crop Idling, and Stored Reservoir Water Purchase	Seasonal changes in the timing of releases and additional water releases from Oroville Reservoir.	Oroville Reservoir warmwater fisheries	Reduction in the acreage of littoral habitat available for spawning and rearing; increase in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Less-than-significant impact	Less-than-significant impact
				Oroville Reservoir coldwater fisheries	Reduction in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Less-than-significant impact	Less-than-significant impact
			Altered flows in the lower Feather River.	Lower Feather River spring-run and fall-run Chinook salmon and steelhead	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for adult immigration, spawning, egg incubation, initial rearing, juvenile rearing, and juvenile emigration.	Changes in flows and water temperatures would not be of sufficient frequency or magnitude to adversely or beneficially affect spring-run or fall-run Chinook salmon or steelhead adult immigration, spawning, egg incubation, and initial rearing, or juvenile rearing and emigration.	Changes in flows and water temperatures would not be of sufficient frequency or magnitude to adversely or beneficially affect spring-run or fall-run Chinook salmon or steelhead adult immigration, spawning, egg incubation, and initial rearing, or juvenile rearing and emigration.	Less-than-significant impact	Less-than-significant impact

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Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	***Area of Analysis***	***Asset Acquisition Type***	***Result***	***Potentially Affected Resource***	***Potential Effects***	***Flexible Alternative Change from Baseline***	***Fixed Alternative Change from Baseline***	***Significance of Flexible Purchase Alternative***	***Significance of Fixed Purchase Alternative***
Upstream from the Delta Region (cont)	Feather River (cont)	Groundwater Substitution, Crop Idling, and Stored Reservoir Water Purchase (cont)	Altered flows in the lower Feather River (cont).	Lower Feather River splittail	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for spawning.	Decreases or increases in flows and water temperatures would not be of sufficient frequency or magnitude to beneficially or adversely affect the availability of splittail spawning habitat or the frequency of water temperatures within the reported preferred range for splittail spawning.	Decreases or increases in flows and water temperatures would not be of sufficient frequency or magnitude to beneficially or adversely affect the availability of splittail spawning habitat or the frequency of water temperatures within the reported preferred range for splittail spawning.	Less-than-significant impact	Less-than-significant impact
				Lower Feather River American shad	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for spawning.	Decreases in flows would not occur during the American shad spawning period; increases in flows would not be of sufficient frequency or magnitude to beneficially affect the number of spawning American shad attracted into the lower Feather River; there would be no substantial change in the frequency of Sacramento River water temperatures within the reported preferred range for American shad spawning.	Decreases in flows would not occur during the American shad spawning period; increases in flows would not be of sufficient frequency or magnitude to beneficially affect the number of spawning American shad attracted into the lower Feather River; there would be no substantial change in the frequency of Sacramento River water temperatures within the reported preferred range for American shad spawning.	Less-than-significant impact	Less-than-significant impact

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Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region (cont)	Feather River (cont)	Groundwater Substitution, Crop Idling, and Stored Reservoir Water Purchase (cont)	Altered flows in the lower Feather River (cont).	Lower Feather River striped bass	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for spawning.	Decreases in flows would not occur during the striped bass spawning period; increases in flows would not be of sufficient frequency or magnitude to beneficially affect striped bass spawning habitat; there would be no substantial change in the frequency of water temperatures within the reported preferred range for striped bass spawning.	Decreases in flows would not occur during the striped bass spawning period; increases in flows would not be of sufficient frequency or magnitude to beneficially affect striped bass spawning habitat; there would be no substantial change in the frequency of water temperatures within the reported preferred range for striped bass spawning.	Less-than-significant impact	Less-than-significant impact
	Yuba River	Stored Reservoir Water Purchase, Groundwater Substitution	Seasonal changes in releases and additional releases from New Bullards Bar Reservoir.	New Bullards Bar reservoir warmwater fisheries	Reduction in the acreage of littoral habitat available for spawning and rearing; increase in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Less-than-significant impact	Less-than-significant impact
				New Bullards Bar coldwater fisheries	Reduction in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Less-than-significant impact	Less-than-significant impact

Table 9-75
Fisheries and Aquatic Ecosystems
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	***Area of Analysis***	***Asset Acquisition Type***	***Result***	***Potentially Affected Resource***	***Potential Effects***	***Flexible Alternative Change from Baseline***	***Fixed Alternative Change from Baseline***	***Significance of Flexible Purchase Alternative***	***Significance of Fixed Purchase Alternative***
Upstream from the Delta Region (cont)	Yuba River (cont)	Stored Reservoir Water Purchase, Groundwater Substitution (cont)	Increased Yuba River flows from July through September.	Yuba River spring-run and fall-run Chinook salmon and steelhead.	Increases in flow resulting in the non-volitional movement of juvenile steelhead and decreases in water temperatures resulting in the attraction of non-indigenous salmonids into the lower Yuba River.	Rate of flow increase would not be of sufficient frequency or magnitude to result in the attraction of non-indigenous salmonids into the lower Yuba River or the non-volitional movement of juvenile steelhead downstream of suitable rearing areas.	Rate of flow increase would not be of sufficient frequency or magnitude to result in the attraction of non-indigenous salmonids into the lower Yuba River or the non-volitional movement of juvenile steelhead downstream of suitable rearing areas.	Less-than-significant impact	Less-than-significant impact
	American River	Stored Reservoir Water Purchase, Stored Groundwater Purchase	Additional water releases from French Meadows and Hell Hole reservoirs.	French Meadows and Hell Hole reservoirs warmwater fisheries	Reduction in the acreage of littoral habitat available for spawning and rearing; increase in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Less-than-significant impact	Less-than-significant impact
				French Meadows and Hell Hole reservoirs coldwater fisheries	Reduction in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Less-than-significant impact	Less-than-significant impact

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Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region (cont)	American River (cont)	Stored Reservoir Water Purchase, Stored Groundwater Purchase (cont)	Altered flows in the Middle Fork American River.	Middle Fork American River recreational fisheries	Decreases in flow.	Decreases in flow would not be of sufficient frequency or magnitude to result in violation of minimum instream flow requirements; increases and decreases in flows would not be of sufficient frequency or magnitude to adversely or beneficially affect aquatic insects, which serve as a forage base for recreational fish species in the Middle Fork American River.	Decreases in flow would not be of sufficient frequency or magnitude to result in violation of minimum instream flow requirements; increases and decreases in flows would not be of sufficient frequency or magnitude to adversely or beneficially affect aquatic insects, which serve as a forage base for recreational fish species in the Middle Fork American River.	Less-than-significant impact	Less-than-significant impact
			Seasonal changes in the timing of releases and additional water releases from Folsom Reservoir.	Folsom Reservoir warmwater fisheries	Reduction in the acreage of littoral habitat available for spawning and rearing; increase in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Less-than-significant impact	Less-than-significant impact
				Folsom Reservoir coldwater fisheries	Reduction in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Reductions in reservoir storage would not be of sufficient frequency or magnitude to result in substantial changes in coldwater habitat availability.	Less-than-significant impact	Less-than-significant impact

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Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	*Area of Analysis*	*Asset Acquisition Type*	*Result*	*Potentially Affected Resource*	*Potential Effects*	*Flexible Alternative Change from Baseline*	*Fixed Alternative Change from Baseline*	*Significance of Flexible Purchase Alternative*	*Significance of Fixed Purchase Alternative*
Upstream from the Delta Region (cont)	American River (cont)	Stored Reservoir Water Purchase, Stored Groundwater Purchase (cont)	Altered flows in the lower American River.	Lake Natoma coldwater fisheries	Increases in water temperatures.	Changes in releases from Nimbus Dam would not be of sufficient frequency or magnitude to result in water temperature increases of sufficient frequency or magnitude to adversely impact reservoir coldwater fisheries.	Changes in releases from Nimbus Dam would not be of sufficient frequency or magnitude to result in water temperature increases of sufficient frequency or magnitude to adversely impact reservoir coldwater fisheries.	Less-than-significant impact	Less-than-significant impact
				Nimbus Hatchery	Increases in water temperatures.	Changes in releases from Nimbus Dam would not be of sufficient frequency or magnitude to result in water temperature increases that would adversely impact hatchery operations.	Changes in releases from Nimbus Dam would not be of sufficient frequency or magnitude to result in water temperature increases that would adversely impact hatchery operations.	Less-than-significant impact	Less-than-significant impact
				Lower American River fall-run Chinook salmon and steelhead	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for adult immigration, spawning, egg incubation, initial rearing, juvenile rearing, and juvenile emigration.	Changes in flows and water temperatures would not be of sufficient frequency or magnitude to adversely or beneficially affect fall-run Chinook salmon or steelhead adult immigration, spawning, egg incubation, and initial rearing, or juvenile rearing and emigration.	Changes in flows and water temperatures would not be of sufficient frequency or magnitude to adversely or beneficially affect fall-run Chinook salmon or steelhead adult immigration, spawning, egg incubation, and initial rearing, or juvenile rearing and emigration.	Less-than-significant impact	Less-than-significant impact

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Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region (cont)	American River (cont)	Stored Reservoir Water Purchase, Stored Groundwater Purchase (cont)	Altered flows in the lower American River (cont).	Lower American River splittail	Decreases in the availability of splittail spawning habitat or increases in water temperatures below and above, respectively, thresholds suitable for spawning.	There would be no reduction in the availability of submerged vegetation utilized for splittail spawning habitat; there would be no substantial change in frequency of water temperatures within the reported preferred range for splittail spawning.	There would be no reduction in the availability of submerged vegetation utilized for splittail spawning habitat; there would be no substantial change in frequency of water temperatures within the reported preferred range for splittail spawning.	Less-than-significant impact	Less-than-significant impact
				Lower American River American shad	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for spawning.	There would be no decreases in flows during the May through June American shad spawning period, and no change in the frequency of flows above recommended levels to maintain the American shad sport fishery; there would be no decrease in the frequency of water temperatures within the reported preferred range for American shad spawning.	There would be no decreases in flows during the May through June American shad spawning period, and no change in the frequency of flows above recommended levels to maintain the American shad sport fishery; there would be no decrease in the frequency of water temperatures within the reported preferred range for American shad spawning.	Less-than-significant impact	Less-than-significant impact
			Altered flows in the lower American River (cont)	Lower American River striped bass	Decreases in flow or increases in water temperatures below and above, respectively, thresholds suitable for spawning.	There would be no decreases in flows during the May through June striped bass spawning period, and no change in the frequency of flows above recommended levels to maintain the sport fishery for striped bass; there would be no decrease in the frequency of water temperatures within the reported preferred range for striped bass spawning.	There would be no decreases in flows during the May through June striped bass spawning period, and no change in the frequency of flows above recommended levels to maintain the sport fishery for striped bass; there would be no decrease in the frequency of water temperatures within the reported preferred range for striped bass spawning.	Less-than-significant impact	Less-than-significant impact

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Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region (cont)	Merced and San Joaquin Rivers	Stored Groundwater Purchase	Seasonal changes in the timing of releases from Lake McClure.	Lake McClure warmwater fisheries	Reduction in the acreage of littoral habitat available for spawning and rearing; increase in the frequency of potential nest dewatering events.	There would be no reductions in reservoir water surface elevation; increases in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial changes in the availability of littoral habitat; changes in the rate of drawdown would not be likely to result in a change in the frequency of potential nest dewatering events.	There would be no reductions in reservoir water surface elevation; increases in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial changes in the availability of littoral habitat; changes in the rate of drawdown would not be likely to result in a change in the frequency of potential nest dewatering events.	Less-than-significant impact	Less-than-significant impact
				Lake McClure coldwater fisheries	Reduction in coldwater habitat availability.	There would be no reduction in reservoir storage, and therefore, no reduction in coldwater habitat availability.	There would be no reduction in reservoir storage, and therefore, no reduction in coldwater habitat availability.	Less-than-significant impact	Less-than-significant impact
			Altered flows in the Merced River.	Merced River fall-run Chinook salmon	Decreases in flow of sufficient frequency or magnitude to result in adverse effects on adult immigration, spawning, egg incubation, initial rearing, juvenile rearing, and juvenile emigration.	Flows would not decrease during any month of the year; increases in flows may represent a beneficial effect to adult fall-run Chinook salmon immigration, and would not be of sufficient frequency or magnitude to result in adverse or beneficial effects on adult fall-run Chinook salmon spawning, egg incubation, and initial rearing; there would be no change in flows during the juvenile fall-run Chinook salmon rearing and emigration period.	Flows would not decrease during any month of the year; increases in flows may represent a beneficial effect to adult fall-run Chinook salmon immigration, and would not be of sufficient frequency or magnitude to result in adverse or beneficial effects on adult fall-run Chinook salmon spawning, egg incubation, and initial rearing; there would be no change in flows during the juvenile fall-run Chinook salmon rearing and emigration period.	Less-than-significant impact	Less-than-significant impact

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Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region (cont)	Merced and San Joaquin Rivers (cont)	Stored Groundwater Purchase (cont)	Altered flows in the Merced River (cont)	Merced River striped bass	Changes in flow affecting spawning.	No changes in flow would occur during the striped bass spawning period of May through June.	No changes in flow would occur during the striped bass spawning period of May through June.	Less-than-significant impact	Less-than-significant impact
			Altered flows in the San Joaquin River	San Joaquin River fall-run Chinook salmon and steelhead	Decreases in flow of sufficient frequency or magnitude to result in adverse effects on adult immigration, spawning, egg incubation, initial rearing, juvenile rearing, and juvenile emigration.	Flows would not decrease during any month of the year; increases in flows may represent a beneficial effect to adult fall-run Chinook salmon and steelhead immigration, and would not be of sufficient frequency or magnitude to adversely or beneficially affect adult fall-run Chinook salmon or steelhead spawning, egg incubation, and initial rearing; there would be no change in flows during the juvenile fall-run Chinook salmon rearing and emigration or juvenile steelhead over-summer and fall/winter rearing periods.	Flows would not decrease during any month of the year; increases in flows may represent a beneficial effect to adult fall-run Chinook salmon and steelhead immigration, and would not be of sufficient frequency or magnitude to adversely or beneficially affect adult fall-run Chinook salmon or steelhead spawning, egg incubation, and initial rearing; there would be no change in flows during the juvenile fall-run Chinook salmon rearing and emigration or juvenile steelhead over-summer and fall/winter rearing periods.	Less-than-significant impact	Less-than-significant impact
				San Joaquin River Sacramento splittail	Changes in flow affecting the availability of spawning habitat.	No changes in flow would occur during the splittail spawning period of February through May.	No changes in flow would occur during the splittail spawning period of February through May.	Less-than-significant impact	Less-than-significant impact
				San Joaquin River delta smelt	Changes in flow affecting spawning.	No changes in flow would occur during the delta smelt spawning period of January through June.	No changes in flow would occur during the delta smelt spawning period of January through June.	Less-than-significant impact	Less-than-significant impact

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Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Upstream from the Delta Region (cont)	Merced and San Joaquin Rivers (cont)	Stored Groundwater Purchase (cont)	Altered flows in the San Joaquin River (cont).	San Joaquin River striped bass	Changes in flow affecting spawning.	No changes in flow would occur during the striped bass spawning period of May through June.	No changes in flow would occur during the striped bass spawning period of May through June.	Less-than-significant impact	Less-than-significant impact
				San Joaquin River American shad	Changes in flow affecting spawning.	No changes in flow would occur during the American shad spawning period of May through June.	No changes in flow would occur during the American shad spawning period of May through June.	Less-than-significant impact	Less-than-significant impact
Sacramento-San Joaquin Delta Region	Sacramento-San Joaquin Delta	Crop Idling, Groundwater Substitution, Stored Groundwater Purchase, Stored Reservoir Water Purchase	Increased salvage at the CVP and SWP salvage facilities.	Chinook salmon	Increases in the annual number of Chinook salmon captured at the CVP and SWP fish salvage facilities.	Annual Chinook salmon salvage would decrease; long-term average annual Chinook salmon salvage would decrease; there would be isolated monthly increases in salvage, which would not be of sufficient frequency or magnitude to result in annual increases in salvage in any year.	Annual Chinook salmon salvage would decrease; there would be isolated monthly increases in salvage, which would not be of sufficient frequency or magnitude to result in annual increases in salvage in any year.	Beneficial impact	Beneficial impact
				Steelhead	Increases in the annual number of steelhead captured at the CVP and SWP fish salvage facilities.	Annual steelhead salvage would decrease in 15 of 15 years simulated; long-term average annual steelhead salvage would decrease; there would be isolated monthly increases in salvage, which would not be of sufficient frequency or magnitude to result in annual increases in salvage in any year.	Annual steelhead salvage would decrease; there would be isolated monthly increase in salvage, which would not be of sufficient frequency or magnitude to result in annual increases in salvage in any year.	Beneficial impact	Beneficial impact

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Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Sacramento-San Joaquin Delta Region (cont)	Sacramento-San Joaquin Delta (cont)	Crop Idling, Groundwater Substitution, Stored Groundwater Purchase, Stored Reservoir Water Purchase (cont)	Increased salvage at the CVP and SWP salvage facilities (cont)	Delta smelt	Increases in the annual number of delta smelt captured at the CVP and SWP fish salvage facilities.	Annual delta smelt salvage would decrease in 15 of 15 years simulated; long-term average annual delta smelt salvage would decrease; isolated monthly increases in salvage would be avoided through the real-time implementation of avoidance measures to reduce pumping.	Annual delta smelt salvage would decrease; isolated monthly increases in salvage would be avoided through the real-time implementation of avoidance measures to reduce pumping.	Beneficial impact	Beneficial impact
				Sacramento splittail	Increases in the annual number of splittail captured at the CVP and SWP fish salvage facilities.	Annual splittail salvage would decrease in 14 of 15 years simulated; long-term average annual splittail salvage would decrease; there would be isolated monthly increases in salvage, which would not be of sufficient frequency or magnitude to result in overall annual increases in salvage in more than one year.	Annual splittail salvage would decrease; there would be isolated monthly increases in salvage, which would not be of sufficient frequency or magnitude to result in annual increases in salvage in any year.	Beneficial impact	Beneficial impact
				Striped bass	Increases in the long-term average annual number of striped bass captured at the CVP and SWP fish salvage facilities.	Monthly and annual increases in striped bass salvage would occur, however long-term average annual striped bass salvage would decrease.	Monthly and annual increases in striped bass salvage may occur, however long-term average annual striped bass salvage would decrease.	Less-than-significant impact	Less-than-significant impact

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Region	*Area of Analysis*	*Asset Acquisition Type*	*Result*	*Potentially Affected Resource*	*Potential Effects*	*Flexible Alternative Change from Baseline*	*Fixed Alternative Change from Baseline*	*Significance of Flexible Purchase Alternative*	*Significance of Fixed Purchase Alternative*
Sacramento-San Joaquin Delta Region (cont)	Sacramento-San Joaquin Delta (cont)	Crop Idling, Groundwater Substitution, Stored Groundwater Purchase, Stored Reservoir Water Purchase (cont)	Seasonal changes in the timing of Delta inflow.	Delta aquatic habitats	Decreases in Delta outflow during the February through June period.	Decreases in Delta outflow would not occur during the February through June period believed to be important for rearing and transport of juvenile fish species in the Delta.	Decreases in Delta outflow would not occur during the February through June period believed to be important for rearing and transport of juvenile fish species in the Delta.	Beneficial impact	Potentially beneficial impact
					Changes in position of X2 during the February through June period.	The position of X2 would move downstream or would not shift during the February through June period.	The position of X2 would move downstream or would not shift during the February through June period.	Beneficial impact	Potentially beneficial impact
					Changes in Delta Export/Inflow (E/I) ratio during the February through June period.	Current E/I standards would not be exceeded; use of the relaxation of E/I only would occur if the Management Agencies determine that the risk to sensitive species would be low.	Current E/I standards would not be exceeded; use of the relaxation of E/I only would occur if the Management Agencies determine that the risk to sensitive species would be low.	Beneficial impact	Potentially beneficial impact
					Changes in the frequency and magnitude of reverse flows (QWEST) during the February through June period.	There would be reductions in the frequency and magnitude of reverse flows across all flow ranges, resulting in a potentially beneficial effect to survival of planktonic fish eggs and larvae and downstream migrating juvenile Chinook salmon smolts.	There would be reductions in the frequency and magnitude of reverse flows across all flow ranges, resulting in a potentially beneficial effect to survival of planktonic fish eggs and larvae and downstream migrating juvenile Chinook salmon smolts.	Beneficial impact.	Potentially beneficial impact.

Table 9-75
Fisheries and Aquatic Ecosystems
Summary and Comparison of Flexible Purchase Alternative and Fixed Purchase Alternative Impacts

Region	Area of Analysis	Asset Acquisition Type	Result	Potentially Affected Resource	Potential Effects	Flexible Alternative Change from Baseline	Fixed Alternative Change from Baseline	Significance of Flexible Purchase Alternative	Significance of Fixed Purchase Alternative
Export Service Area	Export Service Area Reservoirs	Source Shifting/All Acquisition Types	Seasonal changes in reservoir water surface elevations.	San Luis and Anderson reservoirs warmwater fisheries	Reduction in the acreage of littoral habitat available for spawning and rearing; increase in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Less-than-significant impact	Less-than-significant impact
				Castaic Lake and Lake Perris warmwater fisheries	Reduction in the acreage of littoral habitat available for spawning and rearing; increase in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Reductions in reservoir water surface elevation would not be of sufficient frequency or magnitude to result in substantial decreases in the availability of littoral habitat or substantial increases in the frequency of potential nest dewatering events.	Less-than-significant impact	Less-than-significant impact

storage and water surface elevation, water temperatures, and various Delta parameters as impact indicators. The following sections discuss the manner in which these indicators may or may not be affected under the cumulative condition.

Within the Upstream from the Delta Region, all five programs (Sacramento Valley Water Management Agreement, Dry Year Purchase Program, Drought Risk Reduction Investment Program (DRRIP), CVPIA Water Acquisition Program, and Environmental Water Program) have the potential to acquire water from the same potential water sources as the EWA. The analysis performed for the Flexible Purchase Alternative was designed to maximize the utilization of available export capacity of Delta facilities, which is the limiting constraint on transfers for these programs. As a result, implementation of one or more of these programs in conjunction with the EWA will alter the beneficiary of the transferred water, but the total supply of water from upstream sources would not be any greater than that analyzed for the Flexible Purchase Alternative. Because transfers under other programs are managed during the same time periods evaluated for the management of EWA assets, these increases or decreases in flows would not be expected to change, relative to levels identified under the Flexible Purchase Alternative.

Water surface elevation and end-of-month storage levels would not be reduced further than those analyzed for the Flexible Purchase Alternative. Thus, reservoir operations under the EWA cumulative condition would not be expected to differ substantially from the conditions described in Section 9.2.5, Environmental Consequences/Environmental Impacts of the Flexible Purchase Alternative, and, therefore, cumulative impacts on reservoir warmwater and coldwater fisheries would be less than significant. Similarly, changes in flows and water temperatures in rivers potentially affected by the EWA cumulative condition also would be similar to those analyzed for the Flexible Purchase Alternative and, therefore, represent less-than-significant cumulative impacts on riverine fishes and their habitats.

In the Delta, potential impacts of the Flexible Purchase Alternative were determined by conducting an analysis based on the maximum utilization of available export capacity of Delta facilities (Maximum Water Purchase Scenario), which is the limiting constraint on transfers for the five programs discussed above, including the EWA Program. Consequently, implementation of one or more of these programs in conjunction with the EWA would not result in additional water conveyed through the CVP and SWP pumping facilities. As described in Chapter 2, water transfers occurring through the Delta under the EWA Program would facilitate associated export reductions to benefit in-Delta aquatic resources. More benefits to fish would be derived from reducing exports from the Delta at key times for fish (EWA actions) than adverse impacts caused by a similar amount of increased export pumping to move the acquired water when fish are not as abundant. Most fish benefits (decreased fish salvage and improved in-Delta aquatic habitat conditions) are provided by the cumulative condition when the Delta pumping capacity for the transfers is utilized by the EWA Program. When some of the transferred water is for a consumptive user within the Export Service Area instead of as part of the EWA Program, there would be no export reductions with that water to benefit fish. A reduction in the volume of water transferred by the EWA Program under the EWA cumulative condition (as would occur under the Typical Water Purchase Scenario) would result in correspondingly fewer overall benefits to in-Delta aquatic habitat and fish salvage than those provided by the EWA cumulative condition under the Maximum Water Purchase Scenario.

The DRIPP, CVPIA Water Acquisition Program, and the EWA Program would operate in the Export Service Area under the EWA cumulative condition. Stored reservoir water is not available for purchase from San Luis, Anderson, Castaic, Perris, Mathews, and Diamond Valley reservoirs in the Export Service Area. In addition, source shifting would only occur under the EWA Program. Source shifting is not likely to occur in dry or below normal years since capacity is not limiting. Sources shifting would occur in wet or above normal years when capacity is limiting. (See Chapter 2, Alternatives, Including the Proposed Action/Proposed Project.)

Source shifting would not be expected to result in reservoir water surface elevations in San Luis, Anderson, Castaic, Perris, Mathews, and Diamond Valley reservoirs lower than those reached under the Baseline Condition. Thus, there would be no reduction in the quantity of littoral habitat available for warmwater fish spawning, and no increase in the frequency of potential nest dewatering events, relative to those levels analyzed under the Flexible Purchase Alternative. Therefore, potential cumulative impacts resulting from implementation of the Flexible Purchase Alternative in the Export Service Area would be less than significant.

As discussed in Section 9.2.6, Environmental Consequences/Environmental Impacts of the Fixed Purchase Alternative, the Fixed Purchase Alternative would involve the same actions as the Flexible Purchase Alternative, but to a lesser degree. Potential cumulative impacts on fisheries and aquatic resources resulting from implementation of the Flexible Purchase Alternative would be less than significant. Therefore potential cumulative impacts on fisheries and aquatic resources resulting from implementation of a lesser transfer amount (the Fixed Purchase Alternative) would also be less than significant.

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